DOCUMENT RESUME

ED 051 666	72	EM 009 044

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TITLE	The Development, Use and Evaluation of Self-Instructional Programs in Israel.
INSTITUTION	Henrietta Szold Inst., Jerusalem (Israel).
SPONS AGENCY	Ruth Bressler Center for Research in Education, Jerusalem (Israel).
REPORT NO	P-460; RR-115
BUREAU NO	BR-5-1406
PUB DATE	Jan 68
NOTE	60p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	*Culturally Disadvantaged, Elementary School Mathematics, *English (Second Language), *Low Ability Students, *Mathematics Instruction, *Programed Instruction, Programed Materials, Program Evaluation, Secondary School Mathematics, Teacher Attitudes, Teaching Methods
IDENTIFIERS	*Israel

ABSTRACT

The use of programed materials to instruct culturally disadvantaged Israeli children in mathematics and in English was evaluated. The primary focus of the study was an evaluation of two mathematics programs--one adapted from an American program and one developed locally for teaching mathematics to low-ability elementary-school students. The teachers who used these programed materials had little training or experience in using programed materials. On the whole, the programed materials were successful in teaching the subject and were helpful in eliminating the large difference between low- and high-ability students. In an ex post facto study of students in a vocational high school who had used programed mathematics materials, similar results were found. A few introductory lessons in English as a foreign language were developed and tried out informally on two fifth-grade students with limited success. These studies suggest, in particular, that the two mathematics programs developed thus far may be used to an advantage in Israeli schools with large populations of culturally deprived students and, in general, that further development of programed materials for use at the elementary and the high school level in Israel is warranted. (JY)

THE HENRIETTA SZOLD INSTITUTE

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THE DEVELOPMENT, USE AND EVALUATION OF SELF-INSTRUCTIONAL PROGRAMS IN ISRAEL

by

PAUL I. JACOBS

RESEARCH REPORT NO. 115

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Israel shares with other countries many educational problems, such as overcrowded schools and lack of trained teachers. These problems have been aggravated in Israel by the large immigration of recent times, which, according to one estimate, has tripled the number of school age children during a ten year period.

In other countries programed instruction has recently been hailed as an aid to solving, if not a panacea for, educational problems. Programed materials have been developed not only in the U.S.A. and Western Europe but also in Japan (National Institute for Educational Research, 1963), and India (Kulkarni, 1965). Workshops have been held in Jordan and Nigeria to help introduce the idea of programed instruction and to stimulate the writing of programs (Komoski and Green, 1964).

In Israel there has also been some activity in programed instruction. The ORT (Organization for Rehabilitation through Training) network of vocational schools has introduced an algebra program developed by Mr. Joshua Fliedel. Other programs in technical subjects are in various stages of development. The Ministry of Education has undertaken some informal tryouts of Hebrew translations of an American mathematics program. The Ministry of Defense has been using a locally-developed geography program with soldiers at Camp Marcus in Haifa.

The project described in the present report attempted to explore more systematically the use of programed instruction in Israel for raising the level of instruction. The reader who is aware of the conflicts that arise between the demands of rigorous experimental control and the realities of administrative necessity in the conduct of large-scale educational research in an American setting may be assured that such conflicts also arose in the work reported here. An attempt has been made to record what was done, why it was done, and what

was found. It is hoped that the present report will complement the earlier cited report of Komoski and Green (1964), and will be of interest to others engaged in adapting an educational innovation cross-culturally.

Choice of subject matters

The subject matters chosen for programing were (a) mathematics, and (b) English as a foreign language.

Mathematics was the prime subject matter chosen to be programed. It is a basic subject in the curriculum, and one for which success in teaching has been relatively poor in Israel. It is the area in which the greatest number of programs were in existence to serve as guidance in the construction of new ones. As a subject it had the added advantage of making minimal demands upon the reading skills of the large proportion of students for whom the language of instruction (Hebrew) was not the language spoken at home. Mathematics was programed at the elementary school level (fifth and sixth grades) and the high school level (ninth grade).

English as a foreign language is taught, usually with limited success, in almost all elementary schools in Israel in grades six through eight. Some preliminary efforts were made in the project in the programing of introductory lessons in English as a foreign language for grade six.

I. Programed Mathematics at the Elementary School Level

Our basic assumption was that in general brighter students will learn no matter how poorly they are taught, and that duller students, without some radical intervention, will not. Our work was therefore primarily directed toward students of lower ability in the hope that programed instruction would be an appropriate radical intervention.

Ideally a program is tried out and revised repeatedly until it is found effective for students of given characteristics, and then it is used with such students. Ideally the classroom teacher is familiar with the theoretical background of programed instruction, with problems in classroom use of programed materials, and, of course, with the specific materials used in his class. We were unable to closely approximate these conditions.

Since there was no American mathematics program available that was aimed at a well-defined group of low ability students, we decided, on the one hand, to use (in translation) an American program aimed at a more general population, while also developing our own program specifically for lower ability students. In the first case we could expect a poor match between the population for which the program was intended and the population with which it was used, and in the second case we could expect that limitations of time and money would preclude the development of a really effective program.

Regarding teacher training, in many instances it was not known prior to the start of the school year who would be the teachers of the classes with which we were to work. It was therefore not possible to give them intensive training before the school year began. Nor was it possible to acquaint them at the beginning of the school year with the entire program, since it was not yet available.

Programs

a. TEMAC. We had information that a commercial publisher in Israel was preparing a Hebrew translation of a TEMAC program*, not specifically intended for low level students, that covered the topics of addition, subtraction, multiplication and division of fractions.** Since the numerically limited Hebrew-language reading public does not usually provide a market for speculative commercial publishing ventures, we hoped that including this program in our project would encourage such ventures.

Several safeguards were taken in view of the fact that the program was not specifically intended for the students of low ability in which we were interested. Revisions were suggested to the publisher, aimed at simplifying the language used, reducing the amount of reading required in many frames, and remedying other deficiencies.

The program in fractions was to be used with sixth grade students who presumably were previously exposed to this material in the fifth grade, and, therefore, were merely reviewing it. The program did not receive informal tryout with individual students prior to classroom use in our study.

b. The Fliedel-Jacobs program. Neither the available bibliographies (Center for Programed Instruction, 1963; Hendershot, 1963) nor informal sources revealed any programs particularly appropriate for teaching elementary school mathematics to lower ability students. For this reason we decided to develop our own program.*** The first one hundred frames were tried out with individual

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*Murphy, D. P. Seventh Grade Mathematics. Chicago, Encyclopedia Britannica Press.

**These topics are taught in the fifth and sixth grades in Israel.

***Fliedel, J., & Jacobs, P. I. Hashever hapashoot: Lefee shetat hahoraa hametukhnetet (Simple fractions: A programed textbook). Jerusalem, Israel: The Szold Foundation, 1964.

students, and revised on the basis of the information obtained during this tryout. Because of time pressures, the remainder of the program was not tried out in this way prior to classroom use.

The program, which was of the constructed response linear type, consisted of frames bound into separate booklets. A vertical format was used, in which knowledge of results for a given frame appeared alongside the succeeding frame. Each student was provided with a cardboard sheet to mask the later frames. A sample page of the program is presented in Appendix A.

Pedagogically, the concept of a fraction was introduced in terms of the concrete experience of dividing a whole into two or more equal parts. An attempt was made to give the learner considerable practice in applying a rule before the rule was formally stated, or to avoid completely stating it if it made no direct contribution to the desired criterion behavior. For example, the learner had considerable experience working with fractions, including adding and subtracting fractions of like denominators, and multiplying a fraction by an integer, before the terms "numerator" and "denominator" were introduced. In general the approach was to get the learner to work with fractions, rather than to get him to talk about working with fractions.

