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THE EFFECTS OF PROGRAMED INSTRUCTION ON ATTITUDE AND ACHIEVEMENT.

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DESCRIPTORS- *PROGRAMED INSTRUCTION, *STUDENT ATTITUDES, ACHIEVEMENT GAINS, COLLEGE STUDENTS, INDUSTRIAL EDUCATION, *ELECTRONICS, TEACHING MACHINES, *EVALUATION, AUTOTUTOR MARK II, CHAMPAIGN, SPRINGFIELD.

FIFTEEN COLLEGE STUDENTS ENROLLED IN TWO CLASSES (GENERAL ELECTRICITY AND INTRODUCTION TO ELECTRONIC THEORY AND PRACTICE) WERE STUDIED FOR ONE SEMESTER TO (1) EVALUATE THE EFFECTIVENESS OF USING THE AUTOTUTOR MARK II WHICH HAD BEEN PROGRAMED TO PERMIT INDIVIDUAL STUDY OF THE ABSTRACT THEORIES OF ELECTRICITY AND CURRENT APPLICATIONS IN INDUSTRY AND IN TEACHER TRAINING, AND (2) EVALUATE INITIAL LEARNER ATTITUDE TOWARD PROGRAMED INSTRUCTION AND SUBSEQUENT ATTITUDE SHIFT AS A RESULT OF CONTINUED EXPOSURE TO THIS INSTRUCTIONAL TECHNIQUE. THE STUDENTS WERE SEPARATED INTO THREE GROUPS--LECTURE-LABORATORY, PROGRAMED INSTRUCTION, AND CONTROL GROUP. THE AMOUNT AN INDIVIDUAL GAINED WAS COMPARED TO THE AMOUNT HE POSSIBLY COULD HAVE GAINED. NO SIGNIFICANT DIFFERENCE IN ACHIEVEMENT WAS NOTED IN THE THREE GROUPS AS MEASURED BY GROWTH. TABLES OF RAW DATA ARE INCLUDED. THE ATTITUDE EVALUATION STUDY OF THE PROGRAMED INSTRUCTION GROUP SHOWED A SHIFT FROM A HIGHLY POSITIVE TO A DEFINITELY NEGATIVE REACTION. THE STUDENTS WERE MOST CRITICAL OF PROGRAMED INSTRUCTION IN THE AREAS OF TEACHING SLOW LEARNERS AND QUALITY OF EXPLANATION. THE TEACHING MACHINE FAILED TO HELP THE STUDENTS BUILD DESIRABLE ATTITUDES TOWARD PROGRAMED INSTRUCTION. (PS)

the effects of programmed instruction on ATTITUDE and ACHIEVEMENT

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VOCATIONAL - TECHNICAL EDUCATION DEPARTMENT

THE EFFECTS OF PROGRAMMED INSTRUCTION ON ATTITUDE AND ACHIEVEMENT

Barbara Rosenquist & Mark Miller

The report prepared for
The State Board of Vocational Education
by
The Department of Vocational-Technical Education
College of Education
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FOREWORD

The genesis of this report was a publication by the U.S. Office of Education which revealed that Illinois was one of the few states that had done no research on the use of the programmed instruction in industrial education. This prompted the preparation of a proposal which was forwarded to the State Department of Vocational Education and subsequently supported by that department and by the University of Illinois, Department of Vocational Technical Education.

The major portion of the conduct of the experiment, the data collection, data analysis, and the writing up of this report has been the responsibility of Barbara Rosenquist and Mark Miller who are credited as the authors of this report.

It is the hope of the persons involved that this experiment will generate interest in classroom experimentation and that this experiment will be the first of a series involving the State Department of Education and the Vocational Technical Education Department of the University and the faculty thereof. The students, faculty, and Illinois public education will undoubtedly profit to some extent from this experiment and the report and additional experimentation which it is hoped will follow.

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INTRODUCTION

Industry is not the only group to feel the quickening pressures of automation. The requirements necessary to gain entry into the occupational setting have been rising. Incorporated into the knowledge necessary to fulfill a job function is an increasing reliance upon the interdisciplinary knowledge upon which the industry is predicated. However, even with the postponed entry into the labor field, there is insufficient time for the worker to master both the abstract scientific concepts which contribute to the development of new processes, and the techniques and practical application of those concepts in the production setting (Schill, 1964, p. 3).

The pressure of this development must be borne in part by the people who have elected themselves responsible for preparing the worker for his future job function--the educators. It is up to them to realize a way of equipping the student with the knowledges he must have, and to do so in the time allotted him.

This implies that more effective teaching methods must be inaugurated; that the instructor must be sensitive enough to the times to realize this. To date, industrial education programs have been alien toward accepting these viewpoints. Bateson and Stern (1963) have examined the matter of educational objectives with an attempt to identify and clarify those objectives which are proper and dominant for industrial education. They have outlined their beliefs for the basic causes of proliferation in previous industrial education objectives with suggestions toward ultimate improvement. This is but one example which demonstrates the need for action. To realize an effective solution to the problem,

> (industrial education) teachers, supervisors and teacher educators must critically analyze their past performance with the aim of providing better instruction and inaugurating pilot programs that can test new ideas. (HEW, 1962, p. 64)

Related Research

Instruction is the process by which a teacher presents subject matter to a learner so that he responds to it in a way that enables the teacher to determine the next item of information to be presented.

The planning of instruction will continue to be the province of the teacher; however, recent research has attempted to show how the implementation of this instruction can be accomplished automatically, through the use of teaching machines.

To this end, researchers have been concerned with determining what specific functions are to be optimized and, subsequently, the best way of accomplishing this. They have employed means to manipulate the stimulus to which each criterion response is attached. Furthermore, they have varied methods for eliciting the desired performance, predicated on different reinforcement techniques.

One result that is apparent from a survey of the research is the effectiveness of machines for teaching a variety of different subjects or materials; a second is its effectiveness for a variety of different learners (Stolurow, 1961, p. 103). However, the question, "How well do students learn from programs as compared to how well they learn from conventional methods of instruction?" cannot be answered so confidently. On one hand is the situation which can be explicitly controlled, on the other is the situation that is unique to the type of teacher and course.

One of the more comprehensive investigations of programmed instruction has been conducted by Geer (1962) under the sponsorship of Bell Laboratories. This study compared the performances of three groups: conventional instruction, and programmed instruction with and without laboratory experiences, also programmed, covering the subject matter of basic electricity. Pre-tests with Form 2B of the Otis Employment Test (Electrical) and a test constructed by the investigator, with content drawn from concepts in the verbal program, showed all groups to be drawn from the same population.

The group receiving programmed theory and laboratory exercises gained significantly more electrical knowledge than either of the other group conditions as indicated by a post-test constructed by an external group, the Communications Social Science Research Department of Bell Laboratories.

Thirty six similar reports, comparing programs with conventional classroom instruction, were tabulated in an annotated bibliography prepared by the U.S. Department of Health, Education, and Welfare. Of these thirty-six comparisons, eighteen showed no significant difference when the groups were measured on the same criterion test. But seventeen showed a significant superiority for the students who worked with the program, and only one showed a final superiority for the classroom students.

