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PROGRAMMED INSTRUCTION AS AN ADJUNCT TO A COURSE IN ADOLESCENT PSYCHOLOGY.

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TO INVESTIGATE THE EFFECTIVENESS OF PROGRAMMED INSTRUCTION AS AN ADJUNCT TO MORE TRADITIONAL METHODS OF COLLEGE TEACHING, THE EXPERIMENTORS IN THIS STUDY DEVISED METHODS OF TESTING RELATIVE EFFECTIVENESS OF TEACHING MACHINES, WORKBOOKS, SELF-PACED AND IMPOSED SCHEDULES, TRADITIONAL TEXTBOOKS AND SELECTED READINGS. THEY ALSO EXAMINED THE EFFECT OF A PRE-INSTRUCTIONAL COGNITIVE ORGANIZER ON SUBSEQUENT LEARNING. ALL LEARNING WAS MEASURED BY A 100 QUESTION MULTIPLE CHOICE TEST DEVISED FOR THE EXPERIMENT. AS PREDICTED, PROGRAMED INSTRUCTION PROVED SIGNIFICANTLY MORE EFFECTIVE THAN TRADITIONAL METHODS, THOUGH THE SUBJECTS DEMONSTRATED CONSIDERABLE ATTACHMENT TO THE OLD METHODS. THE TEACHING MACHINE DID NOT SIGNIFICANTLY IMPROVE SCORES OVER THE WORKBOOK AND SELF-PACING DOES NOT IMPROVE MEASURABLE LEARNING OVER AN IMPOSED SCHEDULE. THE TRADITIONAL TEXTBOOK PRODUCED HIGHER SCORES THAN THE BOOK OF SELECTED READINGS OVER THE TEST GROUP AS A WHOLE. RESULTS INDICATED THAT A DESIRE FOR THEORETICAL KNOWLEDGE, SITTING AT THE BACK OF THE ROOM, CREATIVITY AND LOW LEVEL OF OPINIONATION TENDED TO PRODUCE HIGHER SCHORES ON THE POST-TEST. THE TABULAR RESULTS OF THE STUDY ARE INCLUDED. (GJ)

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PROGRAMMED INSTRUCTION AS AN ADJUNCT TO A COURSE IN ADOLESCENT PSYCHOLOGY

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Underwood (1964, 133-315) has suggested that never before in the history of psychology has there been so much interest in and research on human learning. Much of this may be attributed to the development of programmed instruction. Schramm (1964, 1) declared that never before has such a flurry of research activity accompanied the development of a new method of instruction. However, for more than a decade, much of this research has been characterized by frenetic efforts rather than by careful thought and investigation (Stolurow, 1962). Those who have been so flamboyant in describing the new instructional technology and who have made such hyperbolic claims for its future, have generally lacked sound research data on which to base their exaggerations (DeCecco, 1964, 11).

Filep (1964, 205-209) has inferred that the programmed instruction movement has reached a plateau and that it is "undergoing a period of intellectual incubation prior to some new breakthroughs." Schutz and Baker (1966, 183-185) felt that further progress must be preceded by careful planning, restraint, and resolution. They did not foresee a spectacular revolution or breakthrough. On the other hand, Gage and Unruh (1967, 358-359) recently declared that programmed instruction is fomenting a revolution in teaching and that it "threatens to render irrelevant much of the research on teaching that has been done, including much of that published since 1962."

Most writers agree that programs do teach (Cartier, 1963, 3-8; Garner, 1966, v; Lysaught and Williams, 1963 15). Nevertheless, many valid criticisms of research on programmed instruction have been made. Among these criticisms are the following: (1) often the programs are too brief and of poor quality, (2) failure to use a pretest and the use of an inadequate criterion test of achievement or learning, (3) the use of very small samples of subjects and failure to study their personal characteristics, (4) failure to control for novelty or Hawthorne effects, and (5) generally poorly designed studies lacking adequate experimental control (Carr, 1962; Gentile, 1967; Moore and Smith, 1962; Strong, 1964; Trow, 1963).