Selection of classes

The Ministry of Education routinely classifies certain schools as primarily serving "culturally deprived" students. The classification takes into account the students' scores on an end-of-eighth-grade national examination (the Seker), and the students' socioeconomic circumstances. It was from this category of schools that our sample was drawn.

For the purposes of supervision of the elementary schools, Israel is divided into six districts: Tel-Aviv, Jerusalem, Haifa, Central, North, and South. To facilitate the distribution of materials and observation visits to the schools, we restricted our sample to those "culturally deprived" schools in the Tel-Aviv and the Jerusalem districts. Table 1 indicates by district the distribution of available mean scores on the Seker examination for the "culturally deprived" schools. There is considerable overlap in the distributions for each district. Our decision to work only with "culturally deprived" schools in the Jerusalem and Tel-Aviv districts, does not, therefore, give a grossly distorted picture of the entire population of "culturally deprived" schools, at least with regard to their mean Seker scores.

In the author's judgment, based in part upon observations made during a pilot study in three Jerusalem schools, the TEMAC material would have assumed a level of reading ability and of ability to manipulate symbols that students in the lowest level of "culturally deprived" schools did not possess. For this reason, the schools given the TEMAC material were chosen from among those "culturally deprived" schools having the highest Seker test scores, while Fliedel-Jacobs material, not having been developed yet, was to be aimed specifically at the lowest levels of "culturally deprived" schools.

Table 1

Distribution by District of Available Mean Scores on

Seker Examination for "Culturally Deprived" Schools

Mean	North	Haifa	South	Jerusalem	Central	Tel-Aviv
71 - 75		3			1	1
66 - 70	3	1	2	1	2	3
61 - 65	9	5	2	6	9	7
56 - 60	13	12	13	10	19	15
51 - 55	11	5	10	7	13	4
46 - 50	2	1	5	2	5	1
41 - 45	—	—	2	—	—	—
Number of "Culturally Deprived" Schools in District	38	27	34	26	49	31
Total Number of "Culturally Deprived" Schools in District	64	33	62	33	77	46

The 57 of the 79 "culturally deprived" schools in the Tel-Aviv and Jerusalem districts for which mean Seker scores were available were rank-ordered in terms of those scores. Of the two highest, one was chosen at random to provide a TEMAC-taught sixth grade class, and the other to provide a sixth grade control class for this program; this procedure was repeated with the next two highest, etc., to obtain ten TEMAC-taught classes and ten control classes. Of the two lowest schools, one was picked at random to provide a fifth grade class to be taught by the Fliedel-Jacobs program, and one to provide a control class for this program; this procedure was repeated with the next two lowest, etc., until ten such pairs were obtained. If a school chosen in this way contained two sixth grade classes (or fifth grade classes), the better of the two, in the judgment of the principal, was included in the study. The intention was to first obtain a rough initial basis for a matched-groups design and later obtain more precise information for matching from the aptitude test and arithmetic pretest scores of the specific students in the selected schools who would be in the study.

In three cases the schools picked by this method were judged to be difficult to visit (e.g., not on a main bus route). In one of these cases a more conveniently located school from the Central District, having the same mean Seker score as one of the three, was chosen as a replacement. The other two replacements were chosen to be roughly equivalent to the replaced schools in the judgment of the school district supervisors. Seker scores were not available for these two schools.

There were several known shortcomings of the information given by the Seker score for our purposes:

1. We had to assume that a test given to the eighth grade class in a school one year would indicate the relative level of the fifth or sixth grade class in the same school the following year.

2. In some instances the Seker scores were not available, or, if available, reflected undesirable biases from our point of view:

a. Among some of the smaller schools there had been no eighth grade class the previous year, and therefore no Seker scores.

b. Whether the test had been given at a particular school, and if so, to whom, depended in a complex way upon both the principal and the students. The principal might decide not to give the test, or, in a larger school, to give it to only one of the two eighth grade classes, etc. Students not interested in further schooling beyond the eighth grade might decide not to take it, or to go through the motions of taking it without really trying, etc.

The utility of the information provided by the Seker scores will be discussed in a later section.

Input and Outcome Measures

Arithmetic Pretest. This was a 26-item multiple-choice test dealing in a straightforward manner with the operations of addition, subtraction, multiplication and division of whole numbers. Sample item:

43 x 2 = ?

a) 46

b) 45

c) 83

d) 86

e) none of these

Aptitude Test. Raven's Progressive Matrices Test, 1938 Form, provided a measure of academic aptitude. Only Sets A, B, and C were used.

Teachers' Questionnaire. This questionnaire (reproduced in Appendix B) attempted to measure teacher attitude toward programed instruction (questions 2 to 17), teacher attitude toward teaching arithmetic (questions 18 and 19), procedures and problems in classroom use of the programed instruction (questions 20 to 26), and teacher evaluation of the specific program used (questions 27 and 28).

Booklet Tests. For each booklet of both the Fliedel-Jacobs and the TEMAC program two parallel achievement tests were constructed. They ranged in length from 15 to 20 items.

Posttest. This fifty item test, reproduced in Appendix C, was designed to yield subscores on facility in addition and subtraction with fractions (items 1 to 16), facility in multiplication and division of fractions (items 17 to 35),

understanding of the concept of a fraction (items 36 to 44), and word problems (items 45 to 50).

Student Attitude. This single item (reproduced in Appendix D) attempted to measure student liking for arithmetic.

Procedure

Teacher Training. A two hour training workshop was held during the first month of the school year for the teachers whose classes were to be in the experimental (program-using) classes. The workshop began with the teachers themselves serving as students taught by a Hebrew translation of a self-instructional program on binary numbers (Silverman and Alter, 1961). This was intended to give them some direct experience with programed instruction. It was followed by brief discussion of the theoretical background of programed instruction, problems of classroom management, and the purpose, design and procedure of the present study. Finally the teachers were shown the first (and, at that time, only available) booklet of the Fliedel-Jacobs program.

Classroom routine. The use of the program was begun during the second month of the school year in order to avoid interruptions in the experiment due to a series of holidays occurring in the first month. During the initial class lesson in which the program was used the teacher went over the first five or six frames with the class at a group pace. Then the students proceeded on their own. The teacher circulated among the students, making sure that they understood the mechanics of going through the program, and also offering substantive help with the subject matter as needed.

The teacher answered student questions, and encouraged students to ask them. In general the comparison of experimental and control classes was one of teacher-plus-program-taught vs. teacher-taught conditions, rather than program-taught vs. teacher-taught conditions.

The students were told not to "cheat" by looking ahead at the program answers before producing their own. They were told they would be evaluated on the basis of separately adminstered tests, rather than on the basis of performance on the program itself.

The booklets tests were given individually to each student as he completed the corresponding programed booklet, and then graded by the teacher. If the student scored 80% correct or better, he then received the next program booklet. If a student scored lower than 80% correct, he was to be given some combination of additional instruction, determined by the teacher, of tutoring by the teacher, reuse of program booklet, or use of textbook. He was then to be retested with the alternate form of the test and allowed to begin the next booklet regardless of score.

The booklet tests were intended to give feedback to the student as to his progress, which is sometimes subjectively hard for him to gauge during exposure to a long series of carefully graded small steps. They were also intended to give diagnostic information to the teacher as to what exactly had not been mastered, and to give to the programer both general feedback as to the success of the program, and for the Fliedel-Jacobs program still in the process of development, feedback on the usefulness of certain specific features of the program, e.g., the use of segmented rectangles as a schematic device (see Appendix A , frame 104).