By and large, the experiments to date have been conducted over short periods of time with a small number of students. These have been basically exploratory in nature. There are some results, however, that indicate the desirability of comparing student achievement in the traditional teaching pattern over the same length of time. It is suggested that the

research reported herein will further the investigation in that previous research indicates that the materials to be presented and the mode of presentation are equivalent to, if not better than, other existing programs and modes. Moreover, the research in this area has characteristically dealt with factual assimilation to the exclusion of the emotional aspects of this new approach. Some studies which did consider attitudes and feelings of the learner (Collins, 1962) limited themselves to very unstructured interviews with no attempts at quantification.

This study also represents an effort to detect, assess, and quantify changes in attitude toward programmed instruction as it is presented by the teaching machine over an extended period.

The Problem

Industrial education concerns itself with the theoretical information and the manual skills needed to perform satisfactorily in the occupations as well as the relationship of these skills and knowledges to the culture. The project method that is so widely used in industrial education is expensive in time and energy, and in addition, it can well become the vehicle for occupying student time while negating the necessity of keeping abreast of the applied theory and industrial skills which should be part and parcel of the educational setting. If today's industrial arts teachers are meek, mild, and mediocre, it may well be because they have insufficient preparation in the theory applicable to their subject matter area.

The Department of Vocational and Technical Education, College of Education, University of Illinois, Urbana,

currently offers a course in general electricity which is concerned with an introduction to basic theory and industrial practice. This is not an atypical course. If the teacher training institutions are going to produce teachers capable of imparting the fundamental abstract theories of electronics to high school students, and at the same time, acquaint them with the basic skills necessary to perform in industry, there must be an increase in the efficiency of the presentation of materials.

Automated programmed instruction provides a possible source of individual student tutoring. The availability of programs written by experts in the field may serve to expand upon the teacher's knowledge of that field. Subject matter presentation by programmed devices could also serve to fill the gap when qualified teachers are not available. The generalist in industrial arts may be able to improve his teaching by relying, in part, on programmed materials which cover theory he is not prepared to teach.

The study reported herein, because it is a long-term intensive study of a small group, can properly assess student growth and the change of attitude toward programmed materials as the result of exposure to them.

Objectives

The objectives of this study were to:

1. evaluate the efficacy of using an existing automated instructional device, which has been programmed to permit individual study of the abstract theories of electricity and current applications in industry, in teacher training;

2. evaluate the effect of practice in application upon student achievement in related theory;
3. evaluate initial learner attitude toward programmed instruction and subsequent attitude shift as a result of continued exposure to this instructional technique; and
4. acquaint prospective industrial education teachers with newer educational media.

METHODOLOGY

Subjects

The students enrolled in VoTec 285, General Electricity, and Aviation 181, Introduction to Electronic Theory and Practice, comprised the population of the study. The enrollment of these classes was fifteen students. While prior studies have used considerably larger N's in investigating the effects of programmed instruction on student achievement, it must be recognized that these prior studies were also conducted over a relatively short time and the exposure to programmed instruction per student was measured in minutes or hours rather than months.

The students in VoTec 285 were assigned to one of two groups: five full-time in the lecture-laboratory setting and four full-time in the programmed instruction setting. The assignment was on the basis of pre-test achievement scores in electrical theory. The students were paired on pre-test scores and then randomized into two groups. Using Kruskal-Wallis one-way analysis of variance,* it was ascertained that there was no significant difference between the groups at the 5% level, 7 df.

The students enrolled in Aviation 181 comprised the control group; they had no knowledge of the existence of the experiment.

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*The Kruskal-Wallis (H) one-way analysis of variance does not require normal distribution, but it does require that the data being analyzed be continuous.

The reason for using this statistic is to determine if the differences that exist among the test scores in this study could have occurred by chance. The Kruskal-Wallis (H) statistic compares the placement of the sub-groups within.

All three groups were assumed to be random samples from a common population, again, H not significant at the 5% level.

The Equipment

The Autotutor Mark II is a partially adaptive machine built by Western Design; it is illustrated in Figure 1.

Fig. 1 The Autotutor Mark II

Basically the Autotutor is an automatic, random-access, 35 mm recording projector displaying one frame at a time. The student finds the first unit of subject-matter information on image 1 of the film, along with a multiple-choice question based on that unit of information. He then selects an answer to the multiple-choice question, enters into a keyboard the frame number (address) accompanying the answer he selects (a frame number is always located beside each alternative answer) and presses the button of his choice. The device then automatically locates and projects the image found at the address selected by the student. If the correct answer to the multiple-choice question was chosen, the image selector will not only contain knowledge of results, e.g., "you are right," but also will contain the next unit of information, and the next question. If an incorrect alternative is chosen, the corresponding image will tell the learner of his error, provide information designed to correct the particular error, and direct him to return to the image at which he made his mistake and try again (Stolurow, 1961, p. 31).

Appendix A contains three frames which typify those found in the Autotutor program on Electronic Theory. These show the statement of a problem, an incorrect solution response, and a correct solution response, respectively.

A recorder was connected to the machine to print the number of frames visited by the student. These data were utilized for computation of error rate.

Development and Conduct of Instruction

The author of the proposal that resulted in support for this study was engaged for a year and a half in the editing

of the material on electricity and electronics for Educational Science, Incorporated, Division of U.S. Industries. In his opinion the material is sufficiently detailed and adequately programmed for use in this study.

The programmed instruction device was housed at a separate location from the rest of the facilities for students in electricity. A log was kept of student time which also served as a check on error rate and number of frames covered during each session. To minimize student involvement with the device, and to maximize efficient utilization of the programmed material, the machine was always in operating order with the proper film installed and on the right frame for the student who was next to view the instructional material. Students viewed the programmed material by appointment, permitting the participation of four students with only one programmed device.

The lecture-lab instruction included all of the information that was included in the programmed device, although it was not necessarily presented in the same order. The lecture followed Electronics for Scientists by H. F. Malmstadt and C. G. Enke (W.A. Benjamin Co., 1962). The text was elaborated upon as needed to clarify concepts for the student. The laboratory sections consisted of breadboarding, circuit analysis, and measurement exercises designed to reinforce the lectures and readings.

The students enrolled in this course attended class for one semester. During the first week, the pre-test was administered, the data was analyzed to determine the class grouping, and orientation to the programmed device took place. Additional sessions were used for criterion tests

and the final examination (post-test). Considering these intervening variables and the fact that an instructional hour is fifty minutes, the total time available to the students in the formal instruction setting was about sixty-five hours for each group.

Instruments

The data collected during this study was comprised of the information found in Table 1. The test measures employed are described below for further clarification of the content and the method employed.

1. Pre- and post-achievement tests--The achievement test was first administered to students in January, 1963. The split half reliability of this form was .873 (each concept tested was represented by two versions of the same item). From this, an item analysis was completed which identified the 151 items to be retained for use in the experiment.

2. Semester quizzes--Two objective tests were given during the course of the semester. They consisted of twenty-five multiple choice questions designed to measure specific aspects of electrical theory that had been covered up to that time.

3. Laboratory practical test--This test was prepared to assess student capability on the use of basic test and measuring equipment. It involved the use of the volt-ohmmeter and oscilloscope in a variety of applications. Grading was done through a subjective assessment by the instructor with each item being scored "zero" for poor, "one" for fair, and "two" for good.

