Sixth Annual Report

Agency for International Development

APPLICATION OF RADIO TO TEACHING ELEMENTARY MATHEMATICS IN A DEVELOPING COUNTRY

Klaus Galda, Jose Gonzalez

Barbara Searle, and Jamesine Friend

with the assistance of

Alicia G. de Quintanilla, Norma Guadamuz Cermeno,
Juan Jose Montenegro Pineda, Marvin Saballos Ramirez,
and Vitalia R. Vrooman

September 1, 1979

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U. S. Agency for International Development, Department of State,
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INSTITUTE FOR MATHEMATICAL STUDIES IN THE SOCIAL SCIENCES

STANFORD UNIVERSITY

STANFORD, CALIFORNIA

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INTRODUCTION

The Radio Mathematics Project was established to design, implement, and evaluate a prototype system of teaching elementary mathematics, using radio as the major medium of instruction. Since June 1974, the Institute for Mathematical Studies in the Social Sciences of Stanford University (funded by the United States Agency for International Development) and the Government of Nicaragua have been collaborating on the development of such an instructional program for use in the primary schools of Nicaragua.

In this report we summarize the work accomplished during 1978--the last on-site operational year of Stanford involvement in the project--and the first half of 1979. A more detailed account of the project activities during 1978 will be presented in a book to be published later this year.

In many ways 1978 was a crucial year in the history of the Radio Mathematics Project. As 1978 was intended to be a transitional year, Nicaraguan staff members were primarily responsible for the development and production of the fourth-grade programs. In developing the fourth-grade programs, as well as in the use of the feedback system and in much of the formal evaluation, Stanford staff members served mainly in a consulting capacity. About the middle of the year Project Director Jamesine Friend left Nicaragua (to consult with a radio project in the Philippines), leaving Klaus Galda as the only expatriate in the project office. Galda left Nicaragua on January 5th, 1979. The Nicaraguan Ministry of Education is now completely responsible for the operation of the Radio Mathematics Project.

During 1978 the project staff distributed materials to over 300 classrooms using project lessons. About 10,000 students in these classrooms listened to the programs. The number of schools, classes, and students using radio lessons in 1978 by grade are presented in Table 1. There was also a large listening audience outside of these classrooms, both in schools and at home, but these did not receive supplementary materials.

The project also had an exceptionally heavy pre- and posttesting schedule in 1978, administering pre- and posttests to over 200 classes in Grades 1 through 4 in the three departments of Managua, Granada, and Carazo. Approximately 90 first-grade classes from the worksheet experiment groups, control group, and textbook group from the World Bank textbook experiment were included in this testing program. The second grade evaluation (including 40 radio and control classes) was repeated to obtain further data. Twenty-four third-grade radio classes were tested in order to measure the cumulative effect of radio experience in successive years on mathematics achievement. Finally, a formal evaluation of the fourth-grade program was conducted, beginning with the testing of the control group in 1977 and continuing with the testing of the radio group and World Bank textbook group in 1978. All of the formal evaluation activities were successfully completed in spite of a very tight schedule and adverse political conditions in Nicaragua in 1978. A detailed report of all formal evaluation activities will be presented in the project book

Table 1

Number of Schools, Classes, and Students Using Radio Lessons in 1978 by Grade and Department

Department	# of schools	# of classes				# of students			
		1	2	3	4	1	2	3	4
Masaya	40	38	28	25	30	1,824	776	628	600
Granada	25	22	18	17	16	1,056	508	424	320
Carazo	23	22	17	15	17	1,114	479	373	360
Rio San Juan	39		46	25			1,258	428	
TOTAL	127	82	109	82	63	3,994	3,021	1,853	1,280

in preparation. The results of the fourth-grade evaluation are summarized in this report.

In addition to the development and broadcast of the fourth-grade lessons and the evaluation of the first- through fourth-grade programs, a large number of other activities were planned and carried out in 1978. For the first time project programs were officially used outside of the experimental area--in the Department of Rio San Juan, a thinly populated, largely undeveloped rural area stretching along the Costa Rican border between Lake Nicaragua and the Caribbean. Radios for the schools in Rio San Juan were purchased by the Ministry of Education, using the money won in the Japan Prize competition of 1977. Education officials in Rio San Juan cooperated fully with the project, as did the Proyecto Rio San Juan, a government sponsored integrated rural development program in the area. In February several supervisors from the departmental inspectorate of education in Rio San Juan spent more than a week at the Radio Mathematics Project office, being trained to provide teacher training for local teachers. These supervisors also transported and distributed project materials in their local areas. According to a report sent from the Proyecto Rio San Juan to the Ministry of Education, the radio mathematics lessons were among the most successful of all the activities in Rio San Juan in 1978.