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It should be noted that the classroom situation we wished to generate in the teacher-plus-program-taught classes was much more of a radical departure from "conventional" instruction than it would be in the United States. In most of the classes in our sample, lecture by the teacher and a limited amount of recitation by the student was normally the predominant pattern of classroom activity. An American class that has not used programed instruction *per se* has generally had more prior experience with individual pacing, teacher interaction with individual students, and use of workbooks or other materials for individual use.

Testing. The fifth-grade classes were given the arithmetic pretest and the student attitude inventory during the first two months of the school year, prior to beginning the use of the program in the experimental classes. The following instructions were sent to the teacher:

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''We are now conducting an experiment on programed instruction. Some classes, in the experimental group, are using newly-developed materials called programs, while other classes, in the control group, are using conventional materials.

In your school, class ____ is in the (experimental) (control) group.

At this time we would like a measure of both how the student feels toward arithmetic as a subject and a measure of what the student can do in arithmetic. For these purposes we have a questionnaire and a test which we would like to have given on (date) during the arithmetic class.

1. The questionnaire. The teacher should show how this type of questionnaire is answered by putting on the blackboard this sample question:

Which do you like to do most?

Play football

Read

Go to movies, etc.

Which do you like to do least?

The teacher should tell the class that no answer is "right" or "wrong" for everybody. Allow five minutes for the questionnaire itself.

2. The test. The teacher should go over the instructions on the first page and make sure that each student understands them. Then allow each student to work on the test until the end of the double class hour. We do not expect all students, and perhaps no student, to finish during this time.''

For the sixth grade classes, score.on the arithmetic pretest were already available from a testing program carried out during the previous school year. The instructions were therefore modified accordingly to refer only to the student attitude inventory.

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The Progressive Matrices Test was administered to both experimental and control classes during the course of the school year. It was assumed that experimental treatment would not differentially affect scores on the test, and that therefore the same relative rankings of classes would have been obtained had the test been given at the start of the school year.

The test was administered in group sessions. The proctor (from the research staff of the Szold Institute) explained the nature of the tasks in the test, and the use of the separate answer sheet. He went over with the class the first three questions (A_1, A_2 and A_3) and then allowed 20 minutes for working the remainder of Sets A, B, and C (a total of 36 items). For almost all students this was sufficient time for attempting all items. The test was scored for number right. The writer was present during the administration of the Progressive Matrices Test in 36 of the 40 classes.

The teacher attitude inventories were administered by mail to the teachers of experimental classes only, four months after the start of the experiment. Provision was made for anonymity of reply. The arithmetic post-test was administered and the student attitude inventory readministered at the end of the school year.

An attempt was made to visit each experimental class at least once a month during the course of the experiment. Each control class was visited at least once for administration of the Progressive Matrices Test.

Departures from the Plan

The preceding pages have provided an idealized view of the planned procedure. There were a number of departures from this plan, some of the type that are likely to occur (but not necessarily be reported) in any large

scale educational field study in the United States, and some that are probably unique to the Israeli setting. The departures from the plan are described here so that each individual reader can decide for himself to what extent the conclusions reached here may require qualification.

It has already been noted that neither the Fliedel-Jacobs or TEMAC program was available in its entirety at the start of the experiment. In this study, as in most others, students were found to go through the program at vastly different rates. This meant that the faster students often had to wait a number of days, or in some cases, weeks, between the completion of one booklet and the start of the next. This waiting period was handled in different ways by different teachers. A "conventional" lesson was often held when a sufficiently large number of students were waiting for the same booklet to warrant it.

To further complicate the scheduling, a nationwide postal strike of more than a month's duration restricted communication between the cooperating schools and the research office. Mail had been a primary channel for sending tests and program booklets, and receiving back booklet tests and other information about the progress of the study from the schools. The strike required that personnel be diverted from other activities for the hand delivery of materials, and also required the greater use of the overtaxed telephone system for communication.

In two cases a sixth grade class in the experimental group was judged by the teacher or the district supervisor at the time of the teacher training workshop as being too weak to derive maximum benefit from the more difficult TEMAC program, and so was given the Fliedel-Jacobs program instead. A particular sixth grade class that had been using the TEMAC program for one month was judged by the research team to be grossly mismatched, and was

switched at that point to the Fliedel-Jacobs program.* In one case most of a sixth grade class were given the TEMAC program, but three students, who were considered "retarded" and who would have been placed in a special class for the retarded had one existed in that locality, were given the Fliedel-Jacobs program, and not included in the data analysis.

The end of the school year brought additional problems concerning the posttesting. For various reasons posttests were not available in five experimental and three control classes. In several of these cases there had been one or more changes of teacher during the school year, and the latest teacher was unwilling to give the test or unaware of the necessity of giving it. In two cases the tests were apparently given but misplaced. Two classes, one experimental and one control, in which conditions had been especially chaotic, were dropped from the analyses. A control class that contained only seven students, in contrast to the overall mean class size of 25, was also dropped from the analyses.

*In subsequent analyses of treatment effects these three sixth grade classes will be considered as fifth grade classes.

Results and Discussion

Following Jacobs, Maier and Stolurow (1966), aptitude, arithmetic pretest, and pre-attitude will be considered as input characteristics and achievement and post-attitude as outcome measures. In this way the evaluation of the two self-instructional programs will take into account both a cognitive dimension (represented by the aptitude, arithmetic pretest, and achievement measures), and an affective measure (represented by the pre- and post-attitude measures).

Our basic questions are whether the experimental and control groups show different levels of input and of outcomes, and how input is related to outcome within each group. Finally, data from the questionnaire administered only to the teachers of classes in the experimental groups will provide information on the strong and weak points of the experimental procedure and of the programs, as seen by the teachers.

The two variables of academic ability and achievement were considered basic in the sense that students who, through absence, had missing data on the Progressive Matrices Test or the arithmetic posttest were dropped from the analyses. The class, which was the unit of assignment to conditions, will be considered the unit for data analysis. For each input and outcome measure a class mean was computed.

Input comparisons. Of the three input measures, six class means for pre-attitude, seven class means for arithmetic pre-test and no class means for academic aptitude were missing. Since mean academic aptitude and mean arithmetic pretest correlated .71 for all the fifth grade classes and .62 for all the sixth grade classes, arithmetic pretest was dropped from further analyses, and academic aptitude alone was taken to represent the cognitive domain in input.

We had used the Seker examination to separate higher level from lower level "culturally deprived" schools, and as a rough basis for matching

experimental with control classes. Our assumption was that the mean on an achievement test battery (the Seker) for a group of eighth graders at a particular school one year could be used to predict mean score on an aptitude test for a group of fifth or sixth graders at the same school the following year. The input data from our sample permit a check on this assumption.

The correlation between mean Seker score for eighth graders one year and mean Progressive Matrices score for the fifth grade class in the same school the following year was .69 ($n = 17$, $p < .01$). The correlation between mean Seker score for eighth graders one year and mean Progressive Matrices score for the sixth grade class in the same school the following year was -.07 ($n = 16$, not significant). These results suggest that the Seker was appropriate for separating higher level from lower level schools, but could not be used for meaningfully matching pairs of schools.

Input-outcome relationships. The means, standard deviations, and intercorrelations of the input and outcome measures are shown separately for all experimental classes together and for all control classes together in Table 2. For each group the input variable of aptitude is highly correlated with the outcome variable of achievement. This is in line with the finding of another large scale program evaluation study that also used the class as the unit of analysis (Maier and Jacobs, 1964).

