DOCUMENT RESUME

ED 046 221 EM 008 639

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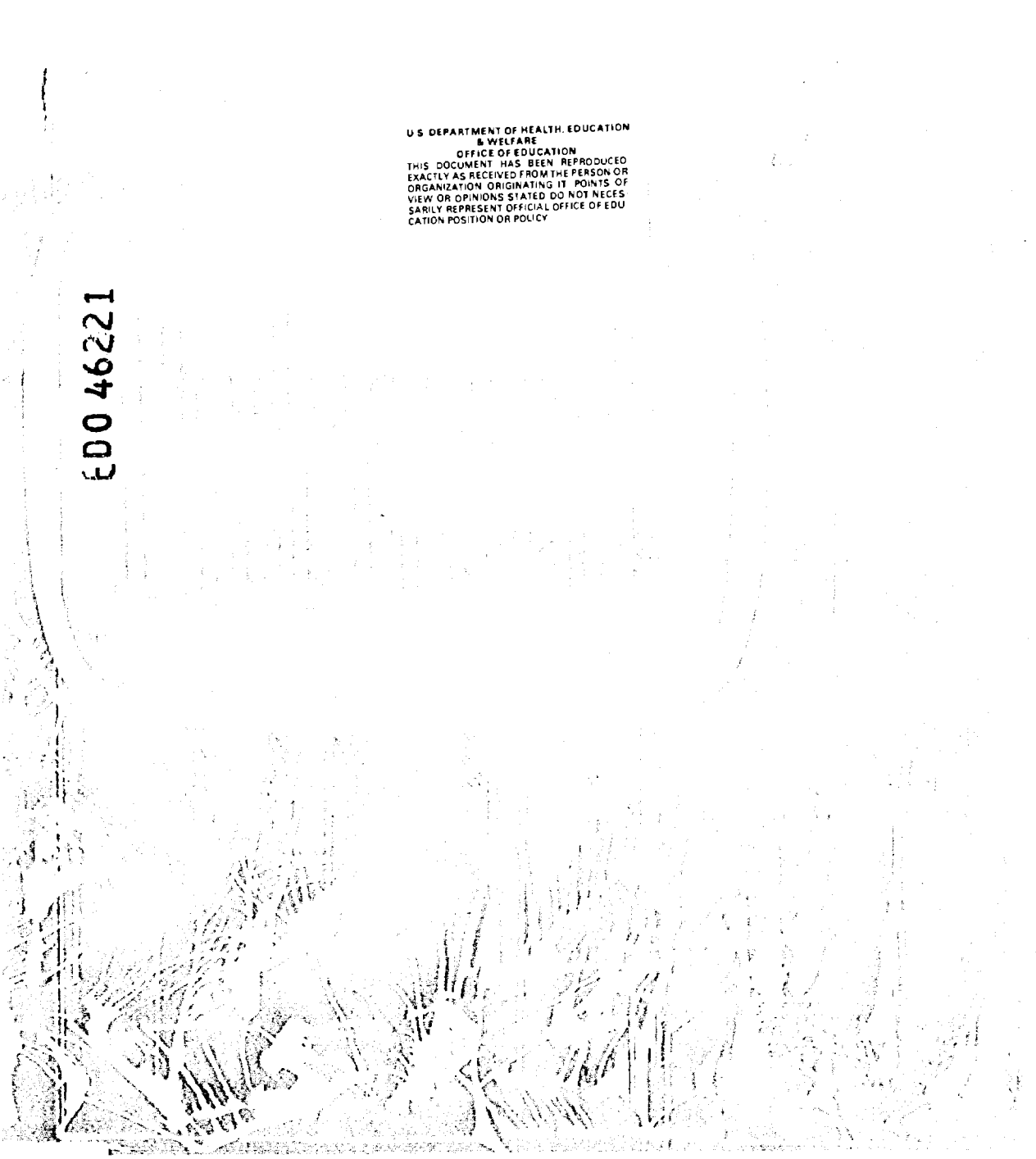
TITLE	An Experiment in Teaching Electronics with Integrated Feedback System.
INSTITUTION	Royal Inst. of Technology, Stockholm (Sweden).
SPONS AGENCY	Swedish Board of Technical Development, Stockholm.
REPORT NO	PE-8
PUB DATE	Jun 70
NOTE	63p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	Diagnostic Tests, *Electronics, *Feedback, *Instructional Television, Laboratory Experiments, Lecture, Multiple Choice Tests
IDENTIFIERS	DIATEST, Electronic Responder Analyser, ESAU, Royal Institute of Technology, Stockholm, *Sweden

ABSTRACT

Brief, motivating television programs, lectures, calculation exercises, and laboratory experiments were integrated to teach a course in applied electronics at the Royal Institute of Technology (Stockholm). The greater part of the learning work was done in the form of independent study checked by diagnostic tests. These tests proved to have an activating effect on the progress of the students, to offer feedback from student to teacher, and to provide a basis for continuous revision of the course material. The integrated teaching has been given to sophomore students at the institute, to teachers at technical colleges, and to industrial engineers. The project comprises the production both of software and hardware. On the software side are teaching models, textbooks, television programs, programed diagnostic tests, examples of circuit calculation, and laboratory experiments. On the hardware side are the program-controlled feedback system DIATEST, which contains equipment for control and display of multiple-choice tests. An electronic responder (ESAU), especially developed for this project, was used for collection of responses. (MF)



REPORT PE-8

AN EXPERIMENT IN TEACHING ELECTRONICS WITH INTEGRATED FEEDBACK SYSTEM

Department of Education, KTH

JUNE 1970

Gunnar Markesjö
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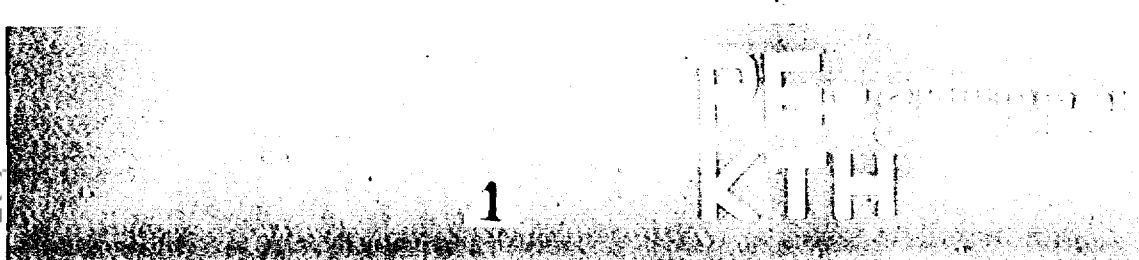

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Report No. PE-8

AN EXPERIMENT IN TEACHING ELECTRONICS WITH INTEGRATED FEEDBACK SYSTEM

June, 1970

Gunnar Markesjö
Peter Graham

This project has been financially supported by the Swedish Board of Technical Development.

Summary

The report describes an experiment in integrated teaching of applied electronics. Programme-controlled diagnostic tests with instantaneous response collection and taped TV programmes have formed an integrated part of the teaching. The integrated teaching has been given to three classes of students at the Royal Institute of Technology (sophmore level, total about 400) and also on concentrated continuation courses for teachers at technical colleges and for industrial engineers. The project comprises the production both of software and hardware.

The software side comprises such items as teaching models (for packaged courses), textbooks, TV programmes, programmed diagnostic tests, examples of circuit calculation, and laboratory experiments.

The hardware side comprises, among other items, the programme-controlled feedback system DIATEST, which contains equipment for control and display of multiple choice tests.

The ESAU responder, specially developed for this project, was used for collection of responses.

Programme-controlled diagnostic tests, which were initially intended as instruments for measuring students' progress, have proved to have an activating effect on their studies. In group teaching these tests permit a direct and effective feedback from student to teacher, and also provide a basis for continuous revision of the course material.

To utilize these advantages of the diagnostic tests, however, high requirements are placed both on test design and on an accurate and detailed specification of course objectives.

Contents

1. INTRODUCTION

The overall aim in the projects that have been and are being run by the PE Group of The Royal Institute of Technology is to find effective methods for teaching of engineering.

Process control of teaching is a conceivable alternative, which seems a natural choice especially for technological subjects. Technical processes are controlled by data which are continuously measured or sampled in different steps of the process. In the same way, of course, it is possible to control teaching processes. In technical processes there are sensitive elements which measure pressure, temperature, quantity etc.; and in teaching process uniquely defined variables are similarly required which can be measured by means of different forms of test and examination.

In technical processes homogeneous basic material is available, but this is hardly so in teaching. The necessity of flexible adaptation to the students' requirements is therefore very much greater in a teaching system The process-controlled teaching system is not intended to be run fully automatically as in technical processes. It is rather an instrument for relieving the teacher of a large part of the routine burden, at the same time as he receives data of his students' performance which enable him effectively to devote his time to individual instruction.

This report discusses the means of replacing conventional lectures by motivating TV programmes and of allowing the greater part of the learning work to be done in the form of independent study checked by diagnostic tests.

2. PILOT PROJECT IN SPRING OF 1968

2.1 Objectives for the pilot project

The role of lectures

Traditionally lectures take up a great part of the scheduled time for technological teaching. But experince shows that, for technological students, lectures are the most passive part of the teaching. The purpose of the lecture has been to transfer knowledge from teacher to student. For large groups of students, however, this transfer of information can be done more effectively through other channels, especially through textbooks and audio visual media.

Hypothesis

We therefore set up the following hypothesis: The information transfer function of lectures can to a large extent be taken over by suitable course literature and their motivating function can be replaced by introductory TV programmes.

Verification of the hypothesis

To verify the hypothesis, a pilot project was instituted covering two classes of students (about 100 in each) taught by two methods, one including certain lectures (Method A) and one altogether without conventional lectures (Method B). In method A, TV programmes were run as repetition of the lecture before the circuit calculation exercise. In method B, TV programmes were run as introduction to independent study. Knowledge has been measured both continuously during the course in the form of programme-controlled diagnostic tests and in the form of normal examinations.

Modified teaching model

An important goal in the pilot project was, on the basis of the experience gained, to set up a modified model, Method C, for the regular teaching of applied electronics. Method C has been tried out in 1969 for the class in E_2 (second-year students, Electrical Engineering) and the results are reported below as project E_2-69.

2.2 Teaching models and course material of the pilot project

Experiments in integrated teaching have been made on the Transistor Pulse Circuits course in the subject of Applied Electronics at the Institute of Technology. (The course earlier comprised 50 h lectures and 34 h circuit calculation exercises.)

Our intentions were to cut down the lecture time to a minimum and replace the lectures by brief TV programmes. This necessitates reinforcement of the activity teaching by calculation exercises and laboratory experiments which are fully integrated with the course, and last but not least a continuous follow-up of the results of study.

To elucidate the role of lectures - or rather the effect of replacing them by introductory and motivational TV programmes - two classes were taught on two different models, Method A and Method B. Fig. 1 shows a comparison between the time schedules for methods A and B and that for the previous course.

	Previous course	Method A 50 % lectures	Method B 0 % lectures
Lectures	2x25	2x10 x)	1x10 xx)
Calculation exercises	2x14	2x10	2x10
Laboratory experiments	2x 3	3x 6	3x 6

x) Every double period consists of 20 min diagnostic test and 70 min normal lecturing.

xx) Consists of diagnostic test, discussion and playback of tape-recorded TV programmes.

Fig. 1 Scheduled time for Transistor Pulse Circuits course.

Method A involves cutting down of the lecturing time by about 50 %, while in method B there are no conventional lectures. In method B there is only a short discussion and questions period immediately following the diagnostic tests.

The cutting down of lecturing time will be compensated for by the tape-recorded TV programmes. Under method A the TV programmes were used for repetition of the abbreviated lecture and at the same time as an introduction to independent study.

The course material was divided into one introductory package and ten course packages with two written examinations, one after package 6, the other after package 11 (Fig. 2).

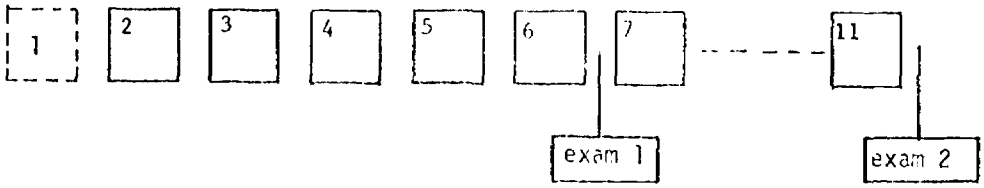


Fig. 2 Division of course into packages and examinations (package 1 is preparatory package for the course).

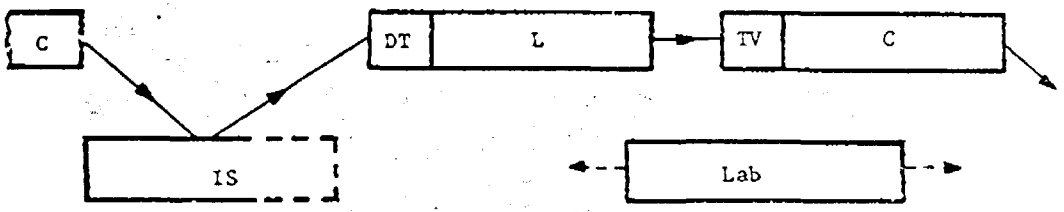
Each package was given a build-up as shown in fig. 3.

The goal for each weekly package was specified in the textbook, App. 1 (see detailed account in Markesjö, G.: Transistorpulskretsar, del 4, Norstedts & Söners Förlag, Stockholm 1968, pp 168-171).

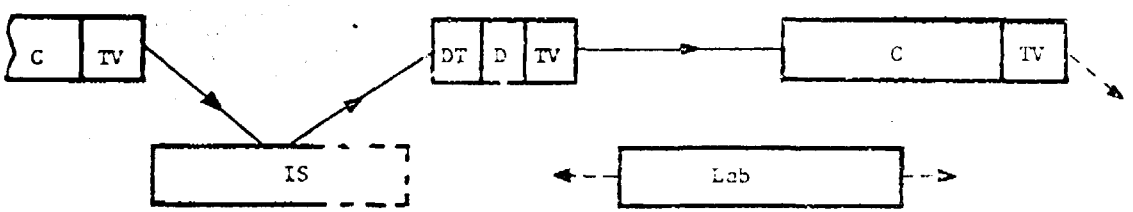
The material produced for the Transistor Pulse Circuits course was as follows:

1. Textbook: Markesjö, G.: Transistorpulskretsar, del 1-4, Norstedts & Söners Förlag, Stockholm 1968 (including examples of exercises in circuit calculation and directions for laboratory experiments)
2. Diagnostic tests programmed for five-screen slide projection (2)
3. TV programmes produced by H. Åkesson, TRU (The Committee for Television and Radio in Education) (11)
4. Exercises in circuit calculation and laboratory experiments. Examples of calculation are included in the Textbook, Part 4. The laboratory experiments were designed by E. Kjelkerud and I. Höglund (4)

Method A: one package



Method B: one package



L = Lecture
C = Calculation Exercise
DT = Diagnostic test
D = Discussion of DT result
TV = Playback of taped TV programme
Lab = Laboratory experiment (only in 6 of the 10 packages)
IS = Independent study (non-scheduled time)

Fig. 3 The course package build-up in methods A and B.