4. Extension test--This test was of the same form as previous written examinations; however, it covered circuit analysis and electronic theory of a more advanced nature. The purpose of this test was assessment of upper limits of understanding in this area.

5. Attitude evaluation--At the beginning of the study it was determined by means of a brief questionnaire that, although many of the students were somewhat familiar with programmed instruction, none had any prior direct contact with this type of teaching. (See Appendix B for a sample questionnaire.)*

After considerable investigation of the types of tools being employed for attitude assessment, the decision was made to construct a device containing 25 statements about programmed instruction and ask the students to react to each statement on a graphic rating scale. (See Appendix C). The responses range in five steps from "Strongly Agree" to "Strongly Disagree" with the number three or center choice indicating "No Opinion." This type of rating scale is a variation of the Semantic Differential which has been developed and used very effectively by Osgood to measure "the meaning, in a given sense, to any individual of literally any concept within his ken" (Osgood, Suci, and Tannenbaum, 1957, p. 91).

*Examples of the questions from each of these tests appear in Appendix D.

TABLE 1
Mean Values of Variables Investigated

	Lect-Lab N=5	Prog. Instr. N=4	Inst. of Avia. N=6
Age	23.60	20.25	20.11
Total Sem. Hrs. Completed	55.40	64.00	9.33
Total Hours Related Study	12.20	9.25	10.00
Math	8.20	7.00	7.17
Physics	2.60	2.00	1.33
Electricity-Electronics	1.40	.25	1.50
Attitude			
Pre	-2.60	+9.00	-11.50
Post	+1.40	-3.00	-13.17
Criterion Tests			
Pre-test (%)	41	54	50
1st Quiz (%)	86	66	
2nd Quiz (%)	86	68	
Post-test (%)	88	83	82*
Practical Test (%)	82	52	
Extension Test (%)	51	48	
Total Time (Hours)		64.19	
Total Frames Viewed		3382	
Raw Error		1175	
Error Rate		54.50%	
Raw Growth	34.	29.25	31.80*
Possible Gain	69.60	64.25	64.2*

* N = 5 for these values

RESULTS AND DISCUSSION

Measures of achievement were predicated upon a pre-test, two criterion tests administered at intervals during the semester, a practical performance test, and an extension test which went beyond the material covered in the course. The total frames, total time, and error rate on the Autotutor were computed for the students using the programmed material.

The control group at the Institute of Aviation was only administered the pre- and post-test; therefore, the N for assessing the relationships between the various test consisted of the nine students enrolled in the lecture-lab and programmed instruction groups.

Table 2 presents the 15 inter-correlations among the various tests. It was expected that they would be highly inter-correlated because they measure essentially selected aspects of the same body of knowledge. However, not evident from the table is the fact that type of instruction had no effect on these relationships.

Kruskal-Wallis one-way analysis of variance was performed to determine if the achievement of the students, on the criterion test, was comparable among modes of instruction. There was no significant difference, using H at the .05 level. Therefore, it was decided that a measure of gain, rather than raw score achievement, might be a more meaningful measure to use. This would consider the fact that the students were not starting at the same initial point in their mastery of the subject matter (as witnessed by the pre-test scores). Achievement might be better described by looking at how much the students elevated their knowledge from differential starting points.

TABLE 2
The Relationship Between The Testing Procedures Employed

1.	Pre	X					
2.	1st Quiz**	.31	X				
3.	2nd Quiz**	.55	.77*	X			
4.	Post	.43	.81*	.71*	X		
5.	Practical**	.49	.79*	.93*	.59	X	
6.	Extension**	.63	.59	.73*	.61	.76*	X
		1	2	3	4	5	6

*An asterisk denotes significance at the .05 level, df varying on N.

**These tests are based on an N of 9, being that they were not administered to the control group.

Measurement of Gain

Measurement of gain was done in two ways. One was to assess the raw score gain from the pre- to the post-test. Another method was to assess the amount an individual gained compared to the amount he possibly could have gained. This was accomplished by taking the raw gain (post-test score minus pre-test score) divided by possible gain (possible score minus pre-test score) to give a percentage score.

These two methods were then correlated, r equaling .52, which is significant for an N of 14 at the five percent level. The opinion of the researchers was that the percent of possible gain was a more descriptive measure. Since it was highly correlated with raw gain, it was the computation which was used for the remainder of the analysis.

Kruskal-Wallis one-way analysis of variance was used to assess the gain in the above measure because of the small N in each group and the unwillingness of the researchers to

assume a normal distribution. The calculation resulted in an H of .2, which indicated no significant difference among the three groups in achievement as measured by growth. This is portrayed graphically in Figure 2.

The importance of this finding rests on the amount of time invested by the groups in studying. The programmed instruction group did as well as the lecture lab group, with no outside reading or homework. Consequently, they spent considerably less total time on study than did the

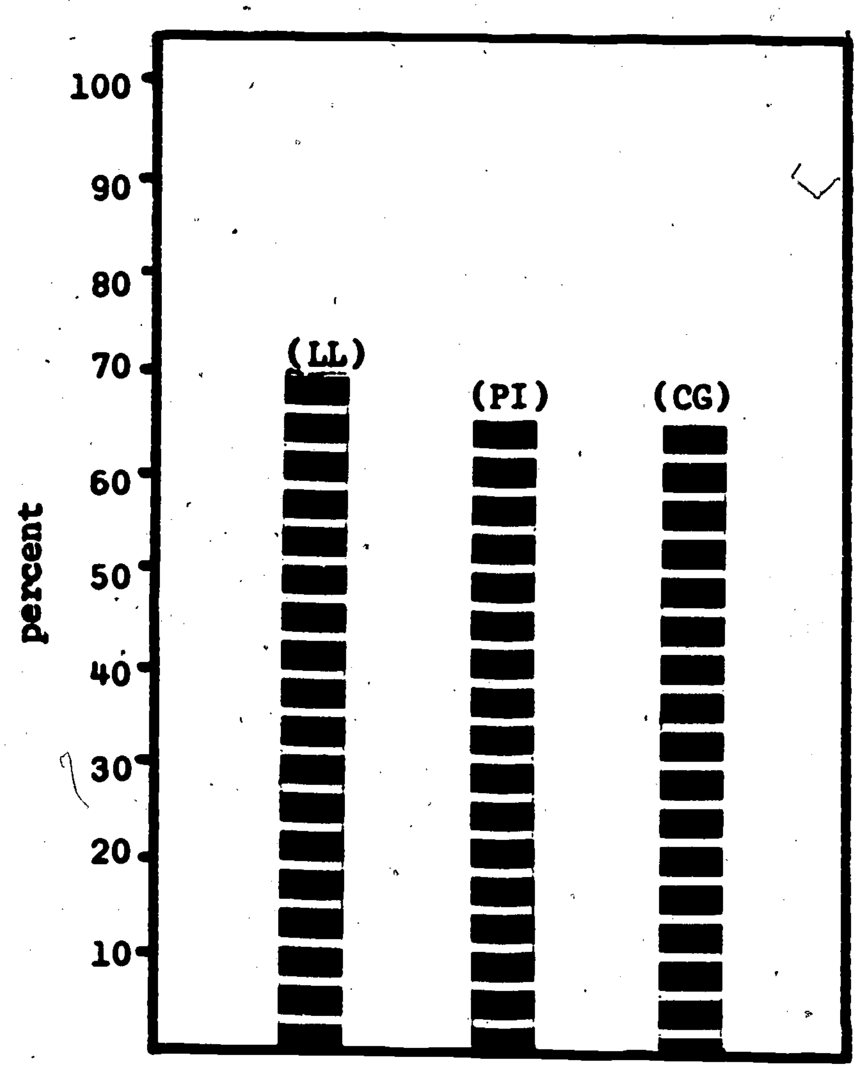


Fig. 2 Possible Gain by Group

other two groups. Of course, this could overlook the possibility that the total time studying theory would be about equal when it is realized that the lecture-lab and control group spent approximately 2/3 of their time in lab.