For both groups, however, all the other correlations are negligible. It is difficult to believe that the lack of correlation between pre- and post-attitude measures reflect instability of attitude under both teacher-taught and teacher plus program-taught conditions. Maier and Jacobs (1964) had found a high relationship between pre- and post-attitude toward the subject matter for different groups of classes taught by teacher alone, by program alone,

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Table 2

Intercorrelations of Input and Outcome Variables
in Elementary Schools

A. Experimental Classes

	1	2	3	4	Mean	SD	N
1. Aptitude		-.06	.82	-.21	20.3	2.92	15
2. Pre-attitude	-.06		.16	.05	2.72	.48	12
3. Achievement	.82**	.16		.19	26.7	7.39	15
4. Post-attitude	-.21	.05	.19		2.65	.42	11

B. Control Classes

	1	2	3	4	Mean	SD	N
1. Aptitude		-.04	.62	.09	20.3	2.32	17
2. Pre-attitude	-.04		.08	.06	2.74	.56	14
3. Achievement	.66**	.08		.04	23.6	7.69	17
4. Post-attitude	.09	.06	.04		2.66	.40	16

** $p < .01$

and by a combination of teacher and program. Perhaps deficiencies in measurement (a single item was used) and differential loss of data (pre-attitude data, post-attitude data or both were missing for nine of the 32 classes) explain the present failure to obtain a correlation between input and outcome in the affective domain. In any event, further analyses of the attitude scores will not be made in the "outcome comparisons" section.

Outcome comparisons. In view of our sampling procedure, and the departures from the plan that have already been mentioned, outcome comparisons between experimental and control groups may be viewed in terms of a somewhat patched-up Posttest-Only Control Group Design (Campbell and Stanley, 1963).

Means for each group on each subsection of the arithmetic posttest are presented in Table 3 . Effects of experimental treatment and of grade level have been analyzed in 2 x 2 analyses of variance, as well as in 2 x 2 analyses of covariance with aptitude as covariate (Table 4).

The analyses of variance indicate for each subtest the sixth graders are superior to the fifth graders, and for the subtests of conceptual understanding and word problems with fractions, the teacher-plus-program-taught classes are superior to the teacher-taught classes. The analyses of covariance indicate that when differences in aptitude level are taken into account, there is no difference in achievement due to grade. In neither set of analyses does a significant interaction appear between grade level and experimental treatment.

It appears, then, that each program makes a significant contribution toward teaching conceptual understanding of fractions, and in handling of word problems with fractions. Furthermore, these benefits of the programs are not offset by a loss of skill in addition, subtraction, multiplication and division of fractions.

Table 3

Group Means and SD's on Subsections of Arithmetic Posttest

	Addition and Subtraction		Multiplication and Division		Concepts		Problems	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Fifth Grade Experimental	9.45	2.54	6.41	2.61	4.32	1.35	3.08	.983
Fifth Grade Control	8.34	1.22	6.10	2.84	2.75	0.92	2.12	.842
Sixth Grade Experimental	11.64	1.65	9.87	3.25	5.29	0.74	3.83	.879
Sixth Grade Control	10.13	2.34	9.84	3.57	4.88	1.23	3.13	.957

Table 4

Analyses of Variance and Covariance of Scores on each Posttest Section

		Analysis of Variance			Analysis of Covariance		
		df	MS	F	df	MS	F
Addition and Subtraction	Grade Level	1	31.558	6.69*	1	.045	--
	Treatment	1	13.675	2.90	1	10.945	3.36
	GLxT	1	.278	--	1	.788	--
	Error	28	4.716		27	3.258	
Multiplication and Division	Grade Level	1	102.951	9.38**	1	3.801	--
	Treatment	1	.230	--	1	.009	--
	GLxT	1	.159	--	1	.002	--
	Error	28	10.980		27	8.010	
Concepts	Grade Level	1	18.898	13.65**	1	.961	1.09
	Treatment	1	7.826	5.65*	1	6.606	7.47*
	GLxT	1	2.691	1.94	1	2.068	2.34
	Error	28	1.384		27	.884	
Problems	Grade Level	1	6.159	6.37*	1	.061	--
	Treatment	1	5.373	5.56*	1	4.660	6.35*
	GLxT	1	.127	--	1	.047	--
	Error	28	.967		27	.734	

*$p < .05$

**$p < .01$

In any such evaluation study one should consider whether the posttest was in some way biased in content or format in favor of the experimental classes. The divergent approaches of the two programs makes this rather unlikely in the present study.

Teacher questionnaire results. One methodological point in interpreting the teacher questionnaire results* is the extent to which the teachers may merely be giving what they consider to be socially desirable responses. The fact that only about half of the respondents thought that one learns faster with programed instruction (question 4) and that learning from programed instruction is not less thorough (question 5), along with the fact that the teachers were willing to volunteer critical comments (free responses 46-52), suggest that social desirability was not a major determinant of their answers. A second methodological point is that only 12 of the 16 teachers of experimental classes returned the questionnaire, and not all of these 12 responded to each question.

The answers to questions 6 through 9 indicate an almost unanimous belief among the respondents that programed instruction teaches the student honesty and responsibility, increases his ability to work independently, and at the same time, does not reduce the student's motivation to learn, or teach him to think in a mechanical fashion. Eight out of 10 respondents were willing to use programed materials for teaching the following year (question 25). In general, then, the teachers were favorably impressed with the advantages of programed instruction, were willing to use programs again, and were able to point out specific features that they felt, if remedied, would increase the effectiveness of the programs.

*See Appendix B.

II Programed Algebra in the Vocational High Schools

In the preceding year a preliminary version of a linear program in algebra was informally tried out in four vocational high school mathematics classes. The results were sufficiently encouraging for further revision and try out of the program. Thirteen experimental (program-taught) and seven control (teacher-taught classes were made available for this purpose. Unfortunately a variety of complex administrative reasons permitted only an ex post facto research design.

Method

Subjects

The 13 program taught classes were located in seven different schools. Complete data were obtained for 369 students. The seven teacher taught classes were located in two different schools. Complete data were obtained for 181 students.

Program

The program (Fliedel, 1964) was of the linear constructed response type, and consisted of approximately 3000 frames. Each of the 26 sections contained a review section, and a unit test. It was presented in the form of a programed textbook, that is, without the use of a machine.

Procedure

The study was carried out among ninth-grade algebra classes in vocational high schools. Classes in the experimental group used the program textbook as the main vehicle of instruction, and did not have a conventional textbook. Classes in the control group used a conventional algebra textbook, and presumably

had more teacher-directed instruction. The assignment to experimental or control conditions depended on a variety of administrative considerations, including supervisor-principal-teacher relations, location of school, and cost factors.

Input Measures

Raven's Progressive Matrices Test, 1938 form (Sets A, B, C, D, E), was administered in group sessions. It served as a measure of academic aptitude.

The mathematics achievement test from the UNESCO battery (Foshay et al, 1962) served as a pre-test in mathematics.

Output Measures

A fifteen item posttest in algebra served as the only outcome measure. The test is reproduced in Appendix E.

Results and Discussion

The means, standard deviations and intercorrelations of the input and outcome measures are shown for experimental and control groups separately in Table 5. The two groups are closely matched in terms of input characteristics, which should make the comparison of the outcome measures in the two groups more interpretable. In general the input and outcome measures, as might be expected, are positively correlated. An exception is the negative correlation (not statistically significant) between aptitude and posttest for the experimental group.

A Mann-Whitney U Test shows the experimental group to have significantly higher posttest scores ($p < .02$, two-tailed test). The correlational results suggest that the success of the program stems from washing out initial differences in aptitude among the classes, a situation often sought after but seldom obtained.