2.3 Design

The experiment followed a design proposed by Professor Åke Edfeldt, TRU Consultant. Each of the two classes was divided into four exercise groups.

These groups were taught in accordance with the scheme in fig. 4, from which it will be seen also how the course was divided into two halves, one comprising packages 2-6, the other packages 7-11.

The Assistant Teachers rotated between the various groups. The grouping was based on ranking of the students according to entrance points. In this way we attempted to have both the teachers' time and the student material uniformly distributed over the four groups.

	Packages 2-6		Packages 7-11	
Group 1	A	T	A	T
Group 2	B		B	
Group 3	A		B	
Group 4	B		A	

Fig. 4 Design for teaching of groups 1-4.
A and B signify teaching method.
T = examination

2.4 Collected data and analysis

The course was moved in 1968 from third year to second year and therefore two classes totaling about 250 students, were taught in accordance with the above models and design. For course E_3 (third year students, Electrical Engineering) which started in mid-February, one package was run per week during the entire spring term. For course E_2 (second-year students, Electrical Engineering) two packages were run per week during the later part of the term.

The following basic data have been collected (variable numbers 1-12 intended for data processing):

No. 1 Military group points from Institute of Military Psychology enlistment test (only group means indicated in this report)

2 Entrance points on application to Institute of Technology

3 Attitude test points after half of course

4 Attitude test points at end of course

5 Attendance during packages 2-6

6 Attendance during packages 7-11

7 Diagnostic test points, packages 2-6

8 Diagnostic test points, packages 7-11

9 Examination points, Calculation Problems, packages 2-6

10 Examination points, Theory, packages 2-6

11 Examination points, Calculation Problems, packages 7-11

12 Examination points, Theory, packages 7-11

Collected basic data have been analysed in a computer and by other means. Basic data have been stored on punched cards, one card for each student. BMD programmes programmed for IBM 360-75 have been used.

A full description of the analysis will be found in Report PE-4.

2.5 Results

No significant difference between methods A and B was measured in respect of examination results. This will be seen from App. 2a. The same applies to the diagnostic tests (App. 2b).

For class E_2 there is according to App. 2b a correlation factor of the order of 0.3 between the examination result (Practical Calculation Problems and the diagnostic tests.

The correlation between results of diagnostic tests and examination (Theory is negative for E_3. This is because class E_3 was credited with the diagnostic test results as points towards the theoretical examination. Students with good results in diagnostic tests, therefore, did not answer the theoretical questions in the examination but devoted all of their time to the calculation examination.

The final result of the pilot project as regards learning may be summarized as follows:

1. Methods A and B yield the same examination results, which indicates that lectures (as in method A) fulfil no major purpose provided that textbooks are available and that the students can be kept active by means of diagnostic tests.

2. A weak but positive correlation factor (approx. 0.3) exists between the results of diagnostic tests (of multiple choice type) and the calculation examination.

2.6 Attitudes, Spring Term 1968

The object of teaching is not merely to pass on a given quantity of factual knowledge. In the long run its value lies to a large extent in the interest aroused in the subject, its principles and methods, and the technique required to gather new information about the subject-field.

The results of teaching can then not be measured only by examinations (whether of theoretical or practical calculation type). Attitude measurements are therefore a necessary complement to pure measurements of knowledge.

The students in the pilot project in the Spring Term 1968 were given two attitude tests, one after package 6 and one after package 11. The tests were fairly comprehensive and are described in detail in Report PE-4. The results of 5 of the 40 questions in the tests are shown in App. 3. The results from E_2 and E_3 are added together.

Question 1 shows a very positive attitude for the detailed course specification. A course can be specified in the form of "content objectives" or "behaviour objectives". Even if the latter is best in principle, the students are greatly assisted by a detailed specification of content objetives issued in advance.

Questions 2 and 3 show that the TV programmes, in the form we have given them, are more suited as introduction than for direct learning. As students differ in the lengths of time needed for learning, learning can hardly be programmed groupwise from a TV screen (unless use is made of a block field or controllable interuptions). The result is therefore not unexpected.

Question 4 shows the need for an extra lecture period (or discussion) after the diagnostic test in method B. In the design of method C attention has been paid to the attitude results of questions 3 and 4.

Question 5 shows the difficulties of combining activity teaching and preproduced TV programmes. The programmes were of an introductory and motivational character and therefore provide too little concrete a basis for exercises in circuit calculation. Different means of building feedback into calculation exercises and laboratory experiments will be dealt with in a special research project in 1970/71 (financed by the Chancellor of the Universities).

3. MAIN EXPERIMENT E_2-69

3.1 Goals and models

The objective of the teaching experiment in Transistor Pulse Circuits was to attain a practically usable model for electronics teaching. On the basis of the experience from the pilot project in the spring term 1968, in which some different models were tried out, a revised model was drawn up for use in the regular teaching in the spring term 1969, Method C.

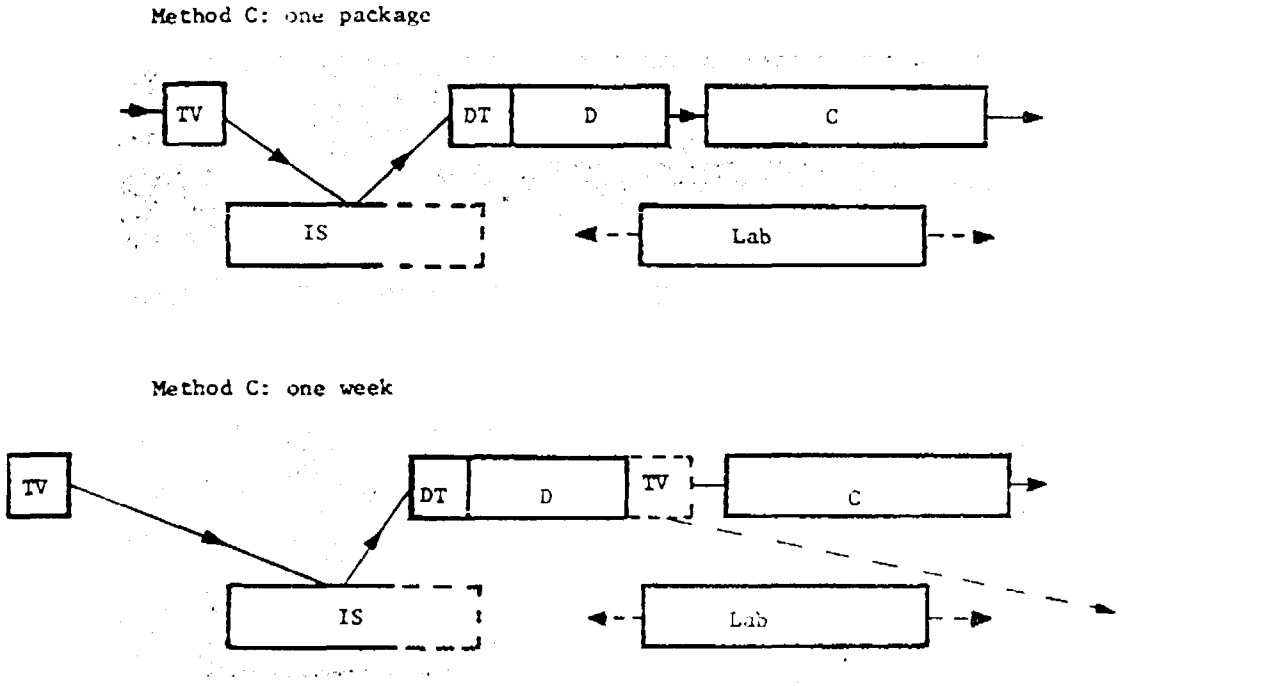
Method C has been designed with regard both to the results of the attitude tests and to the experience gained from the earlier models.

The diagnostic tests were initially intended only for measurements, but soon came to be an integrated part of the learning situation. The posing of well prepared questions, which all students had to answer and thus became actively engaged, while the teacher could directly read the result, proved to be both an effective and popular form of teaching.

As, according to attitude questions 2, 3 and 4 (App. 3), in method B the students preferred to have an extra lecture period and in method A they did not wish to have a repetition of the TV programme, the repetition was eleminated and replaced by a prolonged discussion of the diagnostic test. This then became method C.

To fit this method into the schedule, the TV programme for the following weak is shown at the end of the 2-hour period (normally devoted to lectures allotted for the diagnostic test and its discussion.

An attempt in E_2-68 to run two packages a week was not very successful, for which reason one package a week was run during the 12 weeks of the spring term 1969.



L = Lecture
C = Calculation Exercise
DT = Diagnostic test
D = Discussion of DT result

TV = Playback of taped TV programme
Lab = Laboratory experiment (only in 6 of the 10 packages)
IS = Independent study (non-scheduled time)

Fig. 5 The course package build-up in method C.

3.2 Design

In view of the goal for the main experiment, this experiment was designed as a single-group experiment. Experience from the spring term 1968 had shown that the rotation of the assistant teachers and the division of the examination into two parts had very negative effects on the students. The only special measurements that were made were two attitude tests, one about midway through the course and one at the end. Otherwise a compilation was merely made of available data such as attendance, diagnostic test points and results of examinations.

3.3 Primary material from E_2-69

The course has been a regular item for about 150 students in E_2 during the spring of 1969. Continuous measurements have been made in the form of diagnostic tests (DT). The final result was measured by an examination. The examination was divided into two parts: a calculation part with 4 circuit-calculation problems and a theoretical part with 30 multiple choice questions. The multiple choice questions are of the same character as the DT questions but rather more difficult.

For the analysis the basic data were divided into the following variables:

No. 1 Attendance at diagnostic tests
2 Attitude test 1, question 1
3 " " 1, " 2
4 " " 1, " 15
5 " " 2, " 1
6 " " 2, " 11
7 " " 2, " 21
8 Entrance points to Institute of Technology
9 DT results = total points in tests
10 Examination, practical calculation
11 " , theoretical
12 " , total points
13 DT/N, mean result of DT
14 Preparation time I
15 " II

Basic data are tabulated in App. 5.

A detailed specification of the variables is given below.

No. 1 indicates the number of answered diagnostic tests and varies between 00 and 12.

2-7 are attitude points on the following scale: a = 5, b = 4, c = 3, d = 2, e = 1, absent = -1.

2 question 1:1
5 " 2:1

What is your overall impression of this TV teaching compared with average conventional teaching?

a. much better
b. rather better
c. neither better nor worse
d. rather worse
e. much worse

3 question 1:2
6 " 2:11

As aid for independent study the diagnostic test were

a. very good
b. fairly good
c. neither good nor poor
d. rather poor
e. very poor

4 question 1:15
7 " 2:2

I considered the calculation excercises

a. very good
b. fairly good
c. neither good nor poor
d. rather poor
e. very poor

9 DT points. Every correctly answered question gives 1 point. Wrong answer 0 point. The variable comprises the total points from all tests and may vary between 0 and 84. Total absence = -1.

10 The practical examination consists of 4 problems, each of which gives 0-10 points. Examination paper not handed in = -1.

11 The theoretical examination consists of 30 multiple choice questions. Correct answer 0.5 point. The points may vary between 0 and 15. Examination paper not handed in = -1.

12 Total practical and theoretical points. May vary between 0 and 55. Examination paper not handed in = -1.

13 DT/N = mean result of diagnostic tests.

14 AI:13
15 AII:19

In preparation for each weekly package I have read on an average

	Scale
a. 0 - 14 min	1
b. 15 - 29 min	2
c. 30 - 59 min	4
d. 1 - 2 h	8
e. > 2 h	16

Absence from attitude test indicated by -1.

3.4 Analysis

For analysis of the basic data they have been punched on cards (App. 4). BMD programmes have been used for the statistical analysis.

The following analysis were made:

(3.5) Correlation of basic data for all 186 students starting the course

(3.6) Study of the significance of attendance for the result of study by breakdown into three attendance groups.

3.5 Correlations between basic data

Large parts of the teaching at the Institute of Technology do not involve compulsory attendance. It is therefore not necessary to attend all or a specific number of diagnostic tests or exercises in the Transistor Pulse Circuits course. Certain basic data are thus lacking.

This must be taken into account in the analysis. In the calculations of correlation we have used a special programme - BMD 03D, Correlation with item deletion - so that all available data have been used. Therefore different numbers of individuals are included in the various calculations of correlation.

It is of interest to see how attendance, DT points and preparation time influence the result of the examination.

In the first place it may be said that the highest correlations can be easily explained, since one variable is included in another, e.g. between attendance (1) and DT total (9) or between examination, practical (10) and examination, total (12).

One might perhaps expect that both attendance (1) and high points in the diagnostic tests (13) would be reflected in the theoretical examination (11), which consists precisely of questions of DT type, but this is not the case. (1) and (13) correlate instead with the practical examination. A conceivable explanation is that those who do well in DT are generally good at electronics and those who get poor DT results spend more time reading up the subject, i.e. the feedback from DT functions.

The correlation between DT (13) and the attitude to DT (3) and (6) increases during the course, which may indicate that it takes some time to become accustomed to the method of testing.

Entrance points to the Institute (8) and DT points (13) both correlate with the examination (12), but not with one another, which may indicate that they are measures of different kinds of ability.

The objective of working just hard enough to get through is revealed in the negative correlation between entrance points (8) and preparation time (14, 15).

In general the course does not appear to match up to the qualifications of students who have high entrance points. Their negative attitude (2) is reinforced during the course (3).

If the feedback mechanism with DT functions, there should be no correlation between preparation time (14, 15) and result of examination (12). The correlation is also non-existent in this case. The very low correlation between DT (13) and theoretical examination (11) points in the same direction.