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The overwhelming majority of the programs developed are linear or Skinnerian (Schramm, 1962). Skinner's operant conditioning has provided the theoretical basis for this type of programming and for his teaching machines (Pressey, 1963, 2). However, several writers have pointed out that this type of program and the teaching machines have not fulfilled Skinner's promises (Hilgard, 1964, 134-135; Snygg, 1962; Stafford and Combs, 1967).

Pressey (1965), who has long maintained that autoinstruction should be used as an adjunct to, or as a supplement for traditional modes of instruction, again asserted that it is this type of instruction in which there is the potential for the breakthroughs in teaching. Among others who have recommended the auxiliary use of programmed instruction with traditional methods of instruction are Naumann (1962, 17) and Zaccaria and Adams (1964, 180-181).

Reported research has indicated that students learn programmed material as well from programmed textbooks as from teaching machines (Goldstein and Gotkin, 1962, 35; Holt and Hammock, 1962, 50-56; Hough and Revsin, 1963, 288-291). Strong (1964, 225) stated that for the few studies which attempted to control the scheduling variable, there was no indication of superiority for self-pacing subjects. Travers (1949, 293-294) and others have recommended that noncognitive or personal factors be given more attention if better prediction equations of academic achievement are to be obtained. More recent concern for the utilization of personal factors includes reports by Abe (1965, 303-304), Chauncey (1965, 12-36), Flynn and Morgan (1966, and Holland and Richards (1965). Ausubel and Fitzgerald (1962, 243-249) reported on studies in which advance cognitive organizers facilitated learning and retention of meaningful verbal material. The multiple-choice, subject-centered criterion test, given as a pretest, is assumed to be an initial cognitive organizer.

Problem

The purpose of this study was to investigate the differential effectiveness of programmed instruction which was used as an adjunct to more conventional modes of university instruction in a course in adolescent psychology, and to investigate the main effects of selected cognitive, personal, task, and situational factors on learning from diverse methods of programmed instruction. A secondary purpose was to investigate the prediction of learning at the college level. Learning was inferred from scores made on a 100-item multiple-choice (five choices per item) achievement test, typical of final course examinations.

Hypotheses

Stated as null, it is hypothesized that (1) there is no significant difference in learning from programmed material whether presented by a simple teaching machine or by programmed workbook; (2) students receiving an initial cognitive organizer do not learn significantly more from programmed material than those not exposed to a multiple-choice pretest; (3) there is no significant difference in learning by programmed materials for students whose schedules are self-paced and those students whose schedules are imposed or assigned to them; and (4) there is no significant difference in learning from programmed instruction between students assigned a traditional textbook (Ausubel, 1954) and those assigned a book of selected papers (Seidman, 1960).

Procedure

Experimental Design

A complex 4 x 2 x 2 x 2 balanced factorial analysis of variance design was used to test the main effects of the independent variables of the instructional situation on learning by programmed instruction. The four learning-task independent variables (programmed instruction presented by two types of simple teaching machines, by programmed workbook, and no programmed instruction for control subjects) and three types of learning-situational independent variables (type of pretest or initial cognitive organizer, type of laboratory schedule, and type of textbook) are presented in Table 1. One-half of all students were given the multiple-choice pretest in order to study whether it operated to structure students' course learning selectivity, or "set to learn." The multiple-choice test was given as part of the final examination to all subjects as the criterion of learning.

Laboratory scheduling was varied also, with one-half of all students being given an assigned schedule and the other one-half being permitted to select their schedules (self-pacing). Likewise, one-half were assigned the Ausubel textbook, while the others were assigned the Seidman edited book of selected papers. Subjects were coded so that the sex of each student could be identified, as well as the identification of each student's instructor.