Table 5

Intercorrelations of Input and Outcome Variables

in Vocational High Schools

A. Experimental Group (N = 13 Classes)

	1	2	3	Mean	SD
1. Aptitude		.56*	-.31	68.57**	6.10
2. Pretest	.56*		.40	60.31**	6.55
3. Posttest	-.31	.40		7.38	1.81

B. Control Group (N = 7 Classes)

	1	2	3	Mean	SD
1. Aptitude		.66	.71	67.49**	5.00
2. Pretest	.66		.82*	60.20**	7.00
3. Posttest	.71	.82*		4.66	2.78

---

*$p < .05$

**Test Scores were transformed to percent correct of total.

Since the design here is that of an ex post facto experiment (Campbell and Stanley, 1963), we cannot conclude that the same finding would have emerged had there been random assignment of classes to the treatments. Nevertheless the present results, given the limitations in the degree of experimental control that was administratively feasible, strongly suggest that use of the program be continued.

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III. The Programing of Introductory Lessons in English as a Foreign Language

It was not possible to devote considerable effort to the programing of English as a foreign language. Instead an attempt was made to develop some introductory lessons to demonstrate the approach that could be taken if adequate support were available.

Regarding pedagogy, it was decided to use the direct approach, with minimal teaching of grammar as such, and to have the development of listening and speaking skills precede the development of reading and writing skills.

Materials for several hours of introductory instruction in English as a foreign language were prepared. Only part of this material, dealing with listening and speaking skills, was tried out.

An informal tryout of the English material was held with two Hebrew-speaking fifth grade students who had no previous background of instruction in English.

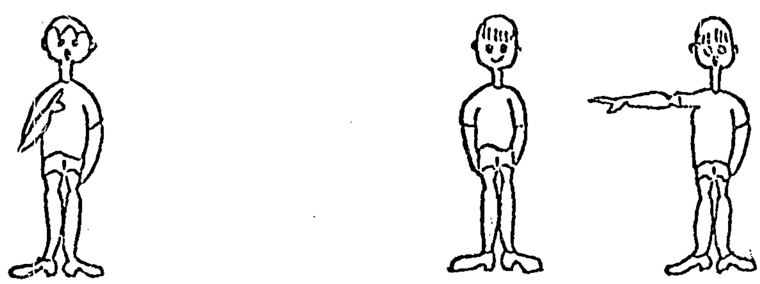
The auditory stimuli and the instructions were conveyed by a pre-recorded tape. The instructions were supplemented, when necessary, by a member of the research team who was present.

The material covered the six sentences "I am a boy," "I am a girl," "You are a boy," "You are a girl," "He is a boy," and "She is a girl." The behavioral objectives were (a) the student, seeing a picture that represented one of these sentences (e.g., Figure 1a represented the sentence "I am a boy"; Figure 1b represented the sentence "He is a boy") should speak that sentence so that it would be recognizable to a native speaker of English; (b) the student, upon hearing one of six sentences spoken, should pick out the appropriate corresponding picture.

The student first listened to each of these six sentences spoken several times. No response was required. This was a <u>familiarization</u> phase intended to accustom him to the sounds of the language, and specifically to the sounds of these six sentences.

In the second phase he listened to 13 pairs of sentences and was required to write down, after each pair, whether the sentences were the "same" or "different." During this <u>sound discrimination</u> phase he received immediate knowledge of results from a programed answer sheet. The discrimination progressed from easy to hard in terms of number of identical elements, e.g., a "different" pair early in the sequence was "I am a boy" and "You are a girl", and a "different" pair toward the end was "You are a boy" and "You are a girl."

The third phase was that of <u>association</u>, that is, linking the spoken sentence to its pictorial representation. The student heard a sentence and



(a) (b)

Figure 1. Drawings to represent "I am a boy" (a) and "He is a boy" (b)

looked at the corresponding picture. No response was required. The set of pictures used in the association phase was then gone through a second time with the student listening to each sentence from the tape while looking at the corresponding picture, then repeating the sentence out loud. This was the <u>vocalization</u> phase, during which the student did not receive explicit feedback as to the correctness of his vocalization. It was followed by the <u>sound-picture discrimination</u> phase, in which the student heard a sentence, decided which of a pair of pictures represented that sentence, and received from a programed answer sheet immediate knowledge of results.

There were five cycles of association phase, vocalization phase, and sound-picture discrimination phase. The number of sentences in each phase in each cycle was as follows:

	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
Association	24	20	15	15	16
Vocalization	24	20	15	15	16
Sound-picture Discrimination	12	6	6	6	4

Results

The two students appeared nervous and ill-at-ease, which was understandable in view of the unfamiliar surroundings (the research office), the unfamiliar task, and the presence at various times of from two to four adults.

The first behavioral objective, "saying what they see", was very poorly attained. Even in the vocalization phase, which involved the lower level skill

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of merely repeating what had just been heard, the sentences were often very garbled, e.g., "I are is girl." This may in part be due to the strained circumstances described above, and in part due to the fact, which became painfully obvious, that the six sentences contained a number of sounds not occurring in Hebrew, and quite unfamiliar to the children.

The second behavioral objective of pointing out the correct picture in response to the spoken sentence was better realized. Out of a total of 34 sound-picture discriminations in the five cycles together, one student had 26 right, and the other student 29 right. A chance level performance would have been 17 right.

From this informal tryout a number of weaknesses in the material and in the procedures were noted.

General Discussion

Implications for improving instruction in Israel. The evaluative studies of three mathematics programs, carried out in Israel and reported here, have shown in each case that classes using the program learned more than classes using conventional textbooks. Clearly one cannot conclude that classes in Israel using any program will learn more than classes using conventional textbooks, or even that classes in Israel using any mathematics program will learn more than classes using conventional textbooks; "...conclusions from an evaluative study of a single instrument apply only to that particular instrument, and the generalization of the results to other instruments of the media it represents have, at most, the status of untested hypotheses (Lumsdaine, 1963, p. 596).

On the other hand, the method of sampling schools and of assigning classes to the experimental conditions for the evaluations of the Fliedel-Jacobs program and the TEMAC program permit the extrapolation of the findings for these programs to the larger population of 315 schools in Israel designated as primarily for culturally deprived students. We may expect that if the TEMAC program were given to a new group of higher level schools in this population (as defined by school mean on the Seker), and if the Fliedel-Jacobs program were given to a new group of lower level schools in this population, both program taught groups would learn more than would comparable groups using conventional textbooks. In Lumsdaine's terms, while we have no basis for generalizing our results to other instruments (programs), we do have a basis for generalizing our results with two particular instruments (the Fliedel-Jacobs and TEMAC programs) to a larger population.

Neither the present research nor any other research can prove or disprove the general proposition that "Programed instruction is better than conventional

instruction". Within the limitations of the present studies, however, both locally produced programs and a translation of an American program have been successful in Israel; and the success has been both at the elementary school and the high school levels. These findings should prove of heuristic value to Israeli educational authorities.

Implications for improving instruction in other countries. According to some observers "...the greatest contribution of programed instruction to education may well be made in the developing countries (Schramm, 1962, p. 34). Schramm cautions, however, that most of the work in programed instruction has been done in the United States, and that we must be sensitive to the different needs and circumstances of the other cultures in which programed instruction may be introduced. The context of the evaluative studies described here differed in several ways from American studies of "programed" vs. "conventional" instruction: in the Israeli setting the teachers in general had fewer years of formal education than their American counterparts, the language of instruction was often not the language spoken in the students homes, the students did not have as much experience with nonprogramed textbooks, workbooks, wall charts, and other teaching aids commonly found in American classrooms, and, in the writer's opinion, the students generally played a more passive role in classroom activities dominated by the classroom teacher. The success of programed instruction under these circumstances may provide encouragement for other countries in which similar circumstances obtain.