3.6 Influence of attendance

When a package course has been prepared, with all subject-matter specified to particular pages in the textbook, one may question whether the students learn the course thanks to or despite the teaching.

In our case it is interesting to study the degree to which a high level of attendance at the diagnostic tests and discussions leads to a better result in examinations.

To study these questions we divided the material into three roughly equalsized groups in respect of attendance:

group 1 with attendance 1 - 3 times
" 2 " " 4 - 7 "
" 3 " " 8 - 12 "

With the BMD programme 07D an analysis was made of the distributions of the various variables and of the correlation within the groups, and the inter-group difference was calculated.

Missing data were excluded in the same way as in the calculations of correlation with BMD-03D.

Some of the group distributions of the variables are shown in App. 7.

The result of the analysis shows that there is a significant difference between the groups in the practical examination and also in their attitude to the satisfactoriness of the calculation exercises, at least at the beginning of the course (App. 7).

Those with a high level of attendance at the diagnostic tests do better in the practical examination than those with low level of attendance.

One may thus presume that the teaching in the form of DT and discussions has had the desired positive effect on learning.

There is a clearly significant positive correlation between the DT results (13) and attendance.

Comparing the correlation between DT (13) and theoretical examination (11) within the three groups, it is found that group 1 (low attendance) has a negative correlation (-0.40), group 2 slightly positive (+0.20) and group 3 (high attendance) positive (+0.50). A high level of attendance thus yields better results in examinations both during and at the end of the course.

Studying the attitudes to the usefulness of DT (3) and (6) one finds that those who take part in many DT become more positive to DT as the course proceeds.

3.7 Attitudes from E_2-69

Two attitude tests were run during the spring term 1969, one in February after package 5 (AI) and one in May at the end of the course but before the examination (AII). The results of the tests with distribution of answers are shown in App. 8.

The general attitude to the course (I:1, II:1) is positive, even if the positive attitude falls off somewhat during the course. This is a familiarization effect which was noticeable also in the 1968 pilot project.

The diagnostic tests are considered to function well (I:2, II:11). On an average they motivate the students for about 1 hour of preparatory work (I:13, II:19), consisting of reading through the week's material (I:14, II:20, II:10). Considering that students normally read up the courses just before the examination, this is a remarkable result.

One reason for this time devoted to independent study was the clear course specification with page references for each package. This course specification was considered a very positive factor and was put to thorough use by the students (II:3).

A more detailed comparison is given below between the questions in the first and second tests. Some questions relating to the diagnostic tests form part of a special report to be issued later and are therefore not commented on in detail at the present juncture.

Comparison between attitude tests I and II for E_2-69

I February	II May	Comments
Question No.		
1	1	The total impression of the course is positive, though slightly less so towards the end of the course
2	11	DT are satisfactory; more positive attitude at beginning than at end
3	7	Pace of TV programmes rather too fast, especially towards the end of the course
4	8	Quantity of information in the TV programmes reasonable
5	9	The adaptation of the TV teaching to the students' level of knowledge is considered to diminish during the course. This may be because the difficulty of the course increases towards the end.
6	-	The TV programmes are considered rather too short.
7	12	Five-screen slide projection better than TV for display of diagnostic tests
8	15	The time allowed for answering of the diagnostic test questions was at large considered to be sufficient.
9	16	DT should be commented on preferably by going through each alternative, including the distractors.
10	-	If a package were to be repeated, the only preference is for the conventional lesson. This may be because the course is rather too difficult and would therefore need more explanation.
11	25	The usefulness of the laboratory exercises was considered quite satisfactory, an opinion which was reinforced as the course proceeded.
12	27	The difficulty of the laboratory experiments was considered reasonable; their difficulty should perhaps be increased as the course proceeds.
13	19	The average preparation time, 1 hour, diminishes slightly during the course.
14	20	The motivation for preparatory work shifts slightly from "to get through DT" to "normal method of study".
15	21	The calculation exercises were mediocre but improved.
-	3	The course specification was of great use.

I February	II May	Comments
Question No.		
-	4	The calculation exercises and laboratory experiments are
-	5	the elements which chiefly need to be improved.
-	6	The theoretical part of the TV programme should be repeated before the calculation exercises.
-	10	DT necessitate some preparation before the lesson, and this is considered a positive factor by many students.
-	13	The feedback from DT is considered to function.
-	14	
-	17	Practically no student is disturbed by the fact that the others can see his DT score during the test.
-	18	Easy to follow one's own score on the ESAU display.
-	22	The calculation exercises should possibly contain more theory.
-	23	The calculation exercises have covered a reasonable number of problems.
-	24	The difficulty of the calculation exercises has been moderate to rather too difficult.
-	26	A generally reasonable number of laboratory experiments.
-	28	The students have received sufficient help in the laboratory experiments.

3.8 Experience from use of different response collection systems

In the development of teaching models and systems the feedback technique is of the greatest significance. There are different types of feedback from the diagnostic test:

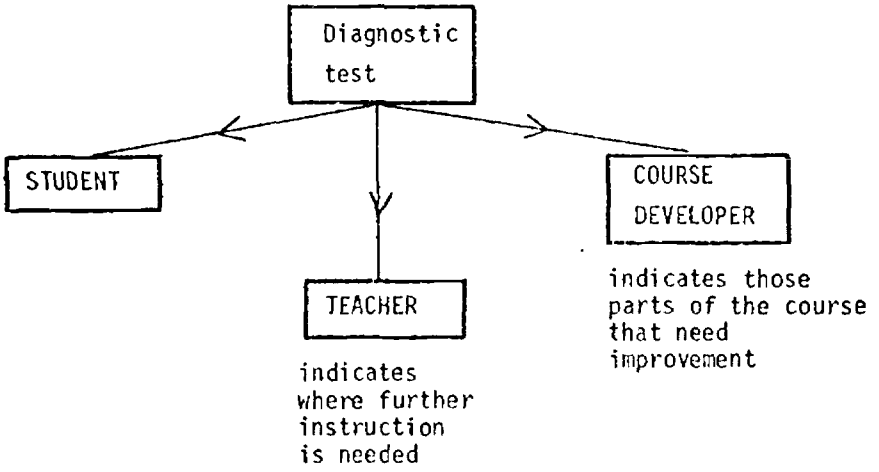


Fig. 6 The diagnostic tests give three types of feedback.

1. to students, who can thereby better plan their studies
2. to the teacher, who can thereby give both better individual and group instruction
3. to the course developer, who thereby obtains an effective basis for revision of the course material.

To obtain feedback, suitable measuring data must be collected and processed into an interpretable result.

In the integrated teaching of applied electronics the actual measuring instrument has been developed in the form of programmed diagnostic tests of multiple choice type (2).

There are several ways of collecting the answers from these tests. The choice of method will depend on the type of feedback desired and the cost that can be accepted.

The types of response collection that we have used are:

1. Template-corrected answer forms
2. Respondex, Elopin system (multiple choice mentometer type)
3. ESAU, electronic responder with individual response collection
4. Optically read response cards for correction in a computer (Service Group for Optical Scanning, SOL, former KLP Group).

In the first term in which the course was used the main object of the tests was to collect data for evaluation of the function of the TV programmes in the teaching model under trial. We then used template-corrected answer forms, the result from one week being discussed in the following week. Correction and item analysis were done by hand and took rather a long time.

But it soon became clear that some form of instantaneous electronic response collection would be desirable for quicker feedback.

A specification for an electronic responder (ESAU) was then drawn up in collaboration with Gerhard Westerberg, who later developed the prototype of ESAU, the cost of which were borne by the TRU Committee.

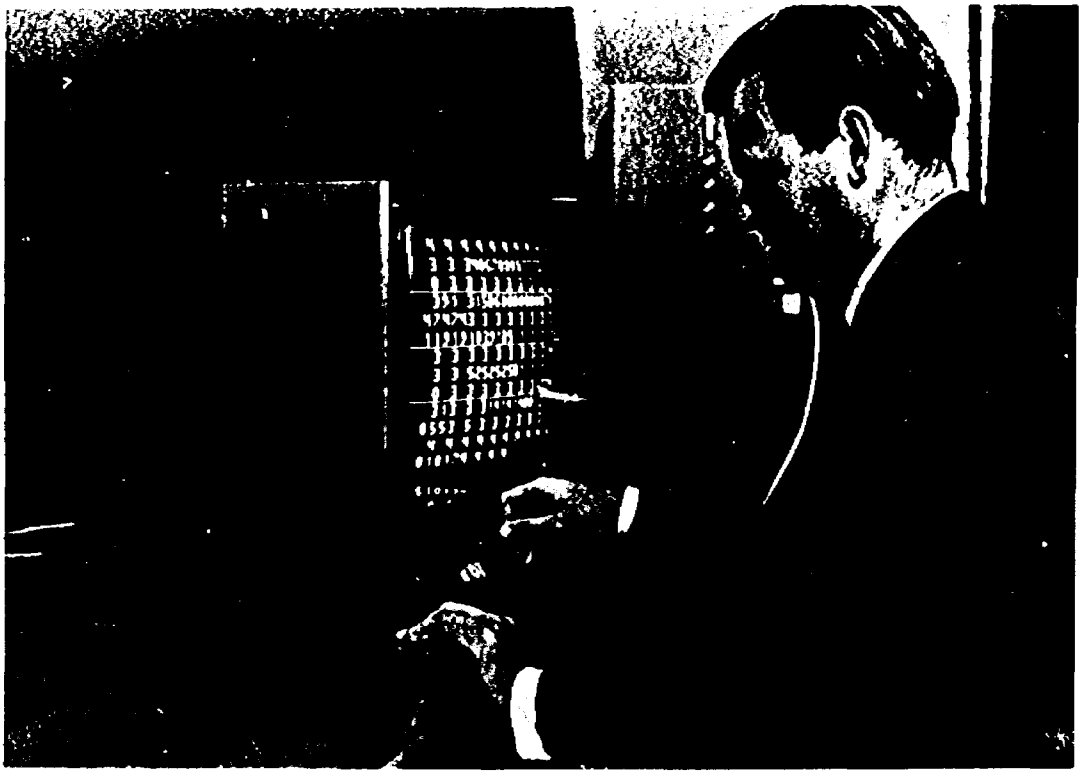


Fig. 8 The electronic responder ESAU with central unit and TV-display. The central unit is here operated by the designer Gerhard Westerberg.

ESAU was used for the first time on a refresher course for teachers in August 1969 and met with a very positive reception. The diagnostic tests met with a very favourable response in their attitude test. The teachers also expressed a desire to use the DT technique in their own classes.

Another system, Respondex, was used for the same group of teachers. This merely shows the numbers of answers under each alternative, which suffices for the student and teacher, but one loses the information for the item analysis which is of value to the question designer.

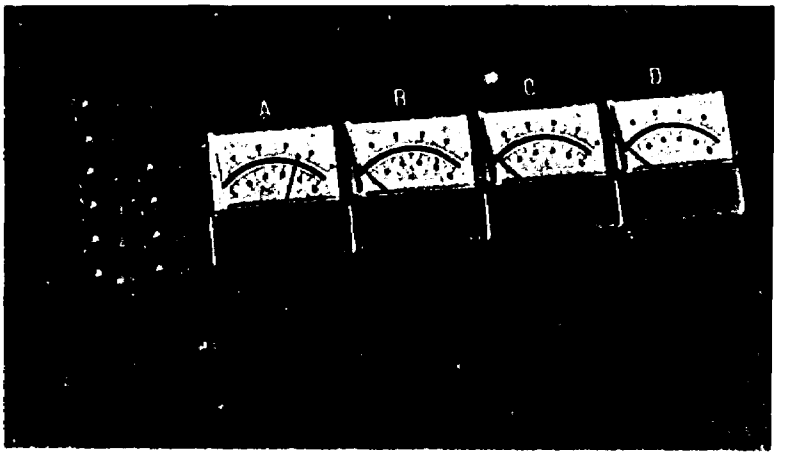


Fig. 9 The Respondex system only gives total scores on each alternative A - D.

ESAU was then used on a regular basis in the Transistor Pulse Circuits course in the spring term 1969. The quick recording of answers meant that the DT questions could be used in a new and more active manner. Each question was immediately followed by comments on the correct alternative and the distractors.

The time taken on discussion of each question was adapted to the result, and more time could therefore be given to unclear points. To facilitate the running of the tests, a control system was developed which both controlled the display of questions and issued scanning orders to ESAU. The new system, DIATEST, was run with good results during the autumn of 1969 for E_3 in the linear course.

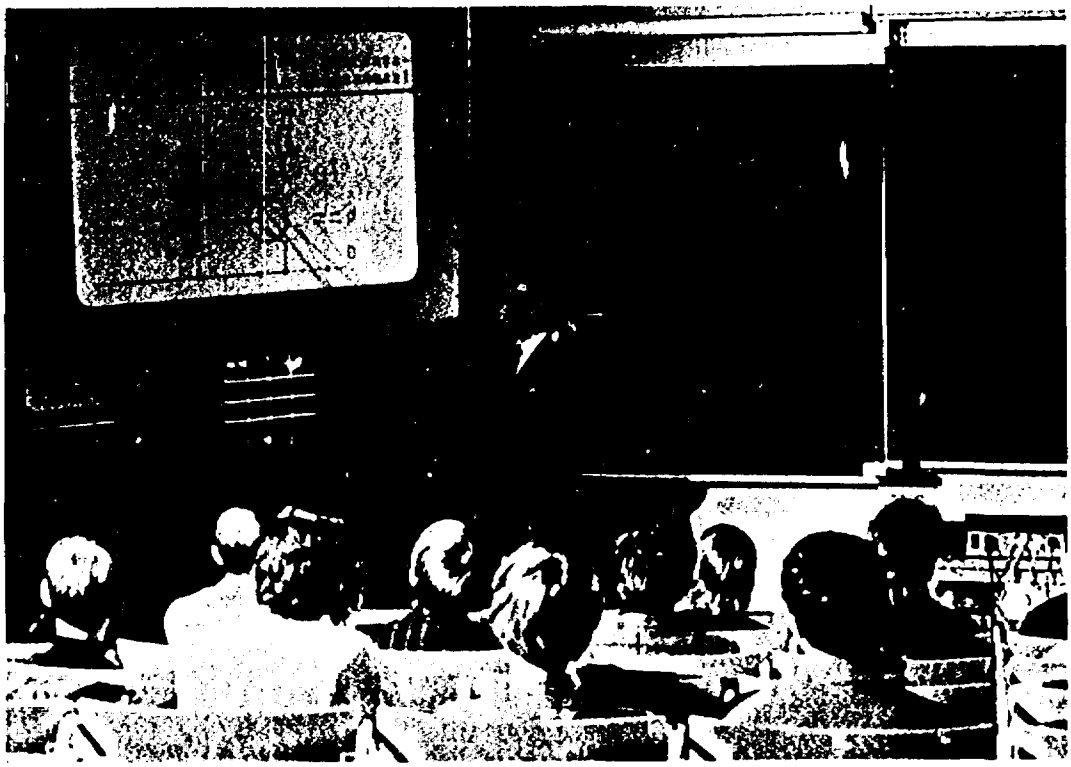


Fig. 10 A diagnostic test run with ESAU. After each question the alternative answers are discussed in detail.