Scores on the Extension and Practical Test

The purpose of these tests was to determine if the "no significant difference" comparison between the lecture-lab and programmed instruction group* would break down when:

1. The groups were asked to extrapolate beyond the knowledge gained in this course on an objective test, mainly covering theory with some circuit analysis.
2. The groups were asked to demonstrate their ability to use simple test and measurement devices; one group having been actively involved with this type of material, and the other having only read about it.

The extension test was analyzed via Kruskal-Wallis one-way analysis of variance resulting in an H equal to .5. Again we find that the assessed method of instruction did not contribute to any significant difference.

Using the same analysis of variance technique to assess the scores on the practical resulted in an H of 2.9. This is significant at the .05 but not at the .01 level.

*These tests were not administered to the control group at the Aviation Institute because the time involved impinged too greatly on their allotted schedule. Therefore, the N in this case is 9.

Undoubtedly, the small N in this case is contributing in part to this result. There is still something not to be overlooked; this is the fact that the students in programmed instruction, having no intimate relationship with the devices -- only the theoretical presentation, were still able to demonstrate an acceptable performance on the practical test. Table 2 also shows significant relationships between the practical, the two quizzes, and the extension test. This further indicates that the relationship between theory and practice in the lab is not being fully exploited with the size of this group and the length of time involved.

The Influence of Variables Other Than Tests on Achievement

An attempt was also made to analyze the effects of:

1. previous formal educational experiences related to electricity;
2. total semester hours of university study; and
3. age on the assessment of gain in this course.

To this end, the students' exposure to mathematics, physics, and electricity-electronics in the formal education setting was totaled and the inter-correlations computed. Since the total time of study in these areas correlated significantly high with the individual courses it is the value which was used in the analysis. The effect of this variable

did not indicate a significant relationship with any of the others. It was concluded, therefore, that the measures of achievement in the experiment were sufficiently independent of past studies in these three areas so as to be ignored.

Age, as another gross assessment of experience, was also found to have no significant correlation with any of the other variables. However, total semester hours was related; the effect coming largely from the fewer number of hours completed by the group at the Institute. This was highly correlated with the amount of physics studied. The apparent reason for this is that the study of physics on the University of Illinois campus is generally postponed by education students until later in their academic careers. Essentially then, this can also be ignored in looking at achievement in the experiments.

Performance on the Teaching Machine

This research indicates that there is no tenable basis for rejecting the conclusion that one method of instruction is more satisfactory than another for a particular group of students. However, there are still some interesting insights to be gained from taking a closer look at what was taking place with the students using programmed instruction. Figure 3 shows that this method started with a group of students whose differential starting points were similar (range of pre-test scores) and diversified them with regard to their final achievement (range of post-test). On the other hand, the lecture-lab method started with a group having a large range of scores on the pre-test and brought them up to similar levels, as witnessed by the small range on the post-test.

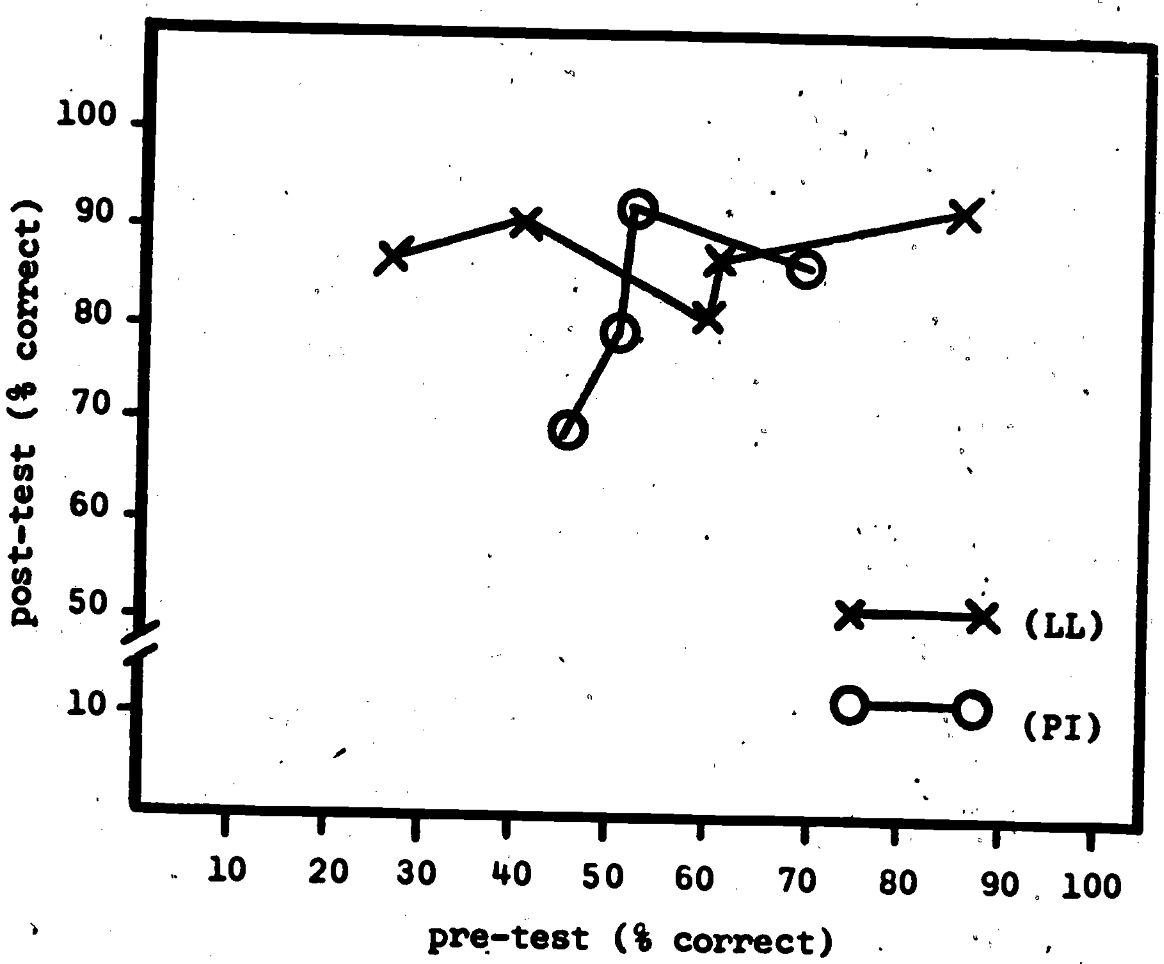


Fig. 3 The Percentile Range of Scores by Individuals for Pre- and Post-test

This finding would appear to be at odds with the popular conception of programmed instruction. Research has indicated that the use of programmed learning would serve to decrease the effect of students' heterogeneity on teaching practices. Student differences would show up at the beginning of a course of instruction and would be reduced by the end of the course, each student proceeding at his own pace.