Implications for research in comparative education. In a recent pioneering study (Foshay et al, 1962) comparative data were collected on the scholastic achievement of thirteen-year-olds in twelve different countries. This was a first step in obtaining information about the outcomes of different national educational systems. A further step forward would be to test the scholastic achievement of students in various countries after they have had a common learning experience. Programed instruction could serve as a common learning experience, by providing basic control over both the content and the method of instruction.

In the present studies the widely used Progressive Matrices Test was an input variable highly correlated with achievement under both programed and conventional instruction. This test could be used in various countries, together with translations of the Fliedel-Jacobs or TEMAC programs, and the corresponding posttest, to add a new dimension to research in comparative education.

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Appendix A. Sample Page from Fliedel-Jacobs Program

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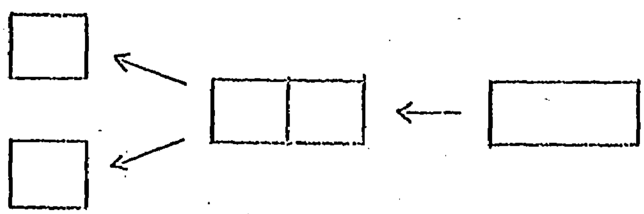
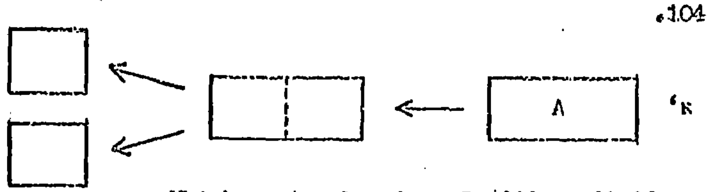
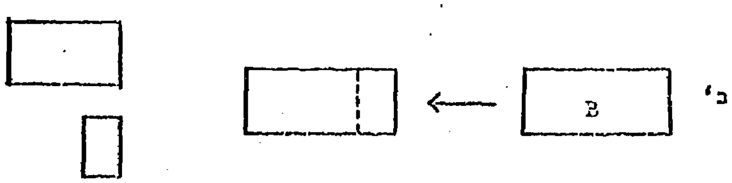


We divided the rectangle into ____ equal parts.
חלקנו את המלבן ל ______ חלקים שווים.

.104



Which rectangle, A or B, did we divide into two equal parts?



איזה מלבן חלקנו לשני חלקים שווים, מלבן א', או מלבן ב'?

two (or 2)

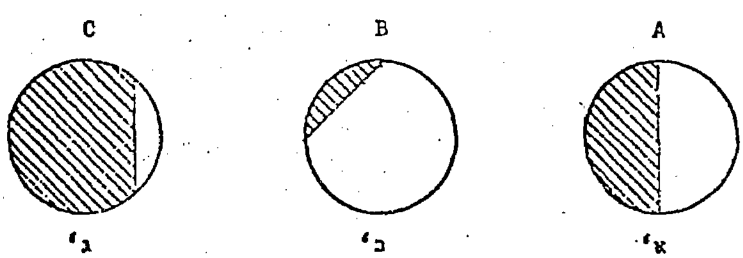
שני (או 2)

.105 כדי לקבל שני חצאים של עגול שלם חלקנו את העגול השלם
In order to get two halves of a whole circle, we divided it into ____ equal parts. Each part is ____ of the whole circle.
ל ______ חלקים שווים.
כל חלק הוא ______ העיגול השלם.

A

א'

.106



באיזה עיגול צבענו חצי בשחור, עיגול א', עיגול ב', או עיגול ג'?
In which circle, A, B or C, did we shade half?

two (or 2)

one-half

שני (או 2)

חצי

A

א'

Appendix B. Teacher Questionnaire

Dear teacher:

At the initiation of the Ministry of Education, the Szold Institute is conducting extensive research on teaching arithmetic through programed instruction. We are interested in the reactions of the participating teachers to help us plan the continuation of our work. Please answer the questions presented in this questionnaire.

Answer the questions in the order they are presented here. Answer all of them; if you have some difficulty in replying, choose the most appropriate answer. Your answers will be confidential, and used only for research purposes.

1. What did you know about programing at the start of this school year?
   a. I knew nothing about it. (7)*
   b. I had heard about it, but knew very little. (4)
   c. I had read about it in the press. (1)
   d. I had examined some programed instructional materials. (0)

In the next two questions you are asked about the general opinions of other teachers about programing. You meet many teachers and hear their opinions. Try to answer here according to your impression of what their opinions are. Remember, you are not being asked about your own opinion.

2. What is the general opinion of teachers about programing?
   a. It is useless. (0)
   b. It has a little use. (5)
   c. It is of much use. (3)
   d. It is of very much use. (1)

---

*The number of respondents choosing each alternative is given in parentheses. Free responses to questions 20 to 29 are listed in this Appendix following the questionnaire itself.

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3. Programing, like any other system, has advantages and disadvantages. What is the general opinion of teachers about its disadvantages?
   - a. The disadvantages are so big that it is not worthwhile to use this system. (1)
   - b. The disadvantages are large, but even so it is worthwhile to use programing. (1)
   - c. It is possible to overcome the disadvantages. (7)
   - d. The disadvantages are of little importance. (1)

For the following statements answer "right" or "wrong" according to <u>your</u> opinion. There may be some statements that are not completely right or wrong. In such cases choose the answer you think is the more appropriate of the two.

For each statement indicate your answer by circling the letter "R" or "W". For example: Jerusalem is the capital of Israel. R W

4. One learns faster with programed instruction than with other systems. R(6) W (6
5. Learning from programed instruction is not as thorough. R(5) W(7)
6. Programed instruction reduces the students motivation to learn. R(0) W(10
7. Programed instruction teaches the student to work independently. R(12) W (0
8. Programed instruction teaches the student to learn mechanically, without developing his thinking ability. R(1) W(11)
9. Programed instruction teaches the pupil honesty and responsibility. R(12) W (0
10. Programed instruction is appropriate for all the pupils in the class. R(4) W (8
11. Programed instruction is appropriate for only the best pupils. R(7) W (5)
12. Programed instruction is appropriate for only the worst pupils. R(0) W(1

13. It is not worthwhile to teach Bible studies in the sixth grade by p.i. R(6) W(4)

14. It is worthwhile to teach Hebrew studies in the sixth grade by p.i. R(6) W(4)

15. It is worthwhile to teach English (as a foreign language) in the sixth grade by p.i. R(5) W(4)

16. It is not worthwhile to teach arithmetic in the sixth grade by p.i. R(3) W(7)

17. How does programed instruction affect teacher-pupil relations?

a. It improves relations because the teacher will dedicate more time to individual work with the pupil. (7)

b. There is no difference in this regard between programed and conventional instruction. (5)

c. It worsens relations because the pupil learns from the book and not from teacher. (0)

18. How interested are you in teaching arithmetic in the school?

a. very interested (8)

b. fairly interested (4)

c. slightly interested (0)

d. I am not interested (0)

19. Rate the following subjects according to how difficult you find it to teach them. Put a "1" next to the hardest subject to teach, and so on, and a "4" next to the easiest subject to teach.

a. arithmetic (1, 1, 2, 2, 3, 3, 3, 3, 3, 3, 4, 4)

b. Hebrew

c. Bible studies

d. History

In the following section you are asked some questions about how programing was used in your class. For each question a space is provided for you to elaborate upon your answer.