One might think that courses based on well programmed material and containing diagnostic tests for check of learning would run pretty well under their own steam. That this is not so is shown by the Transistor Pulse Circuits course in the spring of 1970. The course was run with temporarily deputizing teachers (four teachers took part) and with different types of response collection in the diagnostic tests, as during certain periods ESAU was unavailable, being under trial for other assignments.

At half-term the students reacted against this arrangement and demanded - and obtained - the conventional lecturing.

A contributory reason may be that the course is relatively difficult, as shown also by attitude tests in previous years.

The attitude to this course indicates that programmed courses with DT require accustomed teachers and sufficient time for the students to become familiar with the apparatus.

Responder systems of ESAU type are probably still too expensive for the broad educational market, and in particular they are not available in schools today, so that other forms of response collection must be used.

The same applies to the examinations which we have run with multiple choice questions, in which the cheating risk is all too great with ESAU. We have therefore used the SOL (Service Group for Optical Scanning) system with optically read answer forms which are processed in a computer. The correction programme includes an extensive item analysis.

The design of good questions is difficult and takes much time. We have therefore developed a questions bank in which the questions and their item analysis are collected. New questions are successively added to the bank in collaboration with other institutes. The work on the questions bank will be dealt with in a separate report.

Fig. 11 Next page shows an example of an answer form for optical scanning used by the SOL Group.

SERVICEGRUPPEN FÖR OPTISK LÄSNING

NAMN (texta)

SOL 1051 — SIBAM 846-51066

1051 Svarsblankett

Gör jämna och kraftiga markeringar mellan de streckade linjerna.
Använd blyertspenna nr 2 eller HB.
Obs. att bläck-, kul- eller filtpenna EJ får användas.
Försök undvika raderingar. Ev. raderingar skall göras noggrant med radergummi av plasttyp.
För varje uppgift skall genomgående endast ett alternativ markeras. Dubbelmarkeringar räknas som blankt svar.

PERSONNUMMER

TYP 0 1

GRUPPKOD

1	2	3	4	
5	6	7	8	
9	10	11	12	
13	14	15	16	
17	18	19	20	
21	22	23	24	
25	26	27	28	
29	30	31	32	
33	34	35	36	
37	38	39	40	
41	42	43	44	
45	46	47	48	
49	50	51	52	
53	54	55	56	
57	58	59	60	
61	62	63	64	
65	66	67	68	
69	70	71	72	
73	74	75	76	
77	78	79	80	
81	82	83	84	
85	86	87	88	
89	90	91	92	
93	94	95	96	
97	98	99	100	
101	102	103	104	
105	106	107	108	
109	110	111	112	
113	114	115	116	
117	118	119	120	

4. ECONOMY

The PE Group project with "integrated teaching of Transistor Pulse Circuits" must be regarded as a research and development project of new and partially untried methods. The costs of the project can therefore not be said to be representative of regular teaching with integrated feedback and computer follow-up of the results.

To give some idea of the costs and investments involved in a development project of this type, the six largest items of expenditure are tabulated below.

		1000's of kronor
1.	Swedish Board of Technical Development grant for development of methods	225
2.	4 textbooks at 50,000 kr	200
3.	ESAU prototype, cost borne by TRU Committee	100
4.	15 TV programmes at 15,000 kr	225
5.	TV installations (Chancellor of the University) approx.	150
6.	New investment in laboratory (oscilloscopes) (Institute of Technology and Division of Applied Electronics)	100
	Total approx.	1 million kr

The investments made in this project by different organizations and companies have brought a dividend in different forms.

1. The Swedish Board of Technical Development grant was necessary for the development of methods and follow-up of knowledge and attitude results in pilot and main projects. The methods have partially served as a pattern for other projects at the Institutes of Technology in Stockholm and Lund. Programme-controlled multiple choice systems are now used within the Divisions of Physical Metallurgy and Electrical Engineering at the Institute of Technology in Stockholm, and packaged courses have been further developed at the Division of Applied Electronics at the Institute of Technology in Lund.

   Programme-controlled diagnostic tests were originally introduced as a measuring instrument in the TV teaching of Transistor Pulse Circuits, but are now an integrated part of the teaching.

The methods for diagnostic follow-up have been tested on a large scale in a project run jointly with the Swedish Broadcasting Corporation and the teaching aid producing company Läromedelsförlagen.

As appears from the half-year report of the PE Group (Jan. - June 1970) the methods developed have met with a great interest both among technicians (for continuation courses within industry) and among educationalists. The methods have been presented at a number of conferences and in lectures at the request of various interested parties.

The development project may therefore be said to have a value as a model for similar teaching systems, which justifies the grant made by the Board of Technical Development. This grant represented a forward-looking investment in a field in which the Board had earlier had little experience.

2. Ninety per cent of the textbooks have been sold outside the Institute of Technology, which justifies the publisher's investment.

3. The firm Lumalampan has taken up the manufacture of ESAU, which will partially compensate the TRU Committee for its investment in the prototype.

4. The TV programmes have been used at the Institutes of Technology in Stockholm, Linköping and Lund. Several upper secondary schools (Class 4, Telecommunications Line) could have made use of these programmes. Unfortunately these schools have been unable to obtain copies of the tapes from the TRU Committee (although no copyright objection exists). From the economic aspect it is regrettable that the TV production as early as February 1968 has not been put to wider use despite a considerable demand.

5. The installation of TV monitors, cabling, video tape recorders and intercom telephones in lecturing rooms in the old Electrical Engineering wing at the Institute of Technology must be partially regarded as a test of suitable equipment and cannot be charged in its entirety to the teaching of applied electronics. The installation has later been used for regular TV teaching also of other subjects.

6. The change to parallel running of the laboratory experiments in applied electronics was done on pedagogical grounds. This investment would soon have become necessary even if no development project had been under way. The role of the TV project in this respect was chiefly to accelerate an inevitable investment.

5. FINAL SUMMING UP

The experiment in integrated teaching of Transistor Pulse Circuits shows that lectures can very well be replaced by introductory TV programmes and independent study checked by diagnostic tests. A condition for effective integrated teaching is a clearly formulated course specification and carefully designed diagnostic tests. To facilitate the teacher's work these tests should be programme-controlled and there should be means for quick correction.

Properly designed diagnostic tests can be used by the student for checking the results of his studies, by the teacher for adjusting his teaching to the needs of the students, and by the course developer for revising the course material. Automatic methods for display of questions, recording of answers, and data processing of the results are essential if the teaching is to be process-controlled.

Experience from the programme-controlled DIATEST system has been very promising in this respect.

Altogether three classes of technologist students have taken part in the experimental teaching. Preliminary results from the two courses in the spring of 1968 have been published in the PE Group Report PE-4 (in Swedish), and the DIATEST system has been described in Report PE-7 (in English). The ESAU response analyser has been dealt with in two articles [6, 7].

In a later project - a report of which is expected to be published in the autumn of 1970 - experience will be given of an experiment in process-controlled teaching on a large scale in Class 4 of upper secondary school.

A third project may possibly deal with the means of measuring activity and creativity elements in the teaching process. Such measurements consitute a condition for a more just evaluation of the work done by students and of the results of their studies.

6. REFERENCES

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Appendices

1. Course specification

2a. Examination results, Spring Term 1968

2b. DT results and correlations, Spring Term 1968

3. Attitudes from pilot project, Spring Term 1968

4. Positions of basic data on punched card, E_2-69

5. Primary data from E_2-69

6. Correlation matrix for E_2-69

7. Data stratified on variable No. 1, attendance

8. 1. Attitude test I, February 1969
   2. Attitude test II, May 1969

Course specification

Kurs-paket Nr	Behandlar	Tentamen sidorna	Summa sidor	På övningar räknas	Laborationer	Förberedelse laborationen sidorna
1	Halvledardioden	499—530	32	2.02		
2	Transistorns statiska egenskaper	530—535, 541—551, 9—23	35	1.01, 1.18	1	9—18, 530—535
3	Transistorswitchens dynamiska egenskaper	24—45	22	1.03, 1.09, 1.15	2	19—45
4	Dellinjära modeller	67—78	12	3.07, 3.08, 3.09		
5	Dellinjära beräkningar	79—89	11	3.02, 3.03, 3.05		
6	Dellinjärt med jam	90—99, 149—164	24	3.01, 6.01, 6.03	3, 4	79—84, 90—94
7	Vippan i princip	103—115, 122—124, 129—145, 169—176, 197—207, 213—220	49	4.01, 8.01, 9.01		
8	Räknare och skiftregister	176—191	16	14.01, 7.02, 7.03	8, 9	169—188
9	Logik-kretsar	315—360	46	14.05, 14.06, 14.07		
10	Linjära svep	361—382, 277—295	42	13.02, 13.03, 13.09	12, 13	277—293
11	Likriktare	389—409	21	15.01, 15.14, 15.17		
12	Effektomvandlare	415—457, 413—451	82	16.02, 16.03, 16.05	15	426—455
13	NR-element	613—639, 233—250	45	11.01, 11.02, 11.05		
14	Tyristorkopplingar	457—479	23	17.01, 17.05	16	471—477

TV-program

TV 1: Tillverkning av små dioder på HA O. Diodekvationen. Diffussionsladdningen. Vätskemodellen.

TV 2: Telestyrelsen, relaer, transistorswitchar. Relämaskin. Besk, IBM 360, MOS-register. ADA på KTH. Rela — transistorswitch. Transistorns grundekvation. Bottning.

TV 3: GE:s datamaskin i Västerås. Basladdning. Oscilloskopdemonstration. Vätskemodellen. Spärrskiktskapacitanserna.

TV 4: Dellinjära element. Urladdning av C.

TV 5: EGAP på IBM i Västerås. Dellinjär transistormodell och kapacitiv last. Kapacitiva belastning-fallet.

TV 6: Pace-maker operation på Karolinska. BH-kurvan. Mattning med dellinjär modell. Blockingoscillatorn.

TV 7: Pippi, spolapparaten och fluidistorn. Icke-opererastabil, monostabil och bistabil. Mångtydiga funktioner. Tyristorkretsen.

TV 8: Vätskevippan, triggning. Binärräknaren. Skiftregistret. Principen för en styrautomat. Transistorgruppens elektron-strålefräs med styrautomat.

TV 9: Logikfunktioner. Besök på SAAB, D-1, D22 och CK37. Diagram.

TV 10: Definitioner. Svepets princip. RC-svepet och GR-svepet. Decca Radar. Miller-svepet.

TV 11: Princip, kopplingar och komponenter. Stora dioder från ASEA. Approximationer vid kondensator- och drosselingång. Ohtronix-likriktaren. ASEA-likriktaren. Stabiliseringskopplingar i princip.

TV 12: Grundtyper. LS-omvandlare. Telestyrelsens omvandlare. Mottaktkopplade omvandlare. Besök hos AE-Transistor. Likriktning under återgång. Likströmsbrytare.

TV 13: PNPN-strukturen. Tillslag av tyristor. Vippspänningen. Tyristorns diagram. HAO:s tyristortillverkning. Avalanche-transistorn. Samplingoscilloskopet.

TV 14: Jämförelse tyristor — transistor. Begränsningar. Laststyrning. Dubbeldiodlocken. Pendeltågen, ASEA. Diac och Triac.

Examination results, Spring Term 1968

	Exam 1		Exam 2		
Group	$\bar{x}$	σ	$\bar{x}$	σ	n
1	1.13	0.48	1.06	0.52	20
2	1.16	0.43	1.08	0.68	20
3	1.16	0.40	0.96	0.70	20
4	0.97	0.44	0.90	0.82	22

Second-year course E_2

	Exam 1		Exam 2		
Group	$\bar{x}$	σ	$\bar{x}$	σ	n
1	1.01	0.36	1.07	0.78	24
2	1.08	0.35	0.93	0.64	26
3	1.08	0.39	0.88	0.64	27
4	1.07	0.43	1.12	0.63	23

Third-year course E_3

Standardized group means of points in the two examinations.
(Relate to students who have taken part in both examinations.)

DT results and correlations, Spring Term 1968

	Packages 2-6		Packages 7-11		Entrance points	
Group	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	
1	0.90	0.46	1.05	0.45	44.69	Second-year
2	1.05	0.48	0.95	0.52	45.19	course E_2
3	0.96	0.43	1.00	0.52	42.28	
4	1.06	0.47	0.98	0.54	45.84	

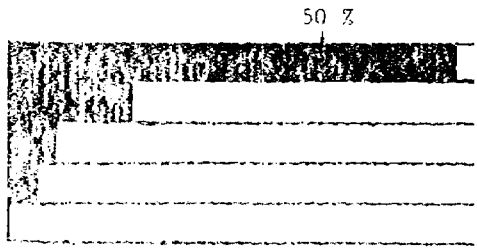
	Packages 2-6		Packages 7-11		Entrance points	
Group	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	
1	1.04	0.47	0.90	0.44	44.57	Third-year
2	0.98	0.46	1.15	0.40	44.61	course E_3
3	1.06	0.35	1.16	0.40	41.96	
4	0.91	0.41	0.75	0.46	41.51	

Standardized DT results added together into half-term values.
Method A underlined.

Correlation between DT and Exam	E_2	F_3
2-6 I practical calculation	0.31	0.41
2-6 I theoretical	0.34	-0.10
7-11 II practical calculation	0.29	0.00
7-11 II theoretical	0.15	-0.62

Coefficients of correlation between DT results and examination results.

