THE EFFECT OF PROGRAMMED INSTRUCTION ON ACHIEVEMENT IN BEGINNING ALGEBRA

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The purposes of this study were: (a) to determine whether ninth and tenth grade students who were taught the first course in algebra by means of programmed instruction achieve more than those who were taught by the teacher-textbook or conventional method of instruction; (b) to measure the effect of programmed instruction on pupil retention of knowledge of the content of beginning algebra; and (c) to ascertain teacher and student opinion regarding the effectiveness of programmed instruction.

Procedure

In preparation to use the new medium of instruction, the principal and mathematics instructor of the junior-senior high school where the new program was to be used attended a three-week workshop on programmed instruction. The workshop dealt with psychology of learning, analysis of experimental programs, and techniques of preparing programmed material. It met four hours daily and forty teachers and administrators attended. The workshop staff consisted of six consultants from the Center of Programmed Instruction, Inc., New York.

To investigate the purposes described above, 156 students from three different schools were selected to participate in the study. They were ninth and tenth grade students who had indicated at the close of the 1960-61 school year that they intended to enroll in the beginning algebra course the following school year. The students were randomly assigned to classes prior to the opening of school in August, 1961. There were seven sections having enrollments ranging from twenty to twenty-five students.

The three schools which were included in the study were selected because of their geographic location within the school system and to provide a group of students having a similar socio-economic background. The teachers who participated in the study were selected because they were experienced teachers in algebra and were interested in the experimental program.

Two of the seven sections were selected to be the experimental group. It consisted of twenty-one ninth graders and twenty-one tenth graders. They used the TEMAC first-year course in algebra which was prepared by Encyclopaedia Britannica Press. The help method was used by the instructor in the experimental sections. The students could ask for and receive individual instruction from the teacher when desired. None of the students using the TEMAC material was assigned any homework.

The remaining five sections, consisting of fifty-six ninth graders and fifty-eight tenth graders, were designated as the control group. These sections used the state-adopted textbook and were taught by the conventional method of instruction. Homework assignments were made when the teacher thought them necessary.

Two experimental sections and one control section were in the same school and were taught by the same teacher. The remaining four control sections were lodged in two other schools and were taught by two teachers.

Because of pupil dropouts and transfers, complete sets of data were obtained for only one hundred thirteen students--thirty-two in the experimental group and eighty-one in the control group.

Testing Procedure

The Iowa Algebra Aptitude Test was administered to all subjects during the first week of school. The results were used to match subjects in the experimental and control groups. Other matching data were obtained from the county-wide testing program which was administered at the eighth-grade level. Students were matched on I. Q. as determined on the Pintner General Ability Test, Intermediate Battery. A math-science prognostic score was determined for each student and it was also used as a matching variable. (1) The Pintner and the Metropolitan Achievement Test scores were weighted as follows to obtain the math-science prognostic score:

Test Stanines	Weight
Intelligence	3
Reading	2
Word knowledge	1
Arithmetic computation	1
Arithmetic reasoning	1
Social studies-study skills	1
Science	1

All subjects were administered the Lankton First-year Algebra Test during the third week of May of the school year in which the study took place. It was re-administered to all subjects three and one-half months later. The first administration was to determine the achievement of both groups on an immediate recall basis. The purpose of the second administration was to determine the retention of content by the two groups over the summer period.

Analysis of Test Data and Results

Scores on the Iowa Algebra Aptitude Test, Pintner I. Q., and math-science prognostic score were distributed separately for the experimental and control groups. From these data the means and standard deviations were computed. Tests of the differences between groups appear in Table 1.

Table 1

Comparison of Means of Raw Score on Pretests and Posttests for Experimental and Control Groups

	Experimental	Control	E Minus C	t
Iowa Algebra Aptitude Test	61.5	60.1	1.4	.670
Pintner I.Q.	118.6	117.1	1.5	.551
Math-Science Prognostic	57.8	57.1	0.7	.227
First semester grades	2.6	2.3	0.3	1.333
Second semester grades	2.4	2.4	0.0	0
Lankton First-Year Algebra Test				
May	29.8	32.2	-2.4	-1.481
September	28.3	27.9	0.4	.248
May score minus September score	1.6	4.3	-2.7	-2.59*

*Significant at the .01 level

No significant difference between the groups was noted on the matching variables. At the end of the first semester the experimental

group's grade-point average was 2.6 as compared to the control group's 2.3 average. (The grades were assigned the customary numerical values of A=4, B=3, C=2, D=1, F=0.) At the end of the second semester the averages were equal, 2.4.