20. Were reading problems a source of difficulty for your class in using programs?
    a. Yes (5)
    b. No (7)

21. Did the pupils acquire a firm knowledge of the subject matter from the program?
    a. Yes (6)
    b. No (3)

22. Did the pupils work on the program at home? If so, tell how much, what problems emerged, etc.
    a. Yes (4)
    b. No (5)

23. Did you also give frontal lessons* In arithmetic?
    a. Yes (11)
    b. No (1)

24. Did you give your class other homework? If so, give details.
    a. Yes (10)
    b. No (2)

---

*Teacher directed lectures or discussions for the entire class.

25. Are you interested in using this (programed) material for teaching next year?

a. Yes (8)

b. No (2)

26. How did you deal with the problem of individual differences in pacing among the pupils?

a. by slowing down the faster pupils (0)

b. by accelerating the slower pupils (1)

c. by permitting each one to progress at his own pace. (11)

In the following section we want your critical comments concerning the material you have been using.

27. What defects in pedagogical approach did the program have?

28. What topics were not sufficiently explained? What other inadequacies in the explanations were there?

29. What are the main problems in teaching with this system?

30. Have you taught arithmetic in 5th (6th) grade in previous years? How many years? Please add any other comments you wish to make.

Free Responses on Teacher Questionnaire

Were reading problems a source of difficulty for your class in using programs?

(1) The difficulty lay in understanding the questions.

(2) A large number of pupils are not reading well without vocalization.

(3) Difficulties were encountered due to misprints, also to the fact that we were giving the material to the pupils in a new form. We had to explain the form of the arithmetic to them.

(4) Some pupils are immigrants, and therefore it is difficult for them to understand what is required of them.

(5) I have only been teaching the class for a month, and I have not noticed any difficulty.

Did the pupils acquire a firm knowledge of the subject matter from the program?

(6) My pupils had already studied this material by the frontal method of teaching, and the new booklets were used only for repetition.

(7) This concerned only the good pupils, the other (illegible) % had to (illegible) the reading.

(8) Only 5 or 6 pupils out of 33 knew the material well when they finished the booklet.

(9) The good pupils succeeded in learning the material by this method. The others understood the material when it was taught gradually, but understanding was not evident from the examination, nor in repetition.

(10) After the pupils became acquainted with the programing format, they learned well.

(11) The good pupils made progress, but the weak ones (also those weak in language) did not master the material.

(12) The programed material succeeded in teaching only some of the pupils, and enabled them to master the material.

(13) Knowledge in this subject is like that in other subjects.

Did the pupils work on the program at home? If so, tell how much, what problems emerged, etc.

(14) A large number of booklets were brought back in bad condition, therefore I preferred to keep them in class.

(15) Each pupil got a book to take home.

(16) With this method, there is no material to study at home, therefore homework can be given from a book which fits the level of the material in the booklet.

(17) The pupils are not taking the booklets home, because I am not sure if they will be perfect.

(18) The pupils work on the booklets at home, and try to finish it quickly in order to get started on the next booklet.

(19) I am not giving the booklets to my pupils, because I cannot supervise them.

Did you also give frontal lessons* in arithmetic?

(20) Because there was not continuity in sending the material, we taught by the two methods together.

(21) When I see that most of the pupils do not understand, I give them frontal explanation.

---

* Teacher directed lectures or discussions for the entire class.

(22) Because I saw that most of the pupils were not making progress from the booklets, I gave them some frontal instruction, but not, on the whole, on material in the booklet.

(23) The pupils usually finish the work in the booklet in 4 lessons: it is hard to explain the material on the black-board:- and so I have time left to teach according to a book which usually corresponds to the stage of the booklet.

(24) In my opinion there is need for frontal lessons from time to time, to teach the material that is lacking in the booklet, and to clarify certain points which are not mentioned there, or are not explained fully enough. (This goes for good pupils as well).

(25) When I see that something is not clear to the whole class, even though they studied it according to the prescribed method, I explain it to them by frontal teaching.

(26) R e v i e w lessons on material are given in frontal lessons, e.g., r e v i e w of material dealing with fractions, adding, subtracting, multiplying or dividing, and review of the multiplication tables.

(27) When the pupils finish one booklet and have not yet got the following one, I give them frontal lessons in the meantime.

Did you give your class other homework? If so, give details.

(28) I want to test their understanding of the ordinary material, by questions and exercises, in the study-book, by the usual method.

(29) When the pupils learn from the booklet, they have no other homework. When I started with frontal lessons, I gave homework based on the material I taught (in class).

(30) Homework from the book, but not very much: because without explanation the homework is not clear. It is not always acceptable to give, on the one hand, lessons by this method, and, on the other hand, work in the booklet according to another method.

(31) I gave lessons to supplement this material, to strengthen and explain other points which are not dealt with in the booklet.

(32) Often when I explain something which is not clear to them, I give them homework just on this material.

(33) Only when frontal lessons are given do the pupils get exercises based on what was studied in the same lesson.

(34) I continue to teach the four basic arithmetical operations, especially long division, adding, subtracting, and the use of 0, - this is true also when we have no booklets.

Are you interested in using this (programed) material for teaching next year?

(35) I cannot give my opinion yet.

(36) I have not yet made up my mind.

(37) To my mind, this method is suitable only for good pupils. For the others, the material which is given in the booklet is too abstract.

(38) The pupils enjoy the work. Problems with those who are weak in arithmetic are solved, especially as there are many grades in this class.

(39) (a) This method of work gives the pupils an opportunity to study by himself, and to test himself on what he learns.

(b) The pupils <u>like</u> this method.

(c) This form of study is <u>varied</u>, and (again) the children like it.

(d) This method explains the material well to the children.

(40) Everyone works individually.

How did you deal with the problem of individual differences in pacing among the pupils?

(41) The pupils who study quickly, finishing the booklet, have to reread the material.

They have opportunity to work on the appropriate material in the textbook, and I examine on it.

(42) Here is the biggest absurdity: - those who finished the booklet first were generally the best pupils; they had frontal teaching, and other practice in the material, and also more homework than the slower pupils.

(43) It makes it possible for each and every pupil to progress at his own rate. The class is advancing more or less at the same rate, and up till now (end of booklet 3) I have not come across this problem.

(44) Because there are various grades in my class, I do not spur the weak pupils, and do not hold back the good ones.

(45) I give the slow pupils booklets to take home, also we review before the examinations, to wait for the slow pupils.

What defects in pedagogical approach did the program have?

(46) The material is given in too abstract a way. There are no explanations given as to the transition from one grade to another. Practice is always with the same fractions.

(47) The fact that the answers are immediately next to the questions is not good because pupils can copy the answers, especially near the end when he wants to finish the booklet. It would be better, then, if the other part of the booklet were without answers, and instead could give practice in various exercises, and material which would be done by the pupils with the help of the teacher and the frontal lessons.

(48) In my opinion the defects in this programme are: there are some basic terms in studying how to deal with fractions which are not explained until booklet 3. The format of the booklet and the format of the test are different.

(49) The sections which describe pictorially addition and subtraction of fractions are not clear enough. The language is difficult for the immigrant. It would be better if there were more repetitions of the material.

(50) There are exercises in which the explanation is not detailed enough, and this causes difficulty for the pupils. The transition from easy material to the difficult material is not explained fully enough, although it is based on continuity in the previous material.

(51) In my opinion the programed teaching does not give the children an understanding of the arithmetical operations, they need also to see parts being taken, and then collected, in order to understand the improper fractions, etc.

(52) I came across difficulties especially in Booklet 3. The answer that the pupils should give is not clear enough. There are some right answers, and the teacher's explantions are taking up time, which in my opinion is unnecessary. It would have been better if there had been only one possible answer.