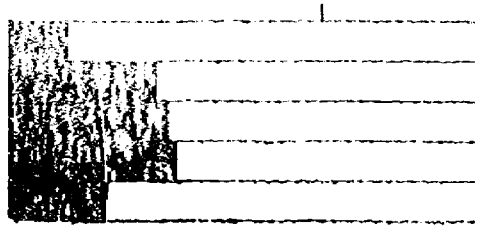
1. The specification of the course objectives to particular pages for each package was an aid which I utilized



a) every time
b) usually
c) sometimes
d) occasionally on trial
e) not at all

(Question 1 relates to methods A and B)

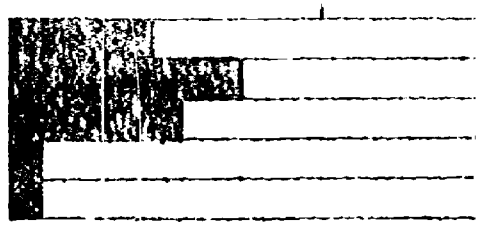
2. The replacement of a lecturing period by a repetition of the TV programme would, I consider, be



a) much better
b) rather better
c) neither better nor worse
d) rather worse
e) much worse

(Question 2 relates solely to method A)

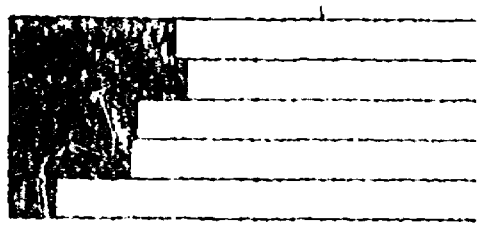
3. Being able to see the TV programme before reading the textbook was, I consider,



a) much better
b) rather better
c) neither better nor worse
d) rather worse
e) much worse

(Question 3 relates solely to method B)

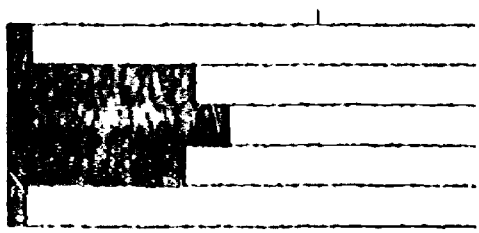
4. To add an extra lecturing period between diagnostic test and TV programme would be, I consider,



a) much better
b) rather better
c) neither better nor worse
d) rather worse
e) much worse

(Question 4 relates solely to method B)

5. The ability of the TV teaching to provide a basis for the circuit calculation exercises was



a) very good
b) fairly good
c) neither good nor poor
d) rather poor
e) very poor

(Question 5 relates solely to method A)

Positions of basic data on punched card, E_2-69

	Variable	Positions on card
	class + year	1 - 6
	national registration number	7 - 16
1	presence at DT and lectures	17 - 18
2	Attitude I to the course	19 - 20
3	" I value of DT	21 - 22
4	" I circuit calculation exercises	23 - 24
5	Attitude II to the course	25 - 26
6	" II value of DT	27 - 28
7	" II circuit calculation exercises	29 - 30
8	Entrance points to Institute of Technology	31 - 34
9	DT points, total	35 - 36
10	Examination, practical calculation	37 - 39
11	" , theoretical	40 - 42
12	" , total	43 - 45
13	DT points, mean	46 - 47
14	Preparation time I	48 - 49
15	" " II	50 - 51

PRIMARY DATA FROM E_2-69

Variable No.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	5	4	3	4	5	3	4675	61	32,0	14,0	46,0	5,5	3	2
00	-1	-1	-1	-1	-1	-1	5150	-1	-1	-1	-1	-1	-1	-1
11	1	3	3	1	2	1	4625	41	0,0	8,0	8,0	3,7	8	16
07	4	4	4	-1	-1	-1	4300	27	6,0	13,5	19,5	3,9	1	-1
07	4	4	4	-1	-1	-1	4875	32	0,0	11,0	11,0	4,6	16	-1
01	-1	-1	-1	-1	-1	-1	4875	02	-1	-1	-1	2,0	-1	-1
04	5	4	2	-1	-1	-1	5025	25	-1	-1	-1	6,3	2	-1
00	-1	-1	-1	-1	-1	-1	4250	-1	-1	-1	-1	-1	-1	-1
12	4	4	3	4	5	4	-1	71	27,0	14,5	41,5	5,9	2	2
07	4	2	1	2	2	3	4725	27	9,0	10,0	19,0	3,9	2	2
07	-1	-1	-1	4	5	3	4800	22	16,0	22,0	38,0	3,1	-1	2
04	2	4	2	-1	-1	-1	5375	17	14,0	9,5	23,5	4,3	4	-1
04	-1	-1	-1	-1	-1	-1	4675	09	7,0	9,0	16,0	2,3	-1	-1
10	4	3	4	1	1	5	4700	42	32,0	10,0	42,0	4,2	16	8
09	4	5	3	4	4	3	4750	45	20,0	14,0	34,0	5,0	8	8
09	5	4	2	3	4	4	4775	49	20,0	11,5	31,5	5,5	8	12
10	4	4	4	4	3	2	4700	41	23,0	9,5	32,5	4,1	8	16
00	-1	-1	-1	-1	-1	-1	4850	-1	20,0	10,5	30,5	-1	-1	-1
06	2	5	5	2	4	2	4925	27	-1	-1	-1	4,5	1	1
01	-1	-1	-1	3	3	2	4700	03	0,0	6,5	6,5	3,0	-1	1
06	4	4	2	-1	-1	-1	4725	23	-1	-1	-1	3,8	4	-1
07	4	3	1	2	1	2	4825	29	-1	-1	-1	4,1	8	16
12	4	4	5	3	4	4	5175	56	19,0	12,5	31,5	4,3	4	6
03	3	4	3	-1	-1	-1	4250	08	-1	-1	-1	2,7	2	-1
06	5	-1	4	4	-1	4	4900	33	33,0	14,0	47,0	5,5	8	4
01	-1	-1	-1	-1	-1	-1	4675	05	10,0	11,5	21,5	5,0	-1	-1
11	4	4	4	4	4	4	4425	42	0,0	8,0	8,0	3,8	4	4
00	-1	-1	-1	-1	-1	-1	4375	-1	9,0	7,5	16,5	-1	-1	-1
11	4	4	4	3	4	4	5050	39	20,0	9,0	29,0	3,5	4	4
01	-1	-1	-1	2	3	3	-1	05	-1	-1	-1	5,0	-1	1
03	-1	-1	-1	-1	-1	-1	4875	10	-1	-1	-1	3,3	-1	-1
03	-1	-1	-1	-1	-1	-1	-1	08	13,0	10,5	23,5	2,7	-1	-1
01	3	4	1	-1	-1	-1	4775	02	-1	-1	-1	2,0	2	-1
00	-1	-1	-1	3	3	2	4925	-1	-1	-1	-1	-1	-1	1
07	4	5	3	4	4	2	4475	31	11,0	11,5	22,5	4,4	4	2
-1	-1	-1	-1	-1	-1	-1	4400	-1	-1	-1	-1	-1	-1	-1

11	4	4	4	4	4	4	4600	49	15,0	12,0	27,0	4,5	8	3
04	2	5	3	2	4	2	5100	15	-1	-1	-1	3,8	2	2
06	2	5	2	-1	-1	2	4475	22	0,0	0,8	0,8	3,7	2	2
00	-1	-1	-1	-1	-1	-1	4266	-1	-1	-1	-1	-1	-1	-1
10	3	4	3	-1	5	3	4675	48	20,0	13,0	33,0	4,8	4	4
09	4	4	3	4	4	4	4566	37	3,0	11,0	14,0	4,1	4	4
12	4	4	3	4	3	3	4275	48	20,0	11,5	31,5	4,0	8	16
03	-1	-1	-1	3	3	1	4525	10	9,0	12,0	21,0	3,3	-1	1
08	-1	-1	-1	-1	-1	-1	4700	36	-1	-1	-1	4,5	-1	-1
11	4	4	4	4	4	4	4525	52	20,0	12,0	32,0	4,7	3	3
09	4	3	2	4	4	2	4650	30	0,0	10,5	10,5	3,3	2	2
05	4	4	2	3	2	4	5000	16	-1	-1	-1	3,2	4	1
03	4	4	2	4	4	4	4450	17	5,0	11,5	16,5	5,7	8	16
08	4	3	4	4	3	4	5500	25	31,0	13,5	44,5	3,1	1	1
05	-1	-1	-1	4	5	4	4850	13	4,0	11,5	15,5	2,6	-1	2
00	-1	-1	-1	-1	-1	-1	4250	-1	-1	-1	-1	-1	-1	-1
05	-1	-1	-1	4	4	4	5025	22	27,0	11,5	38,5	4,4	-1	8
00	-1	-1	-1	-1	-1	-1	5050	-1	-1	-1	-1	-1	-1	-1
01	3	4	1	-1	-1	-1	-1	06	0,0	8,5	8,5	6,0	4	-1
09	4	2	5	4	-1	3	4475	34	0,0	9,5	9,5	3,8	2	4
01	4	5	2	3	4	3	4650	07	5,0	8,5	13,5	7,0	8	4
05	5	2	2	-1	-1	-1	4500	19	-1	-1	-1	3,8	16	-1
08	1	4	4	2	5	4	4725	43	28,0	12,0	40,0	5,4	8	4
02	-1	-1	-1	-1	-1	-1	-1	09	18,0	13,0	31,0	4,5	-1	-1
07	-1	-1	-1	4	4	4	4650	27	10,0	11,0	21,0	3,9	-1	4
10	4	4	3	4	4	5	4500	47	0,0	12,5	12,5	4,7	2	2
03	-1	-1	-1	4	4	4	4525	11	3,0	11,0	14,0	3,7	-1	8
00	-1	-1	-1	-1	-1	-1	5100	-1	-1	-1	-1	-1	-1	-1
06	4	5	4	-1	-1	-1	4550	29	11,0	11,0	22,0	4,8	8	-1
01	-1	-1	-1	-1	-1	-1	5525	06	-1	-1	-1	6,0	-1	-1
01	-1	-1	-1	-1	-1	-1	-1	02	10,0	23,0	33,0	2,0	-1	-1
12	3	5	4	4	5	3	4566	70	12,0	14,5	26,5	5,8	8	8
05	-1	-1	-1	-1	-1	-1	4925	05	4,0	7,0	11,0	1,0	-1	-1
07	5	5	3	4	5	2	4850	32	22,0	20,0	42,0	4,6	8	4
07	3	5	3	4	4	4	-1	28	14,0	12,0	26,0	4,0	8	8
01	4	5	2	-1	-1	-1	4650	03	18,0	10,0	28,0	3,0	-1	-1
01	-1	-1	-1	3	5	3	4200	04	-1	-1	-1	4,0	-1	8
11	3	4	3	3	4	4	-1	55	29,0	13,0	42,0	5,0	8	4
03	5	5	3	-1	-1	-1	-1	10	0,0	6,5	6,5	3,3	8	-1
00	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
07	-1	-1	-1	-1	-1	-1	-1	15	-1	-1	-1	2,1	-1	-1
00	-1	-1	-1	-1	-1	4	-1	-1	-1	-1	-1	-1	-1	-1

06	-1	-1	-1	4	4	4	4725	22	10,0	8,0	18,0	3,7	-1	2
05	3	4	1	-1	-1	-1	4250	21	-1	-1	-1	4,2	8	-1
01	-1	-1	-1	-1	-1	-1	4750	06	-1	-1	-1	6,0	-1	-1
11	4	4	4	4	4	5	4266	52	10,0	13,0	23,0	4,7	8	8
00	-1	-1	-1	-1	-1	-1	4500	-1	-1	-1	-1	-1	-1	-1
11	4	5	2	3	4	2	5000	49	17,0	10,5	27,5	4,5	2	2
07	3	4	3	-1	-1	-1	4300	26	0,0	12,0	12,0	3,7	2	-1
06	-1	-1	-1	4	4	2	4625	21	0,0	9,0	9,0	3,5	-1	4
06	4	4	4	4	4	4	4850	28	20,0	12,5	32,5	4,7	2	2
07	2	3	3	3	3	4	4875	13	-1	-1	-1	2,9	1	1
04	-1	-1	-1	2	1	2	4950	12	-1	-1	-1	3,0	-1	1
08	4	5	2	5	4	2	4575	42	29,0	10,5	39,5	5,3	16	4
09	-1	-1	-1	-1	-1	-1	4350	28	11,0	10,5	21,5	3,1	-1	-1
04	2	4	4	1	4	4	5025	18	27,0	12,5	39,5	4,5	4	2
08	-1	-1	-1	-1	-1	-1	4650	27	17,0	11,0	28,0	3,4	-1	-1
00	-1	-1	-1	-1	-1	-1	5100	-1	-1	-1	-1	-1	-1	-1
05	4	5	4	3	5	3	4275	18	15,0	10,5	25,5	3,6	8	8
11	3	2	4	1	3	3	5225	36	20,0	12,5	32,5	3,3	4	2
08	-1	-1	-1	-1	-1	-1	4525	29	0,0	6,5	6,5	3,6	-1	-1
00	-1	-1	-1	-1	-1	-1	4650	-1	-1	-1	-1	-1	-1	-1
06	1	4	1	1	1	3	4600	17	11,0	9,5	20,5	2,8	8	2
00	-1	-1	-1	-1	-1	4	4900	-1	8,0	10,0	18,0	-1	-1	-1
03	-1	-1	-1	3	4	3	4400	14	20,0	11,0	31,0	4,7	-1	4
04	3	3	4	-1	-1	-1	4550	12	-1	-1	-1	3,0	2	-1
08	4	4	4	3	4	4	5125	34	11,0	13,5	24,5	4,3	4	4
10	-1	4	3	2	3	5	4750	46	14,0	10,5	24,5	4,6	16	12
05	4	5	2	-1	-1	-1	5400	15	-1	-1	-1	3,0	1	-1
00	-1	-1	-1	-1	-1	-1	4575	-1	-1	-1	-1	-1	-1	-1
08	4	5	4	4	4	3	4925	33	-1	-1	-1	4,1	8	16
00	-1	-1	-1	-1	-1	-1	4450	-1	-1	-1	-1	-1	-1	-1
09	3	4	2	4	2	4	4825	38	19,0	9,5	28,5	4,2	4	-1
02	-1	-1	-1	-1	-1	-1	4575	08	14,0	12,0	26,0	4,0	-1	2
03	-1	-1	-1	-1	-1	-1	4350	10	-1	-1	-1	3,3	-1	-1
09	5	4	4	5	4	4	5100	40	16,0	11,0	27,0	4,4	1	1
07	5	4	3	-1	-1	-1	4400	28	-1	-1	-1	4,0	4	-1
09	4	4	2	4	4	2	4650	27	0,0	10,5	10,5	3,0	2	1
07	4	5	2	-1	-1	-1	4400	41	20,0	12,5	32,5	5,9	8	-1
00	-1	-1	-1	-1	-1	-1	4866	-1	-1	-1	-1	-1	-1	-1
05	3	3	4	4	4	4	4825	21	19,0	10,5	29,5	4,2	-1	16
03	-1	-1	-1	4	5	3	4366	12	-1	-1	-1	4,0	-1	2
07	2	4	4	2	4	4	5350	30	26,0	12,5	38,5	4,3	4	2
00	-1	-1	-1	-1	-1	-1	4425	-1	-1	-1	-1	-1	-1	-1