The mean score on the May administration of the Lankton Algebra Test was 2.4 points higher for the control than for the experimental group; however, the difference was not significant at the .05 level. The mean scores for the experimental and control groups on the September administration of the Lankton Algebra Test were not significantly different.

The data reveal that the groups differed significantly as to the difference between the May and September scores. The control groups suffered the greater over-the-summer loss. The differences between May and September scores ranged from a loss of 21 raw score points to a gain of seven points. The distributions of these differences appear in Table 2.

It is noteworthy that the experimental group had less variable differences in scores. Thirty-eight percent of the control group dropped six or more points in the 3 1/2-month period whereas only nineteen percent of the experimental group had a similar loss. Proportionately more of the experimental students gained rather than lost from May to September.

Student Reaction

Students using the TEMAC programmed material were asked to write a report of their opinion of programmed instruction. Analyses of these reports revealed that their reception of programmed instruction was generally favorable. No homework and ability to work at one's own rate without being pushed by the teacher or other member of the class were the most frequently cited comments in favor of programmed instruction. However, many students stated that very few students work at the maximum of their ability and that considerable study time was wasted while the teacher was giving individual help or working with small groups. Many students stated that they were bored by the number of steps in the program they had to complete to learn a concept; therefore, there was a tendency to skip material to relieve the monotony of the work.

Table 2

Distribution of Change in Score on Lankton First-year Algebra Test from May to September, 1962

Difference between May Score and September Score	Frequency of Occurence	
	Experimental	Control
21		1
16		2
15		1
14		1
13		2
12		5
11	1	6
10	1	1
9	0	1
8	2	7
7	1	0
6	1	4
5	3	3
4	2	8
3	3	5
2	0	7
1	3	4
0	4	3
-1	4	4
-2	1	2
-3	2	8
-4	2	2
-5	0	2
-6	1	1
-7	1	1
Total	32	81

The following is a typical statement of one of the students in the experimental program.

> Programmed studies have their good and bad points in my opinion. They allow the student to progress at his own speed

and understanding without having to wait for or keep up with the rest of the class. However, even the slowest student in the class will sometimes get "fed up" with the whole boring thing. Taking two entire pages to teach the spelling of addend and sum or multiplicand and multiplier in a first year algebra course is absolutely ridiculous. While some simple, elementary processes are drilled into you over and over again, other more difficult parts (such as cosines, sines, and tangents) are barely explained.

Teacher Reaction

The teacher of the experimental group believed that the TEMAC programmed learning materials in Algebra I adequately cover the traditional subject matter and is a useful approach to learning if used by a well motivated student. The instructor was able to give the better student a great deal more of individual attention than was possible in the conventional classes. As the students completed the TEMAC course they were given individual or small-group instruction in such areas as modern concepts of mathematics, inequalities, and geometric concepts. The instructor has never been able to find the time to present these topics in a regular class situation. It is the belief of the instructor that if individual units of programmed material were incorporated in a course, it would present a better learning situation than would an entire programmed course.

Conclusions

The classes using TEMAC programmed learning materials and the classes taught by traditional methods were initially equal in intelligence, algebra aptitude, and math-science prognostic score. Semester grades were also equal for the two groups. Although the control group scored higher (but not significantly) on the posttest given at the end of the school year, it retained less than did the experimental group after approximately three and one-half months. Thus, in September, the means for the two groups were practically identical. The classes using programmed material showed very little loss over the three and one-half months. They also showed less variation individually.

Evidently use of programmed instruction in beginning algebra was not detrimental to either immediate or permanent learning of algebra by these students.

Programmed instruction in beginning algebra is to be continued in the school system and extended to the areas of plane geometry and general mathematics.

Reference

1. Burr, W. L. The stability of composite prognostic scores, Florida Journal of Educational Research, 1 (1959), 21-24.

Hopper, June C. Use of Pinellas County Prognostic score to predict standing on the Senior Placement Tests. Talk given at F.E.A. breakfast, March, 1963, Jacksonville, Florida.