Numerous other testing activities were conducted in 1978 which followed up previous project research in elementary mathematics learning. Some of these activities, like the addition-subtraction test administered in Managua, were direct offspring of earlier tests; others, like the numeration and logic tests, were new tests. The project also designed and administered a test of language arts to second-grade radio and control classes, to attempt to determine whether enhanced mathematics achievement in the radio classes was gained at the expense of neglecting other subject areas. There was also a special test in mathematics given to fifth- and sixth-grade students designed to help the Nicaraguan staff plan the radio curriculum for those grades. Earlier project work with the Stanford Mental Arithmetic Test was also continued; the test was given to radio classes in Grades 2 through 4 so that results could be compared with those obtained for 1976 control classes.

In addition to the extensive testing program described above, additional research related activities were planned. (Not all of these were conducted because of the political situation.) In late August, the project planned a series of inspection visits to all of the experimental classrooms in order to estimate the extent of actual radio usage. In addition, these visits were supposed to obtain information regarding the teachers' ideas about the radio programs and related activities. Unfortunately, these visits had to be largely cancelled due to the unstable political situation at the time. The project also administered a questionnaire to about 100 teachers to further previous research into educational wastage (dropout and repetition problems) in the Nicaraguan educational system. Finally, in response to reports of increasing usage of the radio mathematics programs by out-of-school listeners, an extensive informal survey was conducted in about 500 homes,

selected from the experimental area as well as Managua. This survey was conducted in order to estimate the magnitude and characteristics of the out-of-school listening audience. Detailed results of these survey studies will be published in the forthcoming book.

Two additional research activities were carried on in 1978. The first of these was the World Bank textbook experiment. For this experiment, free textbooks were distributed to 20 first-grade and 20 fourth-grade classes. These classes were subsequently given pre- and posttests and compared to classes not using textbooks. The other experiment concerned the use of worksheets in the first-grade radio lessons. Due to the cost and distribution problems involved with the use of the worksheets, there has been a great deal of interest in whether the first-grade lessons could be rewritten so as to eliminate their use without sacrificing the effectiveness of the lessons. In order to test the feasibility of this suggestion, the last 40 first-grade lessons were rewritten to eliminate dependence on worksheets and retaped. These revised lessons were played by tape recorder in 24 experimental classrooms. Immediately prior to the beginning of the experiment and immediately after the last lesson, achievement tests were administered to both the group using worksheets and the group using the revised lessons.

There were a number of dissemination activities conducted in 1978. In April, footage for a 16 mm color film was shot on location in the experimental area by Hearst Metrotone, under contract to the Academy for Educational Development. The film was produced; its premiere took place at the Workshop on Communication in Rural Development, sponsored by USAID in Washington, D.C. in June 1979. (Evaluation results of the workshop rated the film very highly.) A number of visitors, both foreign and Nicaraguan, came to the project office. Foreign visitors included individuals from El Salvador, Colombia, and Chile. Nicaraguan visitors included groups from Instituto de Bienestar Campesino (INVIERNO) and the curriculum section of the Ministry of Education. Both of these groups received training from project staff in different aspects of project operation. INVIERNO was designing an educational program in agriculture for Nicaraguan peasants and used some of the ideas as well as staff from the Radio Mathematics Project. There was also collaboration with the RATES project in Manila, Philippines, in the form of a four-month consulting period with Jamesine Friend. RATPS is a project designing educational radio programs for schools in the Philippines. Many of the Radio Mathematics Project's methods in curriculum planning and feedback are currently being implemented there. Project activities were also described at conferences in Brazil, Chile, Alaska, and Jamaica. The project also established close contact with the Rural Educational Radio project in Puerto Cabezas, Zelaya, Nicaragua. This project is administered jointly by USAID, Wisconsin Partners of the Americas, and the Nicaraguan Ministry of Education. Plans were made to use radio mathematics programs experimentally in the Puerto Cabezas area on the northeast coast of Nicaragua.

Nineteen hundred and seventy-eight was a politically unstable year in Nicaragua. In addition to the beginning of civil war in September,

there were several general strikes and an atmosphere of unrest during the entire year. As indicated above, however, a majority of project activities were completed as planned in spite of many obstacles. The exceptions were the cancellation of classroom inspection visits and the administration of the mental arithmetic test to first-grade classes. The office had to be closed for short periods on several occasions (two of these when homemade bombs landed on the office grounds). Many irreplaceable materials were removed from the office during times of crisis and stored at the American Embassy. The primary setback in 1978 was not to the office directly but to the validity of some of the evaluation activities. This is due to the extreme irregularity of school attendance during much of the school year, especially in Masaya and Carazo. In spite of these difficulties, however, by the end of the year most planned activities had been completed and there was an orderly transfer to Nicaraguan project administration. This report summarizes the results of some of the activities mentioned above.