10	4	5	4	3	5	5	4575	47	8,0	9,0	17,0	4,7	4	2
11	3	4	3	-1	-1	-1	5175	56	18,0	12,0	30,0	5,1	3	-1
03	-1	-1	-1	-1	-1	-1	4625	08	-1	-1	-1	2,7	-1	-1
06	5	5	3	4	3	4	4575	13	-1	-1	-1	2,2	2	-1
02	-1	-1	-1	-1	-1	-1	4575	04	-1	-1	-1	2,0	-1	-1
07	3	3	2	3	3	3	4875	28	-1	-1	-1	4,0	8	-1
01	4	4	5	-1	-1	-1	4475	03	-1	-1	-1	3,0	1	-1
04	2	4	1	-1	-1	-1	4525	11	12,0	9,5	21,5	2,8	4	-1
01	-1	-1	-1	-1	-1	-1	4650	04	-1	-1	-1	4,0	-1	-1
10	4	4	4	3	4	4	4925	44	0,0	10,5	10,5	4,4	8	4
00	-1	-1	-1	-1	-1	-1	4725	-1	-1	-1	-1	-1	-1	-1
03	3	4	3	-1	-1	-1	5100	07	-1	-1	-1	2,1	4	-1
00	-1	-1	-1	-1	-1	-1	4525	-1	-1	-1	-1	-1	-1	-1
02	-1	-1	-1	-1	-1	-1	5000	02	-1	-1	-1	1,0	-1	-1
03	-1	-1	-1	-1	-1	-1	-1	11	0,0	11,5	11,5	3,7	-1	-1
07	3	5	4	4	5	5	5000	33	0,0	10,5	10,5	4,7	4	4
07	2	4	2	-1	-1	-1	4575	23	-1	-1	-1	3,3	2	-1
06	1	2	1	1	-1	1	4850	15	9,0	8,5	17,5	2,5	16	8
09	4	5	3	-1	-1	-1	4850	31	-1	-1	-1	3,4	1	-1
07	3	4	3	2	4	1	4425	27	4,0	11,0	15,0	3,9	16	8
09	4	4	3	-1	-1	-1	4875	22	-1	-1	-1	2,5	1	-1
10	2	5	3	-1	-1	-1	4750	60	20,0	14,0	34,0	6,0	8	-1
04	-1	-1	-1	-1	-1	-1	4300	20	10,0	12,5	22,5	5,0	-1	-1
09	4	5	2	-1	-1	-1	4750	43	-1	-1	-1	4,8	4	-1
04	-1	-1	-1	-1	-1	-1	4250	10	-1	-1	-1	2,5	-1	-1
12	4	5	3	-1	-1	-1	-1	49	2,0	9,0	11,0	4,1	8	-1
00	-1	-1	-1	-1	-1	-1	4775	-1	-1	-1	-1	-1	-1	-1
12	4	4	2	3	4	3	5000	56	17,0	13,0	30,0	4,7	4	4
09	4	5	4	2	4	4	4575	39	20,0	10,5	30,5	4,3	8	16
08	2	2	5	-1	-1	-1	4850	27	5,0	12,5	17,5	3,4	1	-1
06	5	4	5	4	3	4	4525	20	12,0	10,0	22,0	3,3	2	8
04	4	5	3	-1	-1	-1	-1	09	-1	-1	-1	2,3	4	-1
12	4	5	4	3	4	4	4525	52	10,0	10,0	20,0	4,3	4	4
00	-1	-1	-1	-1	-1	-1	4775	-1	-1	-1	-1	-1	-1	-1
01	-1	-1	-1	-1	-1	-1	4575	3	-1	-1	-1	3,0	-1	-1
12	5	4	2	4	4	2	4516	69	27,0	14,0	41,0	5,7	4	8
12	4	4	1	4	3	4	4525	51	16,0	12,0	28,0	4,3	8	8
09	5	4	3	4	4	4	4900	44	21,0	10,0	31,0	4,9	4	8
09	5	4	4	4	4	4	4525	49	10,0	11,0	21,0	5,4	4	4
11	-1	-1	-1	-1	5	4	-1	41	-1	-1	-1	3,7	-1	-1
00	5	4	4	5	5	2	-1	34	15,0	13,0	28,0	4,3	16	16
00	-1	-1	-1	4	3	2	4500	-1	7,0	10,5	17,5	-1	-1	8

00	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
00	-1	-1	-1	-1	-1	-1	5000	-1	-1	-1	-1	-1	-1	-1
04	-1	-1	-1	2	4	4	5025	17	16,0	11,5	27,5	4,3	-1	2
04	-1	-1	-1	3	2	2	4800	11	2,0	11,0	13,0	2,8	-1	2
12	4	5	5	5	4	4	4400	49	0,0	11,5	11,5	4,1	8	16
00	-1	-1	-1	1	1	3	5100	-1	-1	-1	-1	-1	-1	4
00	-1	-1	-1	-1	-1	-1	4400	-1	-1	-1	-1	-1	-1	-1
04	-1	-1	-1	-1	-1	-1	4725	16	-1	-1	-1	4,0	-1	-1
00	-1	-1	-1	-1	-1	-1	4700	-1	-1	-1	-1	-1	-1	-1
02	4	4	2	4	4	3	4675	10	-1	-1	-1	5,0	8	4
06	4	3	2	-1	-1	-1	4975	13	-1	-1	-1	2,2	2	-1
06	-1	-1	-1	-1	-1	-1	4325	21	20,0	10,5	30,5	2,1	-1	-1
00	-1	-1	-1	-1	-1	-1	4675	-1	-1	-1	-1	-1	-1	-1
03	3	4	2	3	4	2	4650	06	-1	-1	-1	2,0	8	1
08	-1	-1	-1	-1	-1	-1	5025	40	22,0	13,5	35,5	5,0	-1	-1
10	5	5	3	-1	-1	-1	-1	50	17,0	13,0	30,0	5,0	16	-1
01	-1	-1	-1	-1	-1	-1	-1	04	-1	-1	-1	-1	-1	-1
01	-1	-1	-1	-1	-1	-1	-1	04	-1	-1	-1	4,0	-1	-1
04	5	5	2	-1	-1	-1	-1	12	10,0	10,0	20,0	3,0	4	-1
05	3	2	4	5	1	4	4283	17	18,0	27,0	45,0	3,4	1	1
07	-1	-1	-1	-1	-1	-1	4625	26	-1	-1	-1	3,7	-1	-1
07	4	4	3	-1	-1	-1	4600	22	-1	-1	-1	3,1	4	-1
08	-1	-1	-1	-1	-1	-1	4550	36	-1	-1	-1	4,5	-1	-1
08	3	3	4	-1	-1	-1	4850	37	21,0	10,5	31,5	4,6	4	-1

Correlation matrix for E_2-69

Data comprise all 186 students starting the course in Spring Term 1969.

The correlation matrix was computed with the BMD programme 03D. The programme excludes the missing values which are marked -1.

CORRELATION MATRIX FOR THE 15 BASIC VARIABLES. DATA INCLUDE ALL 186 STUDENTS ENTERING THE COURSE.

VARIABLE	MEAN	STANDARD DEVIATION	NUMBER OF ITEMS
1	5.3817	3.6613	186
2	14.0381	1.6012	105
3	4.0571	0.8184	105
4	3.7293	1.0823	106
5	3.2955	1.0912	88
6	3.6782	1.0910	87
7	3.2796	1.0167	93
8	47.0514	2.7429	184
9	24.2193	16.8721	155
10	17.9815	9.3657	108
11	11.3593	3.0975	108
12	26.3407	10.6175	108
13	3.9370	1.0830	154
14	5.3577	4.1068	104
15	5.3295	4.0878	88

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BMD03D - CORRELATION WITH ITEM DELETION - REVISED SEPTEMBER 18, 1969
HEALTH SCIENCES COMPUTING FACILITY, UCLA

PROBLEM CODE.....E2VT69
NUMBER OF VARIABLES.....15
NUMBER OF CASES.....186
NUMBER OF TRANSGENERATION CARDS.....0
NUMBER OF VARIABLES ADDED.....0
NUMBER OF VARIABLE FORMAT CARDS.....1

TRANSGENERATION IF ANY, OCCURS BEFORE ITEM DELETION

VARIABLE FORMAT CARDS:
(16X,7F2.0,F4.2,F2.0,3F3.1,F2.1,2F2.0)

CORRELATION MATRIX
(SAMPLE SIZES IN PARENTHESES)

VARIABLE NAME		VARIABLE NO. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Attendance	1	1.00000 (186)	0.15871 (105)	0.02921 (105)	0.26085 (106)	0.15602 (88)	0.23122 (87)	0.21249 (93)	0.03275 (184)	0.90672 (155)	0.23617 (108)	0.08221 (108)	0.22564 (108)	0.27271 (154)	0.09813 (104)	0.22213 (88)
Attitude I to the course	2	0.15871 (105)	1.00000 (105)	0.20428 (104)	0.09793 (105)	0.03779 (87)	0.18922 (89)	0.24413 (93)	-0.11923 (95)	0.19777 (105)	0.08539 (77)	0.14426 (77)	0.11200 (77)	0.19319 (105)	0.05333 (103)	0.11997 (87)
Attitude I value of diagnostic tests	3	0.02921 (105)	0.20428 (105)	1.00000 (105)	0.08961 (105)	0.25037 (87)	0.57555 (89)	0.04543 (93)	-0.06956 (95)	0.12349 (105)	-0.02082 (77)	-0.15978 (77)	-0.06121 (77)	0.24935 (105)	0.04035 (103)	0.04065 (87)
Attitude I quality of calculation exercises	4	0.26085 (106)	0.09793 (105)	0.08961 (106)	1.00000 (106)	0.18396 (88)	0.30030 (89)	0.40818 (93)	0.03167 (96)	0.25733 (106)	0.07568 (78)	0.22459 (78)	0.12491 (78)	0.07030 (106)	-0.09320 (104)	0.04281 (88)
Attitude II to the course	5	0.15602 (88)	0.03779 (87)	0.25037 (87)	0.18396 (88)	1.00000 (88)	0.41439 (85)	0.18206 (88)	-0.12784 (83)	0.18307 (85)	-0.07272 (72)	0.29143 (72)	0.01489 (72)	0.16322 (85)	-0.20187 (67)	0.06792 (86)
Attitude II value of diagnostic tests	6	0.23122 (87)	0.18922 (89)	0.57555 (89)	0.30030 (89)	0.41439 (85)	1.00000 (87)	0.13666 (87)	-0.09214 (81)	0.27288 (84)	0.04217 (70)	0.05452 (70)	0.05190 (70)	0.37386 (84)	-0.05625 (65)	-0.01216 (84)
Attitude II quality of calculation exercises	7	0.21249 (93)	0.24413 (93)	0.04543 (93)	0.40818 (93)	0.18206 (88)	0.13666 (87)	1.00000 (93)	0.07925 (86)	0.24380 (88)	0.18699 (75)	0.19626 (75)	0.19542 (75)	0.23849 (88)	-0.18569 (69)	-0.01019 (88)
Entrance points to MIT	8	0.03275 (184)	-0.11923 (95)	-0.06956 (95)	0.03167 (96)	-0.12784 (83)	-0.09214 (81)	0.07925 (86)	1.00000 (164)	0.00925 (136)	0.32707 (95)	0.03961 (95)	0.29222 (95)	0.02699 (136)	-0.18368 (94)	-0.24996 (83)
Diagnostic test points, total sum	9	0.90672 (155)	0.19777 (105)	0.12349 (105)	0.25733 (106)	0.18307 (85)	0.27288 (84)	0.24380 (88)	0.00925 (136)	1.00000 (155)	0.34909 (104)	0.13956 (104)	0.33892 (104)	0.55144 (154)	0.16818 (104)	0.22802 (85)
Examination, calculation	10	0.23617 (108)	0.08539 (77)	-0.02082 (77)	0.07568 (78)	-0.07272 (72)	0.04217 (70)	0.18699 (75)	0.32707 (95)	0.34909 (104)	1.00000 (108)	0.37303 (108)	0.96267 (108)	0.33095 (108)	0.08225 (104)	-0.02086 (76)
Examination, theory questions	11	0.08221 (108)	0.14426 (77)	-0.15978 (77)	0.22459 (78)	0.29143 (72)	0.05452 (70)	0.18626 (75)	0.03961 (95)	0.13956 (104)	0.37303 (108)	1.00000 (108)	0.61024 (108)	0.12437 (108)	-0.07329 (104)	-0.11072 (76)
Examination, total	12	0.22564 (108)	0.11200 (77)	-0.06121 (77)	0.12491 (78)	0.01489 (72)	0.05190 (70)	0.19542 (75)	0.29222 (95)	0.33892 (104)	0.96267 (108)	0.61024 (108)	1.00000 (108)	0.31899 (108)	0.05157 (104)	-0.01344 (76)
Diagnostic test points, average	13	0.27271 (154)	0.19319 (105)	0.24935 (105)	0.07030 (106)	0.16322 (85)	0.37386 (84)	0.23849 (88)	0.02699 (136)	0.55144 (154)	0.33095 (104)	0.12437 (104)	0.31899 (104)	1.00000 (154)	0.23717 (104)	0.17563 (85)
Independent studytime I	14	0.09813 (104)	0.05333 (103)	0.04035 (103)	-0.09320 (104)	-0.20187 (67)	-0.05625 (65)	-0.18569 (69)	-0.18368 (94)	0.16818 (104)	0.08225 (76)	-0.07329 (76)	0.05157 (76)	0.23717 (104)	1.00000 (104)	0.55110 (67)
Independent studytime II	15	0.22213 (88)	0.11997 (87)	0.04065 (87)	0.04281 (88)	0.06792 (86)	-0.01216 (84)	-0.01019 (88)	-0.24996 (83)	0.22802 (85)	0.02086 (74)	-0.11072 (74)	-0.01344 (74)	0.17563 (85)	0.55110 (67)	1.00000 (88)

Data stratified on variable No. 1, attendance

CORRELATION MATRICES = 3<

THESE ARE SYMMETRIC MATRICES AND THERE ARE PRINTED IN HALF FORM, INCLUDING THE PRINCIPAL DIAGONAL.
A VALUE OF 99.0 INDICATES THE COEFFICIENT IS NOT COMPUTABLE DUE TO A ZERO DENOMINATOR.