Subjects and Sampling Procedure

Originally all students enrolled in all eight sections of a semester-long course in adolescent psychology at The University of Texas at Austin were included in this study. Of the 295 who enrolled, 267 completed the course. Complete data were available for 251 students. Of these, 170 experimental subjects had complete data. These experimental subjects are the ones who received programmed instruction and are of primary interest to this report. While control subjects were assigned to the same autoinstructional laboratory, they performed tasks other than programmed instruction. This was planned to control the Hawthorne effect.

Students were randomly assigned to the various cells of the experimental design. Originally, only one teaching machine was available, so the design was 3 x 2 x 2 x 2. Since a second teaching machine became available early in the study, a small sample was taken from the original teaching machine group and assigned to the second machine. All combinations of the 32 experimental conditions were present in each of the eight sections. This was planned in an attempt to control the influences on achievement or learning due to differences among the five instructors, each of whom was an experienced psychologist.

Analysis of variance results on scholastic aptitude, reading achievement, and English achievement test scores, revealed that there were no initial significant differences in these cognitive variables among students assigned to the five different instructors. Also, experiemental and control subjects did not differ significantly on these scores, although control subjects were slightly favored.

__Programmed Material Used__

The programmed material, authored by Professor Pierce-Jones, contained 2348 frames in 32 chapters or lessons. It was linear or Skinnerian, eliciting simple, composed overt responses, and provided immediate knowledge of results.

__Devices for Presenting Programs__

__Mnemopticon Teaching Machine__. This is a small, inexpensive, plastic device which uses three-by-five-inch cards on which the programs were presented. Generally, one frame appeared on each card. When the card was pulled from its storage box, the correct response for that frame was visible, providing immediate knowledge of results.

__Koncept-O-Graph Teaching Machine__. This is a small plastic device with a knob for turning programs written on standard sheets of paper. The correct response for each frame was masked until the student wrote his response on a separate sheet of paper and turned the knob to the next frame.

__Programmed Workbook__. The format of the programs were identical with those used in the Koncept-O-Graph Teaching Machine. Masks were provided to cover correct responses until the student had written his response to each frame on a separate sheet of paper.

Criterion Test

The criterion test was a multiple-choice examination with 100 items, each with five choices. This test was developed by Professor Marsh and a deliberate attempt was made to develop a difficult test to provide adequate discrimination for a criterion measure of learning. The test did provide an adequate ceiling. Scores ranged between 23 and 76, with a mean of 50.10 and a standard deviation of 9.40. The Spearman-Brown formula was used to estimate the reliability of the criterion test. A correlation coefficient of .70 was obtained.

Instruments Used to Measure Personal Independent Variables

Edwards Personal Preference Schedule. A standardized, 225-item forced-choice inventory designed to assess the relative strength or importance of 15 of Murray's needs.

Gestalt Transformation. A twenty-item, multiple-choice test, each item with five choices. It is a convergent thinking test included in Guilford's (1959) five major groups of intellectual or cognitive abilities.

Marsh Self-Report Social and Demographic Questionnaire. A 55-item, multiple-choice device, each item having between four and nine choices. It was developed to obtain quantitative data such as educational achievement, habits, attitudes, and aspirations; attitude toward programmed instruction; socio-economic status; background and personal information; and values.

Nelson-Denny Reading Test, Form A, Revised Edition. A standardized multiple-choice reading achievement test with 100 vocabulary items and 36 reading comprehension items. It yields separate scores for vocabulary, comprehension, total reading score, and reading rate.

Opinionation Scale. A modification of Rokeach's (1960) Opinionation Scale. There are 40 statements to which the examinee indicates the extent of agreement or disagreement.

Unusual Uses. This is a modification of one of Guilford's (1959) divergent thinking tests. Six different stimulus objects were presented to which each examinee was asked to list as many unusual uses for which each object, or parts thereof, could serve.

Statistical Treatment of Data

Analysis of variance was used to test the main effects of the experimental design. Multiple linear regression analyses were used to develop a prediction equation. High speed digital computers were used to perform these analyses.