For the purpose of investigating this finding three additional variables were computed. These were: total time spent on the programmed material, total frames, and error rate.

Total time was simply the amount of time spent by each student viewing the material.

Total frames was the number of frames viewed by the student as he progressed through the various topics covered on the programmed reels. This was considered pertinent, inasmuch as there was a minimum number possible in order to complete the reels most efficiently.

From this information, error rate was computed; this being the complement of the number of frames viewed, divided by the minimum number possible to view in order to complete the program reels. The calculations were based on the four larger reels of programmed material which were viewed by the students during the middle part of the semester. It was computed this way, rather than for all of the reels, in order to overcome the differential difficulties in orienting the students to the programmed instruction device and to overcome the differential anxiety manifest in the later stage shortly before the final examination.

By inspection of the data, it is apparent that the total number of frames is highly related to error rate. This value is irrespective of total time. In other words, time is the crucial factor. Given the same amount of time, the student with the higher rate of error will progress through the material more slowly; hence, his performance on the criterion measure will be affected inasmuch as he covers less content. Therefore, when the time element is constant, it would appear logical to expect the divergence shown in Figure 3 if the student proceeds at his own rate.

In the lecture-lab setting the student is held to a time schedule. He is, therefore, exposed to the same amount of material as everyone else and has the option of studying on his own to brush up on those points about which he is in doubt. His contemporary on the teaching machine cannot proceed to the

next point until he has mastered the present information. The suggestion here is that, even though performance on the criterion test does not show any significant difference, the optimum procedure for using a programmed device would be to have the length of the program time in accord with the anticipated progress of the less proficient student.

Attitude Evaluation

At the beginning and end of the study the reaction of each of the three groups toward programmed instruction was elicited. The attitude survey instrument was broken down into three areas as follows: (1) presentation of material as related to note taking, understanding, and retention; (2) student-teacher interaction and values derived therefrom; and (3) general assessment involving gross comparisons of programmed instruction with conventional teaching.

Each response was weighted according to whether the statement being responded to was positively or negatively oriented. That is, if space "2" or "4" were checked it was scored ±1, and if space "1" or "5" were checked a score of ±2 was attached.

The results of this study showed the following changes in attitude (see Figure 4). As might be anticipated, the lecture-laboratory group underwent relatively little attitude change since it was not in direct contact with programmed instruction. This group began with a negative attitude score (-13) and moved 20 points in a positive direction (+7). The control group at the Institute of Aviation was the most stable with a range of only 10 points. This group began with a high negative score (-69) and moved even more negatively during the course of study (-79). It is suspected, however,

that the attitude displayed by this group might have reflected a measure of irritation with the study itself rather than a particular reaction against programmed instruction. The programmed instruction group went from a very high positive score (+36) to a negative score (-12) with a total change of 48 points.

Since only the programmed instruction group was exposed to the teaching machine, it is not surprising that it is the only one showing any appreciable shift in attitude during the experiment. The initial positive reaction may well be attributed to the presence of the Hawthorne Effect. That is, at the outset members of this group were reacting to the novelty of the situation rather than to the reality of learning by this method. As the study progressed, the machine lost some of its newness and, consequently, the attitude of the group

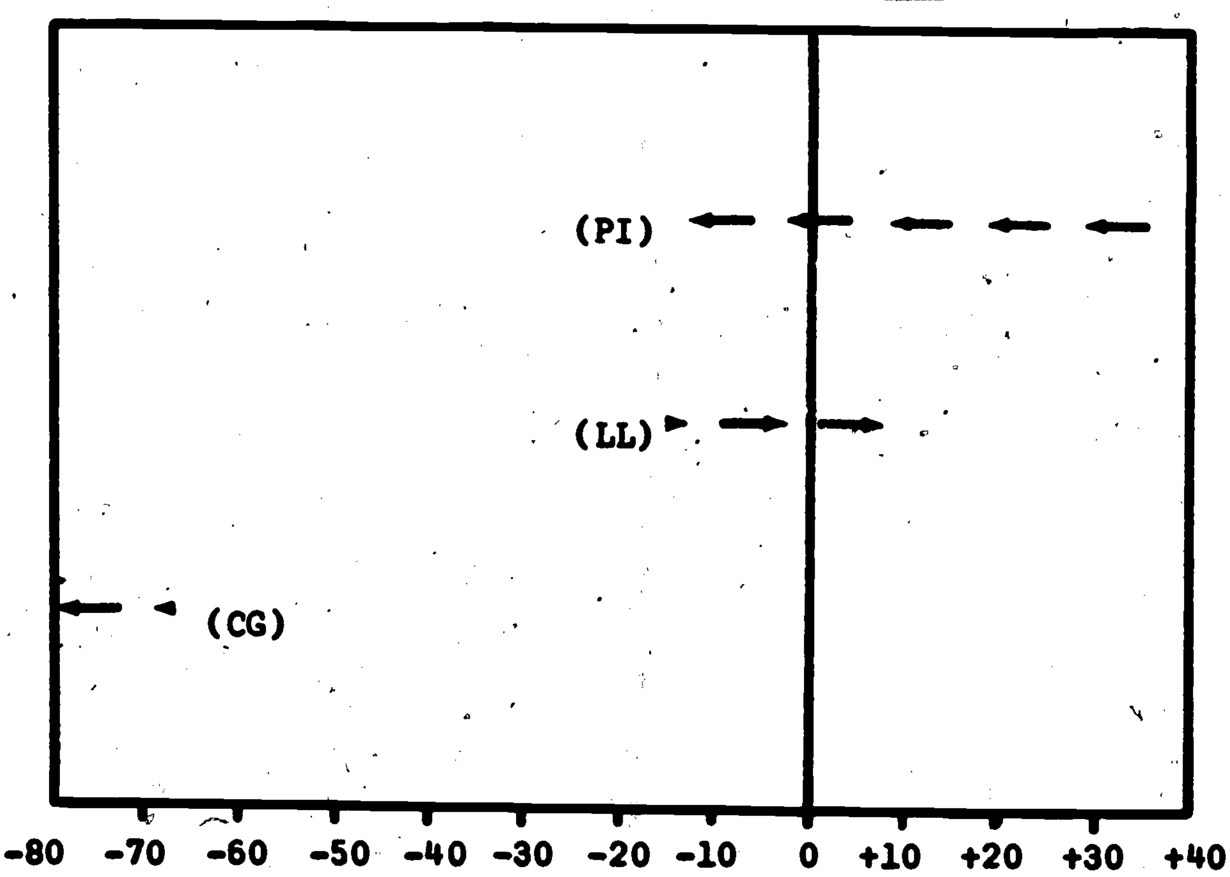


Fig. 4 —Attitude Shift (Direction & Range)

began to grow more negative. This definite negative shift was reflected in a more critical reaction to practically all areas covered by the attitude instrument with 76% of the statements receiving a more negative reaction. Only 12% moved positively with the remaining 12% showing no change.