ANARVARO GROUP 1 (PAGE 1<

	1	2	3	4	5	6	7	8
1	1.0000							
2	0.0534	1.0000						
3	-0.0443	0.6784	1.0000					
4	0.1273	0.3520	0.0449	1.0000				
5	0.4738	0.2700	-0.4586	0.0	1.0000			
6	0.5023	0.0	0.0	0.0	0.5160	1.0000		
7	-0.0275	0.5301	0.0	0.0	0.2396	0.1049	1.0000	
8	-0.1624	-0.1915	0.0269	-0.2228	-0.4668	-0.6258	-0.0443	1.0000
9	0.6013	0.4906	0.1285	-0.1128	0.4951	0.2032	0.4357	-0.3424
10	-0.0939	0.0	0.0	0.0	-0.0621	-0.0934	0.1042	0.0177
11	0.0576	-0.2600	-0.5527	-0.1588	0.1622	-0.0424	0.1360	-0.0327
12	-0.0491	-0.1114	-0.2310	-0.0664	0.0194	-0.0906	0.1381	0.0001
13	-0.1981	0.4473	0.4687	-0.4254	0.0197	0.0931	0.4305	-0.0080
14	0.3038	0.4901	0.4770	-0.3236	0.0	0.0	0.0	0.0979
15	0.1345	0.6603	-0.4267	0.0	0.3578	0.2694	0.4953	-0.3093

	9	10	11	12	13	14	15
9	1.0000						
10	0.1443	1.0000					
11	-0.2588	0.3341	1.0000				
12	0.0043	0.9191	0.0784	1.0000			
13	0.3786	-0.0003	-0.4105	-0.2186	1.0000		
14	0.7283	0.1075	0.0312	0.1436	0.6039	1.0000	
15	0.6870	-0.2543	0.1916	-0.1181	0.3995	0.0	1.0000

BNARVARO GROUP 2 #PAGE 1<

	1	2	3	4	5	6	7	8
1	1.0000							
2	0.0601	1.0000						
3	-0.0217	0.1347	1.0000					
4	0.0676	0.1505	0.2513	1.0000				
5	0.1774	0.7443	0.2191	0.5386	1.0000			
6	0.1514	0.0787	0.7093	0.6181	0.2962	1.0000		
7	-0.0341	0.2643	0.0040	0.4976	0.4458	0.1513	1.0000	
8	-0.1498	-0.1878	0.0526	-0.0101	-0.2709	0.1246	0.1866	1.0000
9	0.6917	0.2208	0.1834	0.2144	0.1922	0.2947	0.0396	-0.0766
10	-0.0970	0.1539	-0.0661	0.2575	0.0057	0.0695	0.4340	0.2954
11	0.1344	0.3256	-0.2870	0.4019	0.4414	-0.1056	0.2103	-0.0780
12	-0.0242	0.2439	-0.1611	0.3539	0.1730	0.0138	0.4181	0.2001
13	0.1457	0.1932	0.1825	0.2197	0.0857	0.2780	0.1347	0.0926
14	0.1699	0.0104	-0.1988	-0.1889	-0.3753	0.1136	-0.5514	-0.1411
15	0.1399	0.2419	-0.2568	-0.1198	0.0417	0.0267	-0.0933	-0.1154

	9	10	11	12	13	14	15
9	1.0000						
10	0.2340	1.0000					
11	0.2194	0.4177	1.0000				
12	0.2659	0.9379	0.7069	1.0000			
13	0.7737	0.3871	0.2057	0.3799	1.0000		
14	0.2489	-0.1204	-0.1245	-0.1413	0.1345	1.0000	
15	0.1824	0.0896	-0.1871	-0.0017	0.0983	0.5725	1.0000

CNXRVARO GROUP 3 %PAGE 1<

	1	2	3	4	5	6	7	8
1	1.0000							
2	0.0368	1.0000						
3	0.1709	0.2462	1.0000					
4	-0.0961	-0.1205	-0.2706	1.0000				
5	-0.1015	0.5405	0.2964	-0.0596	1.0000			
6	-0.0516	0.1362	0.4077	0.0484	0.4746	1.0000		
7	0.0582	0.1556	0.0793	0.3572	-0.1295	0.0175	1.0000	
8	-0.1930	-0.0647	-0.2169	0.0809	-0.2819	-0.1005	-0.0195	1.0000
9	0.6104	0.0479	0.2378	-0.0418	0.0579	0.2431	0.1053	-0.1417
10	0.0014	0.0591	0.0659	-0.1626	-0.1296	-0.0491	0.0246	0.3651
11	0.1227	0.0411	0.0514	-0.0284	0.2361	0.3622	0.0347	0.2363
12	0.0225	0.0609	0.0689	-0.1529	-0.0770	0.0181	0.0284	0.3732
13	0.1754	0.0429	0.3372	-0.1192	0.1394	0.3861	0.1229	-0.1066
14	-0.0129	0.0338	0.2440	-0.0248	-0.1636	-0.2921	0.0060	-0.2720
15	0.0102	-0.0445	0.1886	0.1057	-0.0637	-0.2862	-0.2034	-0.3066

	9	10	11	12	13	14	15
9	1.0000						
10	0.2538	1.0000					
11	0.4652	0.4491	1.0000				
12	0.3115	0.9660	0.5820	1.0000			
13	0.8079	0.4060	0.5127	0.4601	1.0000		
14	0.1276	0.2039	-0.0199	0.1821	0.2696	1.0000	
15	-0.0279	-0.0101	-0.1325	-0.0322	-0.0214	0.5709	1.0000

VARIABLE 4 % ATT115 < %PRINTED INTERVAL DESIGNATIONS ARE LOWER LIMITS OF CLASS INTERVALS<

	GROUP 1 ANARVARO	GROUP 2 BNARVARO	GROUP 3 CNARVARO
SPECIAL VALUES			
-1.000 <	*********56	*********17	*******

TABULATIONS AND COMPUTATIONS WHICH FOLLOW EXCLUDE SPECIAL VALUES

INTERVAL			
5.400 <			
5.100 <			
4.800 <	*	**	****
4.500 <			
4.200 <			
3.900 <		*********12	*********21
3.600 <			
3.300 <			
3.000 <	***	*********11	*********17
2.700 <			
2.400 <			
2.100 <			
1.800 <	****	*********12	**********
1.500 <			
1.200 <			
0.900 <	**	******	*
0.600 <			
MEAN	2.400	2.814	3.321
S DEV	1.174	1.139	0.936
N	10.	43.	53.

ALL GROUPS COMBINED %SPECIAL VALUES EXCLUDED<

MEAN	3.0283
S DEV	1.0819
MAXIMUM	5.0000
MINIMUM	1.0000

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
BETWEEN	10.4558	2	5.2279	4.7882
WITHIN	112.4582	103	1.0918	
TOTAL	122.9139	105		

VARIABLE 10 % TPROBL < %PRINTED INTERVAL DESIGNATIONS ARE LOWER LIMITS OF CLASS INTERVALS<

	GROUP 1 ANARVARO	GROUP 2 BNARVARO	GROUP 3 CNARVARO
SPECIAL VALUES			
-1.000 <	*********46	********23	*******

TABULATIONS AND COMPUTATIONS WHICH FOLLOW EXCLUDE SPECIAL VALUES

INTERVAL			
39.000 <			
36.000 <			
33.000 <		*	
30.000 <			***
27.000 <		**	*****
24.000 <		*	
21.000 <		*	****
18.000 <	***	*****	*********13
15.000 <		***	********
12.000 <	**	****	**
9.000 <	****	*********	*****
6.000 <	**	**	*
3.000 <	***	***	**
0.0 <	****	******	**********
-3.000 <			
-6.000 <			
-9.000 <			
MEAN	8.389	12.135	15.132
S DEV	6.670	8.535	9.572
N	18.	37.	53.

ALL GROUPS COMBINED %SPECIAL VALUES EXCLUDED<

MEAN	12.9815
S DEV	9.0656
MAXIMUM	33.0000
MINIMUM	0.0

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
BETWEEN	651.2031	2	325.6016	4.1987
WITHIN	8142.6445	105	77.5490	
TOTAL	8793.8477	107		

VARIABLE 13 % DP MED <

%PRINTED INTERVAL DESIGNATIONS ARE
LOWER LIMITS OF CLASS INTERVALS<

	GROUP 1 ANXRVARO	GROUP 2 BNXRVARO	GROUP 3 CNXRVARO
SPECIAL VALUES			
-0.100	<*********32		

TABULATIONS AND COMPUTATIONS WHICH FOLLOW EXCLUDE SPECIAL VALUES

INTERVAL			
7.200	<		
6.800	<*		
6.400	<		
6.000	<***	*	*
5.600	<*	*	***
5.200	<	*	*****
4.800	<***	**	********
4.400	<**	********	*********13
4.000	<*****	**********	**********14
3.600	<**	**********12	*****
3.200	<****	*****	******
2.800	<***	**********	****
2.400	<***	***	*
2.000	<******	******	
1.600	<		
1.200	<		
0.900	<*	*	
MEAN		3.697	3.645	4.365
S DEV		1.428	0.984	0.791
N		34.	60.	60.

ALL GROUPS COMBINED %SPECIAL VALUES EXCLUDED<

MEAN	3.9370
S DEV	1.0629
MAXIMUM	7.0000
MINIMUM	1.0000

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
BETWEEN	18.0641	2	9.0321	8.4525
WITHIN	161.3539	151	1.0686	
TOTAL	179.4180	153		

1. Attitude test I, February 1969

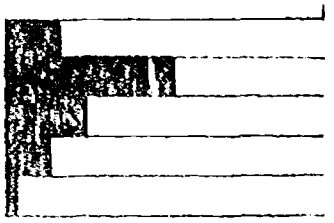
2. Attitude test II, May 1969

Attitude test I, E_2-69 (February 1969)

1. What is your overall impression of this TV teaching compared with average conventional teaching?

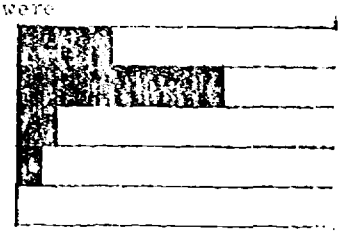
50 %

a) much better
b) rather better
c) neither better nor worse
d) rather worse
e) much worse



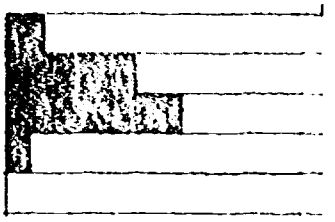
2. As aid in independent study the diagnostic tests were

a) very good
b) fairly good
c) neither good nor poor
d) rather poor
e) very poor



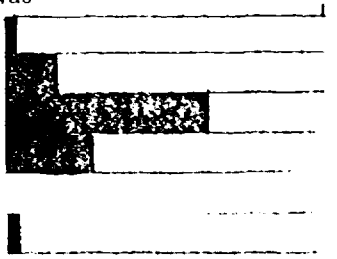
3. The pace of the TV programmes was as a rule

a) much too quick
b) rather too quick
c) reasonable
d) rather too slow
e) much too slow



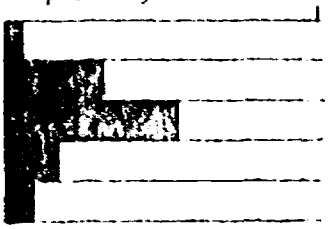
4. The quantity of information in the TV programmes was

a) much too great
b) rather too great
c) reasonable
d) some additional matter could have been included
e) much additional matter could have been included



5. The adaptation of the TV teaching to the students' capability was

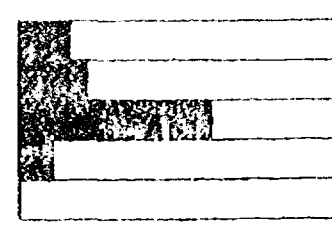
a) very good
b) fairly good
c) reasonable
d) rather poor
e) very poor



50 %

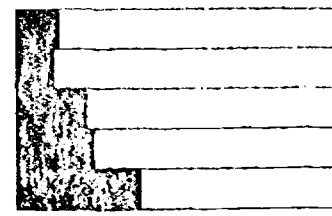
6. I consider the length of the TV programmes was

a) much too short
b) rather too short
c) reasonable
d) rather too long
e) much too long



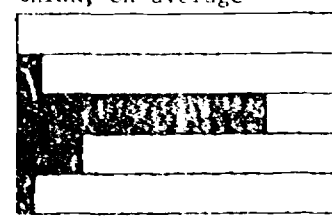
7. Comparing slides and TV for display of diagnostic tests I think that

a) TV is much better
b) TV is rather better
c) TV is as good as
d) slides are rather better
e) slides are much better



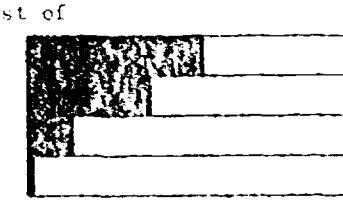
8. The time allowed for answering of questions is, I think, on average

a) much too long
b) rather too long
c) reasonable
d) rather too short
e) much too long



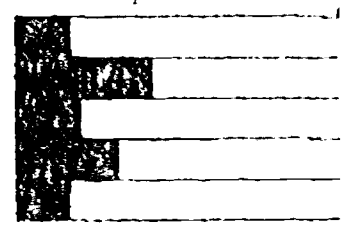
9. Comments after answers to questions should consist of

a) a thorough consideration of each alternative
b) a summary consideration of each alternative
c) consideration only of the correct alternative
d) merely indication of the correct alternative



10. If I were to repeat a course package I would most like a repetition of

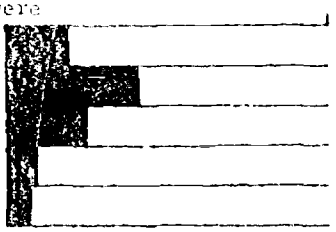
a) the TV programme
b) the conventional lesson
c) a mixed lesson with diagnostic tests and TV
d) the course literature
e) the circuit calculation exercise