Results and Discussion

From Table 2 it is evident that experimental subjects (those who received programmed instruction) achieved or learned significantly more than control subjects, as inferred from scores earned on the criterion test. This agrees with the literature cited that students do learn from programmed instruction.

Anyalsis of variance results in Table 3 and Table 4 support the hypothesis that there is no significant difference in learning whether the programs are presented by teaching machine or by programmed workbook. This also supports cited reports of other studies investigating differential methods of presenting programmed material.

The mean criterion test score of experimental subjects who received the same criterion test at the beginning of the course as an advance cognitive organizer, as indicated in Table 5, was significantly higher than the mean score for experimental subjects who did not receive the multipe-choice pretest. Thus, the hypothesis that there is no significant difference in learning by programmed instruction for subjects receiving an advance cognitive organizer and for those subjects not exposed to this type of pretest, is rejected at the .05 level.

The data in Table 6 reveal no significant differences in mean criterion test scores for experimental subjects whose laboratory schedule was determined for them, and for those who chose their own schedules for completing laboratory assignments. Again, this is in agreement with the literature cited, and supports the hypothesis that there is no significant difference in learning by programmed instruction whether students have imposed schedules or whether they choose their own schedules.

It was hypothesized that there is no significant difference in learning by programmed instruction between students who are assigned a traditional textbook (Ausubel) and those assigned a book of selected papers (Seidman). The data in Table 7, for experimental subjects, support this hypothesis. However, the data in Table 8, for experimental and control subjects combined, indicate that subjects assigned the traditional textbook scored significantly higher on the criterion test. Among possible explanations for this difference are: (1) Students learn more effectively from a synthesized or integrated textbook than from a selection of papers. However, this is not supported for experimental subjects only. (2) The programmed material was more similar in content to that found in the traditional textbook. (3) There may be significant interactions which cannot be revealed by this type of statistical analysis. Both of the latter offer plausible explanations.

Additional analyses of variance revealed that there were no differences in learning by programmed instruction due to sex, nor did students of any of the five participating professors achieve significantly higher mean criterion test scores.

Multiple linear regression analysis of nine personal and cognitive variables from six different measuring devices, for experimental subjects, produced a prediction of achievement or learning equation which yielded an R of .80. In Table 9, these variables are listed in rank order of their relative contribution to the prediction equation for which learning was inferred from scores made by experimental subjects on the criterion test. The first of these variables, the Nelson-Denny Reading Test Total Score, is a cognitive variable which would be expected to be highly relevant to learning meaningful verbal material. The second variable, a type of educational aspiration, Self-Reported Course Grade Expected, was obtained from an item in the Marsh Social and Demographic Questionnaire (S & D), "What grade do you expect from this course?" However, the contribution to the prediction equation is spuriously high because this questionnaire was not developed and administered until the end of the semester. It is highly unlikely that responses to this item made at the beginning of the semester would contribute so much to the prediction equation.

The third variable, Self-Reported Primary Interest in Gaining Theoretical or Practical Knowledge, was also obtained from an item in the S & D, "What I'm really interested in is practical knowledge that I can actually apply." Response choices ranged from always to never. Students indicating a relatively strong interest in theoretical knowledge, or a relatively low interest in gaining practical knowledge, tended to earn higher scores on the criterion test. The fourth variable, Guilford's Gestalt Transformation Total Score, is another convergent thinking, or cognitive factor. The subject is presented with a problem along with five choices of objects from which he is to select the best one for solving the problem.

There was a negative relationship between the criterion test score and the fifth variable, the Need Abasement scale in the Edwards Personal Preference Schedule. Experimental subjects who manifested low needs for abasement tended to score higher on the criterion test. The sixth variable, Self-Reported

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Location of Seat in Classroom during the Course, was obtained fr m responses to an item in the S & D, "Location of your seat in this class." Contrary to expectations, those who sat nearer the back of the room earned relatively higher scores on the criterion test than did those who sat nearer the front of the room. The seventh variable, Guilford's Unusual Uses Figurative or Symbolic Responses, is one of the divergent thinking tests from which creativity is often inferred. An example of such a response for an unusual use of a key is, "It is a key to my heart when worn around her neck."