The most significant positive change in attitude occurred with respect to the level of concentration thought to be required by the teaching machine. Pre-test responses indicated that students strongly agreed that a very high level of concentration is necessary. They later concluded, apparently as a result of increased familiarity with procedure, that this is not a distinguishing characteristic of programmed instruction.

Specific statements reflecting a marked negative shift in attitude dealt with blanket endorsement of programmed instruction, effectiveness in teaching slow learners, and quality of explanation. In these areas students were most critical of programmed instruction.

This definite shift in attitude would certainly seem to be an indictment of the concept of total mechanization of teaching. Many of our leading educational philosophers, following Dewey and Kilpatrick, have emphasized the need for satisfaction in the course of learning if it is to be effective and permanent.

The teaching machine appears to have failed to help the student build desirable attitudes toward programmed instruction. This is not to say that this device is without merit, inasmuch as learning has occurred despite this shortcoming. It is apparent, however, that the fundamental, socially-oriented nature of the human organism will have to undergo

some changes before we arrive at the oft-talked about school of the future wherein all stimuli are "canned" and all responses are in the form of pressure exerted upon a plastic button.

REFERENCES

1. Bateson, W. M., and Stern, J. "The Functions of Industry as the Basis for Industrial Education Programs," Journal of Industrial Teacher Education, 1963, Vol. I, p. 3-16.

2. Collins, John J. "An Experiment in the Use of Teaching Machines at Bakersfield College," Submitted for publication to the Junior College Journal, March, 1962.

3. Geer, L. N. "A Study of Comparative Methods of Teaching Basic Electricity," Training Directors Journal, 1962, Vol. 16, No. 12, p. 17-24.

4. Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. The Measurement of Meaning, (Urbana: University of Illinois Press, 1957).

5. Schill, William John. Curricula Content for Technical Education, U.S. Department of Health, Education, and Welfare, Cooperative Research Project No. 2048, 1964.

6. Stolurow, L. M. Teaching by Machine, U.S. Department of Health, Education, and Welfare, Cooperative Research Monograph No. 6, OE-34010, 1961.

APPENDIX A

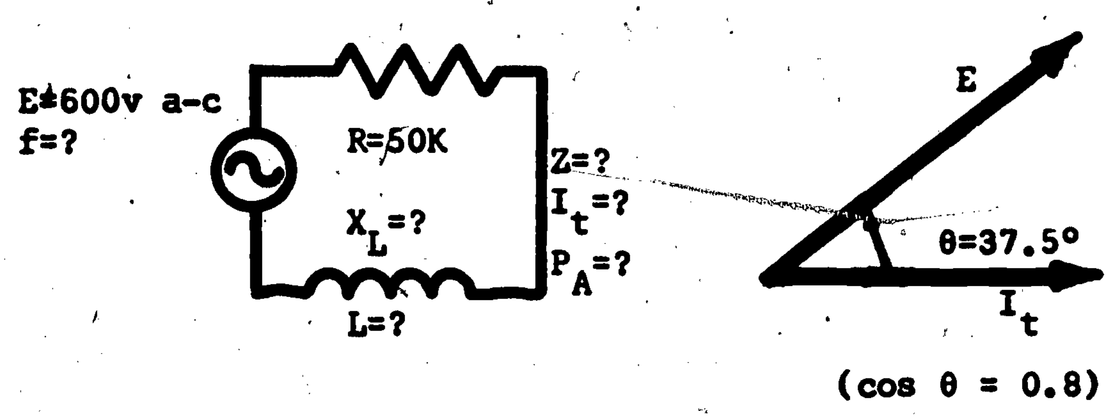
Appendix A contains three frames which typify those found in the Autotutor program on Electronic Theory. These show the statement of a problem, an incorrect solution response, and a correct solution response, respectively.

Good, you probably had no difficulty spotting the incorrect assertion that increasing E decreases the power factor of a series RL circuit.

Here is you last question:

Question 4:

Look closely at the circuit and phase diagram below. What additional information must be supplied before you can calculate the power drawn by the resistor?

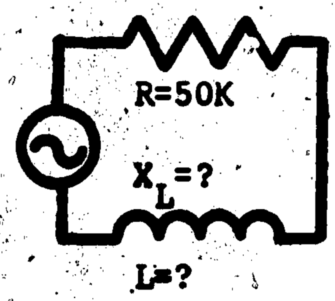


Z must be supplied.	F
I_t must be supplied.	E
L must be supplied.	D
L and f must be supplied.	B
Nothing additional need by supplied.	A

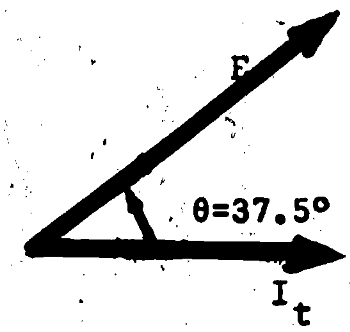
Sorry, your answer is incorrect.

Everything needed to find P_T is given. Look at the problem again:

E=600v a-c
f=?



Z=?
I_t=?
P_A=?



(cos θ=0.8)

Here is the solution:

$$P.F. = \cos\theta = 0.8; \quad \text{and } P.F. = \frac{R}{Z}.$$

Therefore, $\frac{R}{Z} = 0.8.$ Since $R = 50K$,

$$Z = \frac{50K}{0.8} = 62.5K.$$

Now, $P_A = \frac{E^2}{Z}$. E is 600v a-c, so,

$$P_A = \frac{(600v)^2}{62.5K}$$

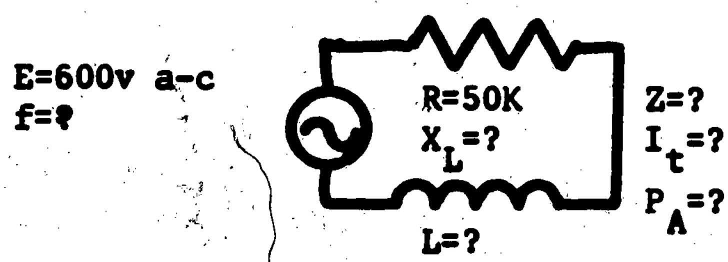
$$= 5.75 \text{ watts.}$$

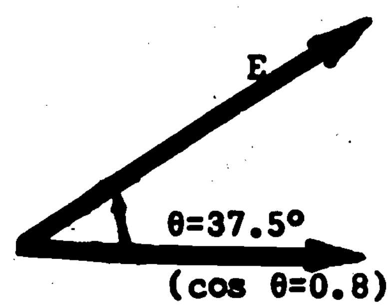
Finally, $P.F. = \frac{P_T}{P_A}$, so $P_T = P_A \times P.F.$

$$P_T = 5.75 \text{ watts} \times 0.8 = 4.6 \text{ watts}$$

This solution is only one of several possible using only the data given. With the proper grasp of the ideas in this section, you should have been able to decide this for yourself. A review is in order; please press Button I as many times as necessary to return to the beginning of this section.