What topics were not sufficiently explained? What other inadequacies in the explanations were there?

(53) The method for adding fractions with common denominator and different denominator was not explained well. The pupils were not able to perform simple exercises in adding and subtracting fractions.

(54) The term "fraction" is not fully explained.

The basic terms - denominator, numerator, are not mentioned.

There are no questions that appeal to the child's reasoning.

There are no real questions in the booklet.

There are many exercises of which the correct method for solution is not clear.

(55) Division of fractions by fractions - the method is not explained well.

(56) Re. fractions having the same value. You do not explain why $\frac{1}{2} = \frac{2}{4}$ etc. In my opinion there is room here for drawing, as in booklet A, B, to illustrate this point more clearly to the pupil.

(57) Definitions of the following are not given:- proper fractions, improper fractions, mixed numbers, common denominators, etc.

(58) In my opinion advances are made too quickly. The steps between addition, subtraction, multiplication, division is quick and not clear to the children. There is great need for more detailed explanation of each step and the many possibilities entailed - e.g., - addition, - adding mixed numbers, adding a fraction and a mixed number, etc...

What are the main problems in teaching with this system?

(59) Studying simple fractions according to this method demands a good deal of common sense.

(60) The pupils are not able to arrive at a specific method, or a general definition in dealing with simple fractions.

(61) The basic problem: after a whole booklet has been dealt with by the pupil, it is often difficult to determine, in retrospect, the exact points at which the child has insufficient understanding of the material. There should be more work - like tests for example - in the actual booklet itself.

(62) Difficult language for immigrants.

(63) I do not see any special problem.

(64) In my opinion there are too many repetitions of the same numbers, and in many cases the pupil, as far as I can see, understands nothing.

Instead of many repetitions, in which parts of the answers are given to them, and they are asked to fill in the rest, I prefer logical explanation and giving many examples, like for instance -

$\frac{1}{2} = \frac{8}{16}$ - to illustrate the two aspects - i.e., the proportion between the numbers (which does not change) and, dividing the whole number into the required number of parts, explaining how many parts we took, etc...
After all the repetitions my pupils did not understand that

$\frac{5}{10} = \frac{1}{2}$, $\frac{25}{50} = \frac{1}{2}$

(65) I do not think that the weak pupil (according to this method) will reach the point of understanding the <u>need</u> for common denominators, or enlarging the denominator and the numerator in the same fraction(s), etc.

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(66) I think that the method of programed teaching is more fitting for children of high intelligence, or children in normal schools, and not schools for "culturally deprived".

(67) I must mention that repetition of the material to be learned helps to produce a reinforcement of the material learned, and the pupils work willingly on the various forms which are given in the booklet.

(68) The material in the booklet should have been roughly parallel to that in the textbook; then the material in the booklet would be based on frontal teaching in class, when the material is not clear enough. In booklet 3 there are tests on multiplication of fractions, and I realized that the material on which no frontal lessons had been given in class, and on which homework had not been given, was not nearly clear enough to the children: only the good pupils were able to understand it by themselves.

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Appendix C. Arithmetic Posttest

1. $\frac{4}{9} + \frac{1}{9} = ?$ ______

9. $\frac{3}{7} - \frac{2}{7} = ?$ ______

2. $\frac{4}{7} + \frac{5}{7} = ?$ ______

10. $\frac{1}{3} - \frac{1}{6} = ?$ ______

3. $\frac{1}{4} + \frac{1}{8} = ?$ ______

11. $\frac{7}{8} - \frac{1}{4} = ?$ ______

4. $\frac{2}{3} + \frac{1}{6} = ?$ ______

12. $\frac{3}{4} - \frac{1}{5} = ?$ ______

5. $\frac{1}{2} + \frac{1}{3} = ?$ ______

13. $1\frac{4}{5} - \frac{1}{5} = ?$ ______

6. $4 + \frac{1}{3} = ?$ ______

14. $1\frac{1}{3} - \frac{2}{3} = ?$ ______

7. $4\frac{1}{10} + \frac{3}{5} = ?$ ______

15. $3\frac{1}{4} - 1\frac{5}{8} = ?$ ______

8. $5\frac{3}{4} + 2\frac{1}{3} = ?$ ______

16. $7\frac{1}{5} - 3\frac{2}{3} = ?$ ______

17. $\frac{1}{2} \times 8 = ?$ ______

18. $\frac{3}{4} \times 8 = ?$ ______

19. $\frac{2}{3} \times 6 = ?$ ______

20. $\frac{1}{6} \times 72 = ?$ ______

21. $\frac{5}{6} \times 40 = ?$ ______

22. $\frac{1}{4} \times \frac{4}{5} = ?$ ______

23. $\frac{4}{5} \times \frac{15}{16} = ?$ ______

24. $\frac{2}{3} \times \frac{1}{5} = ?$ ______

25. $\frac{1}{3} \times 1\frac{1}{5} = ?$ ______

26. $\frac{1}{5} \times 1\frac{3}{4} = ?$ ______

27. $\frac{3}{4} \times 1\frac{7}{9} = ?$ ______

28. $3\frac{1}{4} \times 8 = ?$ ______

29. $5\frac{1}{4} \times 3 = ?$ ______

30. $8 \div \frac{1}{4} = ?$ ______

31. $\frac{5}{8} \div 10 = ?$ ______

32. $12 \div \frac{3}{4} = ?$ ______

33. $\frac{3}{5} \div \frac{1}{5} = ?$ ______

34. $2\frac{1}{7} \div 2 = ?$ ______

35. $1\frac{3}{10} \div 3\frac{4}{5} = ?$ ______

36. In order to get $\frac{1}{6}$ of a whole we must divide the whole into ________ (how many?) equal parts.

---

37. One-third of 60 equals ________.

---

38. 12 is one-half of ________.

---

39. Divide 6 into halves. Each half is ________.

---

40. In $\frac{2}{3}$ of a squad of soldiers there are 30 men.

In the whole squad there are ________ men.

---

41. $12 \times \frac{1}{3} = 12 \div ?$ ________.

---

42. $5 \times ? = \frac{5}{2}$ ________.

---

43. $\frac{7}{3} = ? \times \frac{1}{3}$ ________.

---

44. $30 = 40 \times \frac{?}{4}$ ________.

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45. The weight of one package is $3\frac{1}{5}$ kilograms. Another package weighs $4\frac{2}{5}$ kilograms. The weight of the two packages together is ______?

---

46. David did his homework in $1\frac{1}{4}$ hours. Joseph did his homework in $\frac{3}{4}$ of an hour. David worked ______ (how much time?) more than Joseph?

---

47. A boy traveled with his father for $2\frac{1}{4}$ hours. The next day he traveled $1\frac{1}{2}$ hours. On the two days together he traveled ______ hours?

---

48. A car can go 60 kilometers in one hour. How far will it go in $\frac{3}{4}$ of an hour?

---

49. A bus passes my house every $\frac{1}{4}$ of an hour. In 6 hours ______ buses will pass my house?

---

50. 15 buses will pass my house in ______ hours?

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Appendix D. Student Attitude toward Arithmetic

In your class you learn various subjects: arithmetic, Hebrew, Bible studies, and so on. Do you like to study arithmetic more than the other subjects? Or perhaps you like to study arithmetic just as much as the other subjects, or perhaps less than the other subjects? Or perhaps you don't like to study arithmetic at all.

Below you will find 4 lines. Put an "X" next to the line which is most appropriate for you.

_____a. I like arithmetic very much, more than other subjects.

_____b. I like arithmetic the same as I like other subjects.

_____c. I like arithmetic less than other subjects.

_____d. I don't like arithmetic at all.

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