The eighth variable, Self-Reported Attitude toward Lectures and Class Discussions for this Course, was obtained from an item in the S & D, "Concerning the lectures and class discussions in this course:," with response choices ranging from "Enjoyed them immensely" to "Rather detested them." The negative relationship indicated, on the average, rather favorable attitudes for these traditional modes of instruction. The ninth variable, Rokeach's Opinionation Scale Total Score, was also negatively related to criterion test scores. Since low scores imply liberality, it appears that liberal students tended to achieve relatively better criterion test scores than did the more opinionated experimental subjects.

Conclusion

A complex experimental design was developed which provided for a number of experimental treatments and controls. Random assignment of students to the various experimental and control cells appears to have effectively controlled instructor differences and Hawthorne effects. No sex differences in learning by programmed instruction were observed. The main effects of the experimental design were tested and the results were consistent with findings that have been generally reported by other investigators.

Some learner variables were obtained and analyzed, both cognitive and noncognitive variables. Nine of these variables formed a prediction of learning (as inferred from performance on the criterion test) equation, which yielded an R of .80, but it was pointed out that the grade expectation variable was spuriously high. No attempt at this time was made to make conclusions about the most relevant personal or learner variables of students being instructed with programmed materials as an adjunct to conventional methods of university instruction. Significant interactions most likely exist among the several independent learner variables and these will be analyzed thoroughly later.

It seems very reasonable that the use of programmed instruction as an adjunct to other modes of instruction holds more promise for improving instruction than claims made about using programmed devices only. There appears to be no limit to the possibilities with computer adaptations. When programmed materials are used in addition to other instructional methods, the instructor can actually capitalize on the Hawthorne or novelty effect. The variety should increase interest and motivation, while minimizing boredom. Furthermore, programs for more limited use would be easier and less expensive to develop.

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Table 1

Schematic Design for Evaluating the Influences of Selected Personal, Task, and Situational Factors on Learning from Programmed Instruction in a Course in Adolescent Psychology.

Method of Instruction	Type of Initial Cognitive Organizer	Type of Schedule	Type of Reading Textbook Assigned
Programmed Instruction by Koncept-O-Graph Teaching Machine	Comprehensive Multiple-Choice Subject-Centered Pretest	Imposed Pacing	Standard Textbook
			Selected Papers
		Self-Pacing	Standard Textbook
			Selected Papers
	Subjective Essay Pretest Eliciting Opinions & Beliefs	Imposed Pacing	Standard Textbook
			Selected Papers
		Self-Pacing	Standard Textbook
			Selected Papers
Programmed Instruction by Mnemopticon Teaching Machine	Comprehensive Multiple-Choice Subject-Centered Pretest	Imposed Pacing	Standard Textbook
			Selected Papers
		Self-Pacing	Standard Textbook
			Selected Papers
	Subjective Essay Pretest Eliciting Opinions & Beliefs	Imposed Pacing	Standard Textbook
			Selected Papers
		Self-Pacing	Standard Textbook
			Selected Papers
Programmed Instruction by Programmed Workbook	Comprehensive Multiple-Choice Subject-Centered Pretest	Imposed Pacing	Standard Textbook
			Selected Papers
		Self-Pacing	Standard Textbook
			Selected Papers
	Subjective Essay Pretest Eliciting Opinions & Beliefs	Imposed Pacing	Standard Textbook
			Selected Papers
		Self-Pacing	Standard Textbook
			Selected Papers
No Programmed Instruction (General Lab Assignment)	Comprehensive Multiple-Choice Subject-Centered Pretest	Imposed Pacing	Standard Textbook
			Selected Papers
		Self-Pacing	Standard Textbook
			Selected Papers
	Subjective Essay Pretest Eliciting Opinions & Beliefs	Imposed Pacing	Standard Textbook
			Selected Papers
		Self-Pacing	Standard Textbook
			Selected Papers