Very good. While you weren't asked to find a numerical solution, you may be interested in seeing one.





$$\text{P.F.} = \cos\theta, \qquad \text{and P.F.} = \frac{R}{Z}.$$

Therefore, $\frac{R}{Z} = 0.8.$ Since $R = 50K,$

$$Z = \frac{50K}{0.8} = 62.5K.$$

Now, $I_t = \frac{E}{Z}$, so

$$I_t = \frac{600v}{62.5K} = 0.0096 \text{ amp}$$

Squaring to get I_t^2: $I_t^2 = (0.0096 \text{ amp})^2 = 0.92 \times 10^{-4} \frac{\text{v-amp}}{\text{ohm}}$

Using $P_T = I_t^2 R,$

$$P_T = (0.92 \times 10^{-4} \frac{\text{v-amp}}{\text{ohm}}) \times (5 \times 10^4 \text{ ohms})$$

$$= 4.6 \text{ watts}$$

The next Section combines resistors, capacitors and inductors into a single series a-c circuit. It will give you no trouble.

To continue, press Button A.

APPENDIX B

Appendix B shows a sample of the General Information Questionnaire completed by all students participating in the study. Each question has been answered to show a composite of the responses (Yes or No) made by each of the three groups and the percentage of those answering in the manner indicated.

Name ______________________________ Date ____________
(last) (first)

GENERAL INFORMATION SHEET
on
PROGRAMMED INSTRUCTION

I. Have you had any direct contact with programmed instruction or "teaching machines" before this semester? If "yes", please explain.

Prog. Instr.	Lect-Lab	Control Group
No (100%)	No (100%)	No (100%)

II. Have you read any books or articles dealing with programmed instruction?

Prog. Instr.	Lect-Lab	Control Group
Yes (100%)	Yes (20%)	Yes (17%)

III. Have you heard or participated in discussions of programmed instruction prior to this semester?

Prog. Instr.	Lect-Lab	Control Group
No (50%)	No (60%)	No (83%)

IV. Had you formed any opinion of programmed instruction as a teaching technique before this semester? If "yes", please state your opinion.

Prog. Instr.	Lect-Lab	Control Group
Yes (25%) Negative	Yes (00%)	Yes (17%) Negative

APPENDIX C

Appendix C provides a sample of the Attitude Survey Instrument used in this study. Shown in the "response" section of the instrument is a tabulation of all student responses coded to distinguish between initial and final reactions. The top section of each block indicates responses of the programmed instruction group; the center section shows those of the lecture-laboratory group; and the lower section contains those of the control group. Plus or minus notations beside each number indicate whether that statement is positively or negatively oriented.

Name_______________________________ Date__________

(last) (first)

ATTITUDE SURVEY
on
PROGRAMMED INSTRUCTION

(please check you reaction to each statement in the appropriate space)

+ = pre-test
* = post-test

	1 (Strongly Agree)	2	3	4	5 (Strongly Disagree)
+1. Programmed instruction is superior to conventional lecture-laboratory instruction in all respects.		++ *	++	**	*
		*	++	+++**	**
				++++*	** ++***
+2. Programmed instruction is desirable because it allows students to advance at any desired rate.	++ **	++ *	*		
	+ *	++++ ***		*	
	+ *	++ **	++ *	+ **	
+3. Programmed instruction is desirable because it permits accurate note taking.	++ *	++ *	*	*	
	+ *	++***	+ *	+	
	++	++***	**		++ *
+4. Programmed instruction adequately takes the place of lab activities in the study of Electronics.		*	+ *	+++ *	*
			*	+++ *	++***
			*	+++ *	+++ ****
+5. Programmed instruction is desirable because it presents information in a highly organized form.	++++*	**	*		
	*	+++ ****	++		
	++ *	++ ***	+ **	+	

NOTE: The top line following each statement contains responses of the programmed instruction group; the next line contains the responses of the lecture-lab group; the last line contains the responses of the Aviation Institute.

	Strongly Agree 1	2	3	4	Strongly Disagree 5
+6. The fact that the student is unable to ask questions in programmed instruction is of no serious consequence.				+++ ***	+ *
				+++ ***	++**
				++ ****	++++ **
-7. Programmed instruction should be supplemented with lectures for purposes of clarification.	+ **	++ *	*		+
	+++*	++ ***	*		
	+++++ **	+ ***	*		
+8. A student should experience no difficulty in maintaining a high level of concentration for at least one hour of programmed instruction.	++ *	**	+	+	*
	+++*	+ ***	+ *		
		++ *	++ *	**	++ **
-9. Programmed instruction is of little value and should be eliminated.			+ *	*	+++**
		+	+ *	++***	+ *
		+ *	+ **	+++ **	+ *
+10. Programmed instruction presents material in a more interesting form than is usually encountered in a lecture.		++ **	+ *	+ *	
		*	++***	+++*	
			+++*	+++**	***
-11. Programmed instruction would be more desirable if sessions were supervised by an instructor.	*	+ *	+ *	+	+ *
	*	++ **	+++**		
	++ **	+++ ***	+ *		
-12. Programmed instruction would work well for a non-lab course such as mathematics but not for a course in which equip. familiarization & lab procedure is important.	+ **	+	+ *	+ *	
	++ *	++ ****	+		
	++**	++ **	*	+	+ *

	Strongly Agree 1	2	3	4	Strongly Disagree 5
+13. Programmed instruction is a superior means of teaching the slow learner.	++	+ **	+ *		*
	+	+***	++**	+	
		+ *	+++ ***	++ *	*
-14. The most serious shortcoming of programmed instruction is the lack of opportunity to develop manipulative skills.	++++ **	**			
	++**	++ *		+ **	
	++++ ***	++ *	**		
+15. The learner is more at ease and relaxed with programmed instruction than with a lecturer.	+++ *	**		*	+
		++ **	+++ ***		
	+	++	+****	+ *	+ *
-16. It would be difficult for a student to remain attentive to programmed instruction for a period of two hours.	+ *	+ **		+ *	+
	+	+ **	++**	+ *	
	+++++ *****	+ *			
-17. A serious fault of programmed instruction is the absence of a spririt of competition that prevails in the classroom.		+***	+	+ *	+
		+++ **	+***	+	
	+ *	++ *	++**	**	+
-18. In programmed instruction the student is hampered by the lack of a learning experience such as that provided by public participation in a question-answer sess.	*	++ *	**	+	+
	+	++ *	++**	**	
	++++ *	+***	+ **		
+19. Explanations provided by the machine in prog. instr. are at least as good as, or better than, the explanation which could be expected from an instructor.	++	++***			*
		++**	+++ ***		
	+ *	+ *	+ *	++**	+ *

Item	1 (Strongly Agree)	2	3	4	5 (Strongly Disagree)
-20. Programmed instruction requires a much higher level of attention and concentration than that usually required in a lecture.	++++ **		*	*	
		*	++++**	+ **	
	*	++++ ***	+ **	+	
+21. Programmed instruction reduces anxiety because there is no great sense of failure or scorn from others in the class when a question is answered incorrectly.	++ *	*	+ *	*	+
	+ *	++++ ***	*		
	+ *	++++ ***	**		+
+22. Programmed instruction is superior because here understanding is assured rather than assumed for any point or concept under consideration.		+ **	+++	**	
	+	++ ****	+ *		+
	++ *	++ *	**	+	+ **
+23. More material can be learned and understood in an hour of programmed instruction than in an hour of lecture or laboratory experience.		+++	+***	*	
			+++ ****	++ *	
		++ *	+++ ****		+ *
+24. Material learned by the programmed instruction method is more readily retained and recalled when needed from day-to-day and week-to-week than the mat. learned in lec.	+	+ *	+ **	+ *	
		**	++++ ***	+	
	+ *	+ *	++ ***	+ *	+
+25. Small details are more likely to be ignored by an instructor but covered by the programmed instr.	+	++ **	+	**	
		++***	+++**		
	+	+***	+	++**	+ *

APPENDIX D

Appendix D shows a sequential outline of the topics covered by the Programmed Instruction Group.