50 %

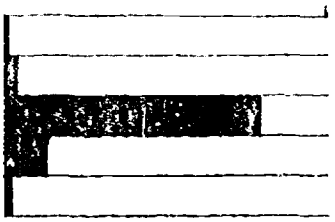
11. As aid in my studies the laboratory experiments were

a) very good
b) fairly good
c) neither good nor bad
d) rather poor
e) very poor



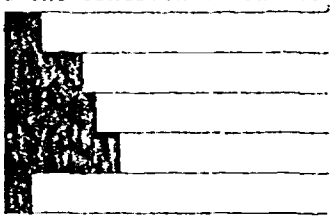
12. I should like the laboratory experiments to be

a) much more difficult
b) more difficult
c) as they are
d) easier
e) much easier



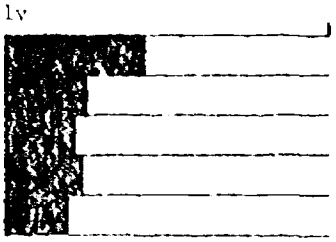
13. As preparation for each course package I have read the textbook on an average

a) 0 - 14 min
b) 15 - 29 min
c) 30 - 59 min
d) 1 - 2 hours
e) > 2 hours



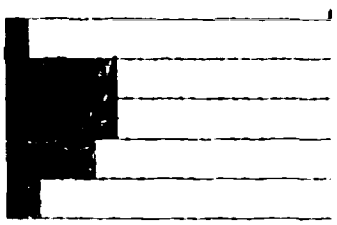
14. The reason for this time of preparation was chiefly

a) to get through the diagnostic tests
b) to prepare for the circuit calculation exercises
c) special interest in the subject
d) my normal method of study
e) other reason



15. I thought the circuit calculation exercises were

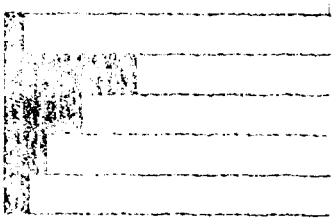
a) very good
b) fairly good
c) neither good nor poor
d) rather poor
e) very poor



Attitude test II, E_2-69 (May 1969)

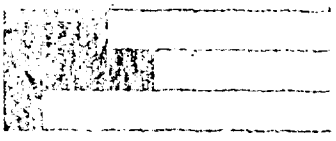
1. What is your overall impression of this TV teaching compared with average conventional teaching?

a) much better
b) rather better
c) neither better nor worse
d) rather worse
e) much worse



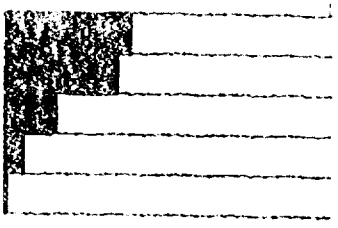
2. Do you miss the lectures which were replaced by TV?

a) yes
b) no
c) don't know



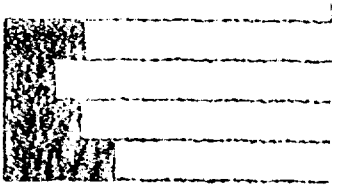
3. The specification of the course objectives to particular pages for each package was an aid which I utilized

a) every time
b) usually
c) sometimes
d) occasionally on trial
e) not at all



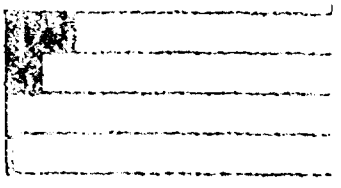
4. Should any of the following phases in the teaching be gone through more thoroughly, repeated, or prolonged?

a) TV
b) DT
c) exercises
d) laboratory experiments



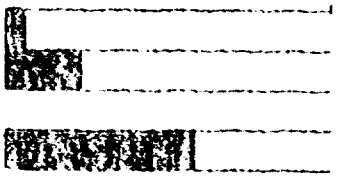
5. Should any of the following phases in the teaching be shortened or perhaps eliminated?

a) TV
b) DT
c) exercises
d) laboratory experiments



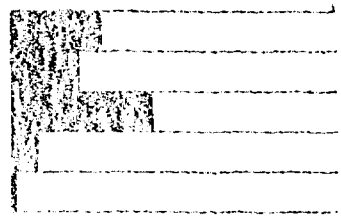
6. Would you like to have the TV programme repeated before the exercise?

a) in its entirety
b) theoretical
c) outside broadcast
d) not at all



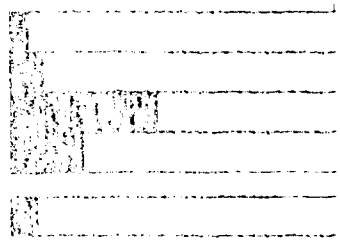
7. The pace of the TV programmes was as a rule

a) much too quick
b) rather too quick
c) reasonable
d) rather too slow
e) much too slow



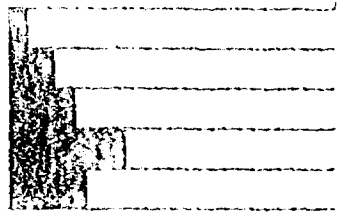
8. The quantity of information in the TV programmes was

a) much too great
b) rather too great
c) reasonable
d) some additional matter could have been included
e) much additional matter could have been included



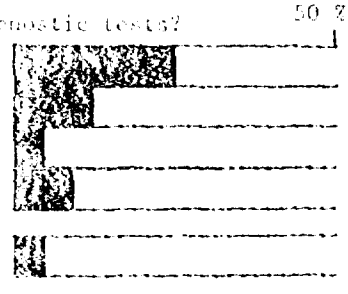
9. The adaptation of the TV teaching to the students' capability was

a) very good
b) fairly good
c) reasonable
d) rather poor
e) very poor



10. What is the greatest value for you of the diagnostic tests?

a) that I prepare the lesson
b) that I learn from the actual test
c) that I read up what I failed in the test
d) that the teacher gets to know what is most difficult in the course
e) no value at all



11. As aid in independent study the diagnostic tests were

a) very good
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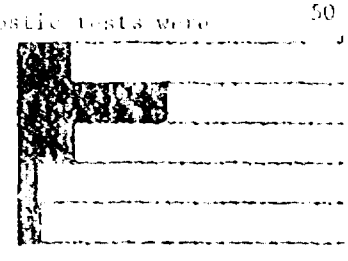

12. Comparing slides and TV for display of diagnostic tests I think that

a) TV is much better
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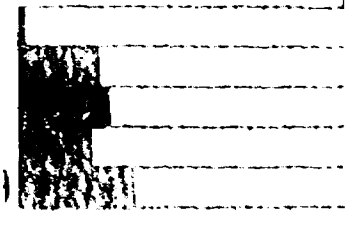
c) TV is as good as
d) slides are rather better
e) slides are much better



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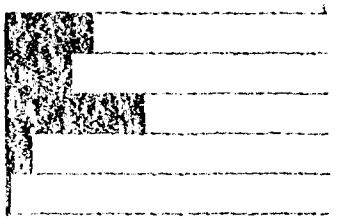

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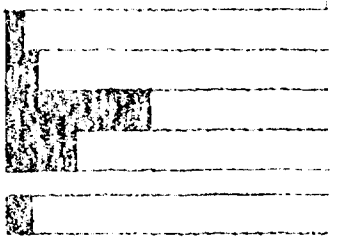

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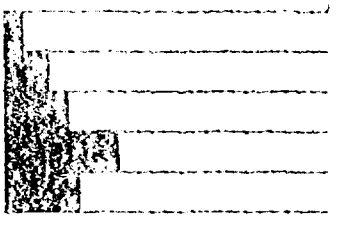

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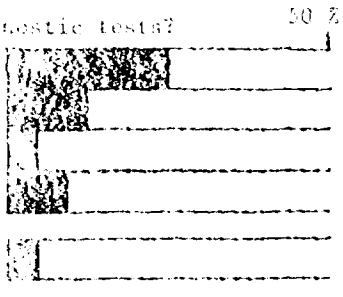
e) no value at all



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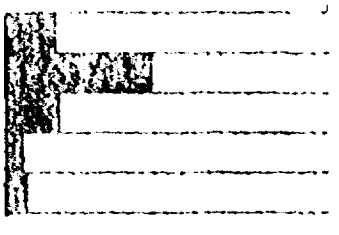

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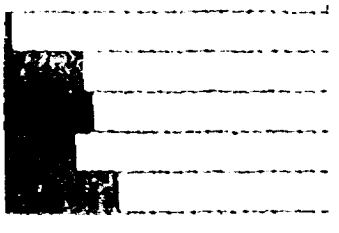
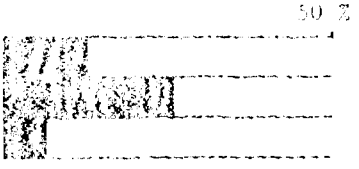


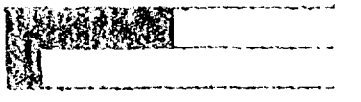
13. Did you obtain any "self-check" of your knowledge through the diagnostic tests?

a) to a large extent
b) partially
c) not at all



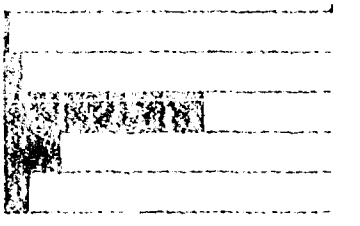
14. Have you received satisfactory answers to the questions you asked after the diagnostic tests?

a) yes
b) no



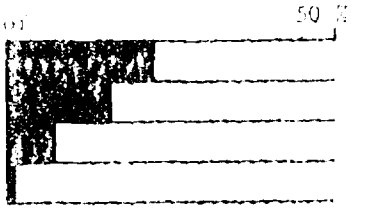
15. I consider the time allowed for answering questions is on average

a) much too long
b) rather too long
c) reasonable
d) rather too short
e) much too short



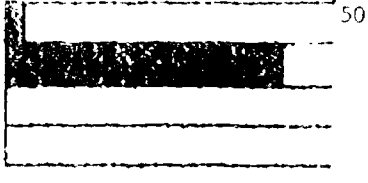
16. Comments after answers to questions should consist of

a) a thorough consideration of each alternative
b) a summary consideration of each alternative
c) consideration only of the correct alternative
d) merely indication of the correct alternative



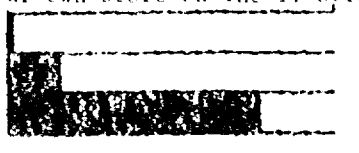
17. Do you mind seeing your fellow-students' scores or that they see yours?

a) I am aware only of my own position
b) makes no difference
c) annoying
d) very disturbing



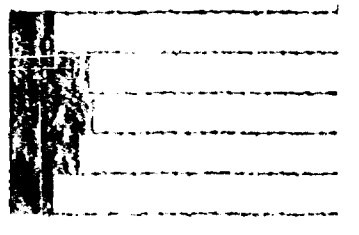
18. Did you have difficulty in following your own score on the TV screen?

a) yes, always
b) yes, occasionally
c) no



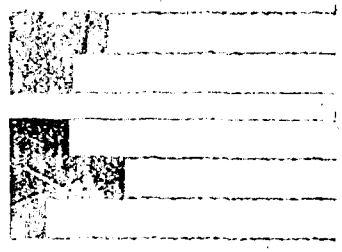
19. As preparation for each course package I have read the textbook on an average

a) 0 - 14 min
b) 15 - 29 min
c) 30 - 59 min
d) 1 - 2 hours
e) > 2 hours



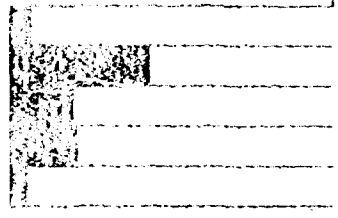
20. The reason for this time of preparation was chiefly

a) to get through the diagnostic tests
b) to prepare for the circuit calculation exercises
c) special interest in the subject
d) my normal method of study
e) other reason



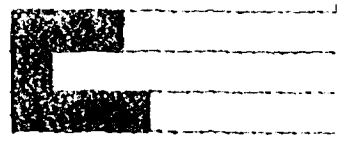
21. I thought the circuit calculation exercises were

a) very good
b) fairly good
c) neither good nor poor
d) rather poor
e) very poor



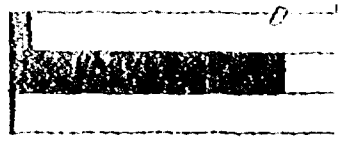
22. I consider the calculation exercises should contain

a) more theory
b) more detailed calculation
c) present content



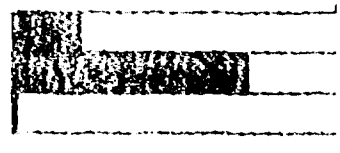
23. Was the number of problems to be solved per exercise reasonable?

a) too many
b) resonable
c) too few



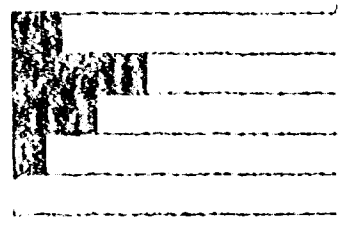
24. What was the degree of difficulty of the calculation exercises?

a) too difficult
b) reasonable
c) too easy



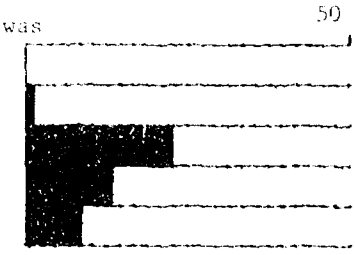
25. As aid in my studies the laboratory experiments were

a) very good
b) fairly good
c) neither good nor bad
d) rather poor
e) very poor



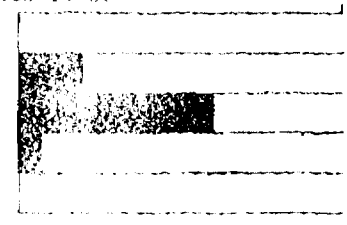
26. The number of laboratory experiments was

a) much too large
b) rather too large
c) reasonable
d) rather too small
e) much too small



27. I should like the laboratory experiments to be

a) much more difficult
b) more difficult
c) as they are
d) easier
e) much easier



28. Did you receive the assistance you needed i. the laboratory experiments?

a) yes
b) no