Table 2

Analysis of Variance of Criterion Test Scores for Experimental Subjects Receiving Programmed Instruction and Control Subjects Receiving no Programmed Instruction

Group	N	Mean, Criterion Test Score	SD	F
Experimental Subjects	170	51.18	9.26	7.06**
Control Subjects	81	47.84	9.39	
Sum or Average	251	50.10	9.41	

df = 1 and 249.
** $p < .01$ level of significance.

Table 3

Analysis of Variance of Criterion Test Scores for Experimental Subjects Receiving Programmed Instruction by Differential Methods

Group	N	Mean, Criterion Test Score	SD	F
Koncept-O-Graph Subjects	19	49.47	8.34	0.41
Mnemopticon Subjects	68	51.66	9.39	
Programmed Workbook Subjects	83	51.17	9.41	
Sum or Average	170	51.18	9.26	

df = 2 and 167.
F = n.s.

Table 4

Analysis of Variance or Criterion Test Scores for Experimental Subjects Receiving Programmed Instruction by Teaching Machines and by Programmed Workbook

Group	N	Mean, Criterion Test Score	SD	F
Teaching Machines Subjects	87	51.18	9.17	0.0001
Programmed Workbook Subjects	83	51.17	9.41	
Sum or Average	170	51.18	9.26	

df = 1 and 167.
F = n.s.

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Table 5

Analysis of Variance of Criterion Test Scores for Experimental Subjects with Pretest Scores and Experimental Subjects Who Did not Receive the Criterion Test as a Pretest

Group	N	Mean, Criterion Test Score	SD	F
Experimental Subjects with Pretest	85	52.62	10.27	*4.23
Experimental Subjects, no Pretest	85	49.73	7.93	
Sum or Average	170	51.18	9.26	

df = 1 and 168.
*$p < .05$.

Table 6

Analysis of Variance of Criterion Test Scores for All Experimental Subjects by Type of Laboratory Schedule Assigned

Group	N	Mean, Criterion Test Score	SD	F
Subjects with Imposed Schedules	84	50.20	8.71	1.85
Subjects with Self-Paced Schedules	86	52.13	9.73	
Sum or Average	170	51.18	9.26	

df = 1 and 168.
F = n.s.; $p < .20$.

Table 7

Analysis of Variance of Criterion Test Scores for All Experimental Subjects by Type of Textbook Assigned

Group	N	Mean, Criterion Test Score	SD	F
Subjects with Ausubel Text	84	52.39	9.47	2.90
Subjects with Seidman Papers	86	49.99	8.95	
Sum or Average	170	51.18	9.26	

df = 1 and 168.
F = n.s.; $p < .10$.

Table 8

Analysis of Variance of Criterion Test Scores for All Subjects by Type of Textbook Assigned

Group	N	Mean, Criterion Test Score	SD	F
Subjects with Ausubel Test	125	51.74	9.25	7.80**
Subjects with Seidman Papers	126	48.47	9.33	
Sum or Average	251	50.10	9.41	

df = 1 and 249.
**$p < .01$ level of significance

Table 9

Nine Personal and Cognitive Variables in Rank Order of Relative Contribution to a Prediction of Learning Equation ($R = .80$) for 170 Experimental Subjects Receiving Programmed Instruction

Nelson-Denny Reading Test Total Score
Self-Reported Grade Expected in Course
Self-Reported Primary Interest in Gaining Theoretical Knowledge or Practical Knowledge
Gestalt Transformation Total Score
Edwards Personal Preference Schedule's Need Abasement
Self-Reported Location of Seat in Classroom during the Course
Unusual Uses Figurative or Symbolic Responses
Self-Reported Attitude toward Lectures and Class Discussions for the Course
Opinionation Scale Total Score