TOPIC 0	<u>Reel</u> I
	Direct Current
TOPIC I	<u>Reel</u> I
	Alternating Current
	Magnetism
	Electro Magnetism
	Electro Magnetic Induction
	<u>Reel</u> II
	Alternating Current & Generators
	Inductors
	Capacitors
	Transformers
TOPIC II	<u>Reel</u> I
	Reactive Circuits
	Vectors, Elementary Trig.
	Square Roots
	Series RC Circuits
	Series RL Circuits
	Series RCL Circuits
	Series Resonance
	<u>Reel</u> II
	Parallel RC Circuits
	Parallel RL Circuits
	Parallel RCL Circuits
	Parallel Resonance

TOPIC III	Reel I	
	Rectifiers, Amplifiers, and Basic Circuits	
	Classification of Vacuum Tubes	
	Introduction to Vacuum Tubes - Diodes	
	Semiconductor Diodes	
	Power Supplies	
	Regulation of Power Supplies	
	Reel II	
	Triodes, Part I	
	Triodes, Part II	
	Tetrodes	
	Introduction to Transistors	
	GAS Tubes	
	Soldering	
TOPIC IV	Reel I	
	Test Instruments, special purpose Tubes, and Transistor Circuits	
	The Cathode Ray Tube	
	Operation of the Test Oscilloscope	
	Basic Measuring Instruments	
	Special Purpose Tubes	
	Transistors	
	Transistor Characteristic Curves	

APPENDIX E

Appendix E shows sample questions from each of the criterion tests. The questions selected are representative of the theoretical concepts which the students are expected to have mastered at designated times during the semester.

FIRST QUIZ

1. Capacitance is that electric property which opposes any change in the

   a. applied voltage.
   b. current flow.
   c. inductance of the circuit.
   d. circuit resistance.

2. Inductive effects are <u>not</u> noted when a field is

   a. expanding.
   b. contracting.
   c. collapsing.
   d. stationary.

3. A current of 5 amp. is flowing through a 50-ohm resistance. The power dissipation is

   a. 1,250 watts.
   b. 250 watts.
   c. 125 watts.
   d. 25 watts.

4. One 20-uf capacitor and one 50-uf capacitor are connected in series. The total capacitance will be

   a. 9.2 uf
   b. 14.2 uf
   c. 30 uf
   d. 70 uf

SECOND QUIZ

1. A transformer is connected across a 100-volt AC source, and the 100-turn primary winding is drawing 1.00 amp. At 100 percent efficiency, what is the voltage across the secondary winding, which has 5,000 turns of wire?

   a. 5,000 volts
   b. 500 volts
   c. 5,000,000 volts
   d. 50 volts

2. When resistance alone is the governing factor in the flow of a current, the circuit is said to be

   a. a resonant circuit.
   b. an inductive circuit.
   c. a capacitive circuit.
   d. a combined inductive and resistive circuit.

3. When an alternating current is applied to the rectifier tube in a half-wave rectifier circuit, a direct current appears in the output side of the half-wave rectifier circuit only when the

   a. anode is negatively charged by the negative part of the AC cycle.
   b. anode is positively charged by the positive side of the AC cycle.
   c. cathode is indirectly heated.
   d. cathode is directly heated.

4. The range of the voltmeter may be extended by a

   a. multiplier resistor.
   b. load resistor.
   c. shunt resistor.
   d. parallel resistor.

PRE- AND POST-TEST

1. When the core of an electromagnet is removed, it retains some of its magnetic properties. This is due to the

   a. internal resistance.
   b. residual magnetism.
   c. magnetic reluctance.
   d. dielectric field.

2. Four voltmeters rated, respectively, at 100, 1,000, 2,000 and 100,000 ohms per volt are available. For highest sensitivity, it is best to use the voltmeter rated at

   a. 100,000 ohms per volt.
   b. 2,000 ohms per volt.
   c. 1,000 ohms per volt.
   d. 100 ohms per volt.

3. A lamp connected in series with a capacitor and an AC voltage source will light up. This is due to the fact that

    a. the dielectric is shorted out automatically when alternating current is applied.
    b. the peak AC voltage, being higher than a DC voltage, can temporarily break down the dielectric.
    c. the lamp is also acting as a capacitor when connected in series with an actual capacitor.
    d. the capacitor is automatically being charged and discharged, resulting in a flow of current through the lamp.

4. Permeability is the opposite of

    a. magnetic reluctance.
    b. magnetic attraction.
    c. ohmic resistance.
    d. magnetomotive force.

EXTENSION TEST

1. Which of the following is NOT considered a triode parameter?

    a. ac plate resistance.
    b. mutual conductance.
    c. filament voltage.
    d. amplification factor.

2. For proper operation a junction transistor must be biased:

    a. emitter reverse and collector forward.
    b. emitter forward and base reverse.
    c. emitter forward and collector reverse.
    d. emitter reverse and base forward.

3. The use of a by pass capacitor in the screen grid circuit of a tetrode tube will maintain:

    a. a constant plate potential.
    b. a constant screen grid current.
    c. the screen grid at a constant potential.
    d. the control grid at a constant potential.

4. The beam forming plates of a beam power tube:

   a. completely enclose the cathode and control grid.
   b. focuses the beam of light onto the photo electric plate.
   c. "channels" the flow of electrons from the cathode to the plate.
   d. none of the above.

Name ____________

CHECK LIST FOR PRACTICAL TEST ITEMS

	RATING		
	Poor	Fair	Good
Voltage			
1. Accurate meter zero set			
2. Proper setting of Function Switch			
3. Proper setting of Range Switch			
4. Accurate reading of DC voltage			
5. Accurate reading of AC voltage			
Current			
6. Accurate meter zero set			
7. Proper connection into circuit			
8. Proper setting of Function Switch			
9. Proper setting of Range Switch			
10. Accuracy of current reading			
Resistance			
11. Proper adjustment of Zero Set & Ohms Adj.			
12. Accurate reading of Resistor #1			
13. Accurate reading of Resistor #2			
Waveform Identification			
14. Proper adjustment of Scope controls			
15. Proper insertion of signal			
16. Correctness of identification			
Frequency Determination			
17. Proper use of Scope controls			
18. Accuracy of frequency determination			
Measuring P-P Voltage			
19. Proper procedure in Scope calibration			
20. Accuracy of P-P measurement			
Care & Safety			
21. Equipment handled in a careful manner			
22. Unknown voltages regarded with respect			
TOTALS			