PROJECT CALENDAR

January 1, 1978 to June 30, 1979

January 20 - 30	Training for school inspectors from Rio San Juan
February 15 - 17	Teacher training for Masaya, Granada, Carazo
February 17 - March 1	Vitalia Rojas at conference in Brazil
February 21 - March 15	Pretests administered to over 200 classrooms in Grades 1 through 4
February 23	Broadcast of project lessons for Grades 1 through 4 began
April 6 - 13	Training for INVIERNO staff
April 25 - May 3	Footage shot for project film by Metrotone
May 20 - 29	Juan Jose Montenegro at conference "Transfer of Technology in Education", Vina del Mar, Chile
June 15 - October 15	Jamesine Friend in Philippines at PATES project
June 28 - July 1	Barbara Searle participated in Seminar in Radio Education, Caribbean Region, Ocho Rios, Jamaica
July - September	Mental Arithmetic Tests administered in radio classes, Grades 2 through 4
July 3 - 10	Addition-subtraction test administered in Managua
July 1 - 7	Visit from director of programming ETV El Salvador
July 25	Visit from Puerto Cabezas Wisconsin Project
August 1 - 3	Listener Survey conducted
August 2 - 11	Numeration test administered, in Managua to Grades 1 through 6
August 12	Training for teachers using new first-grade lessons
August 14 - 21	Pretest for worksheet experiment in 48 classes
August 14 - 28	Logic test in Managua and experimental area
August 16 - 18	Barbara Searle at the Audio Conference of "Educational Telecommunications for Alaska," sponsored by the Northwest Regional Educational Laboratory

August 18	Use of new first-grade lessons (without worksheets) in 24 classrooms with cassettes began
August 28 - 31	Classroom inspection visits began
Oct 3 - Nov 9	Posttesting of over 200 classes grades 1 through 4
October 9 - 11	Special test to 40 fifth and sixth grade classes
October 13 - 31	Spanish test to 40 second-grade classes
October 21	Teachers' questionnaire on promotion given to 96 teachers
November 16 - 20	Klaus Galda at Puerto Cabezas Wisconsin project
December 1978	Second volume of series of books on project published
January 5, 1979	Stanford participation in Nicaragua ended
February 10 - 13	Klaus Galda at 5th Interamerican Conference on Mathematical Education at Campinas, Brazil.
March 18 - 28	Follow-up visit to Nicaragua
June 1 - 7	Klaus Galda at Conference on Communications in Development, Jamaica
June 29	Project film shown at Workshop on Communications in Rural Development, Washington, D.C.

1. FOURTH-GRADE INSTRUCTIONAL PROGRAM

A. Curriculum Development

Curriculum development for fourth grade followed the same procedures as described in earlier annual reports for lower grade levels. The curriculum covered the major topics of numeration, addition, subtraction, multiplication, and division, extending these basic arithmetic processes to both fractions and decimals. Table 2 describes the curriculum content and indicates how the 404 exercise classes of the curriculum are distributed among strands.

B. Summative Evaluation

Sample selection. A summative evaluation of the fourth-grade instructional program was conducted during the same year that the program was being developed. The basic comparison for the fourth-grade summative evaluation is between an experimental group of 30 classes pre- and posttested in 1978 and a control group of 21 classes pre- and posttested in 1977. The control group was tested during the 1977 school year for two reasons. First, when administered a year in advance, the fourth-grade pretest provided data for use in curriculum development. Second, as the programs were beginning to be better known it was increasingly difficult to assure the existence of an uncontaminated control group. There is a possible drawback in testing the control group a year earlier, however, since there is the possibility that other conditions will not be equivalent in two different years. That is in fact what did happen to the fourth-grade evaluation.

A ratio of approximately five rural classrooms to three urban classrooms was used in the fourth grade experimental and control groups because declining enrollments in rural schools in the upper grades resulted in smaller class sizes. Of the 21 control classes, 8 were urban and 13 were rural; of the 30 radio classes, 12 were urban and 18 were rural.

The procedure for randomly assigning schools to treatment condition and then randomly assigning classes within schools is described in the Fourth Annual Report (Searle, Friend, Suppes, & Tilson, 1977). The comparison reported below is between randomly selected classrooms stratified by school location (rural/urban), department, and years of previous radio experience.

Test design. Unlike the fourth-grade pretest which was administered with recorded instructions, the fourth-grade posttest was entirely written. The test administrator worked through a standard set of examples with the children and then the children worked through the test on their own. No time limit was imposed, so that all the children could finish the test.

Table 2

Distribution of Exercise Classes for Fourth-grade Curriculum

Topic	Strand	# of exercise classes	
Numeration	Whole numbers	20	
	Successors and predecessors	21	
	Comparison of whole numbers	7	
	Comparison of decimals	10	
	Fraction and mixed number concepts	19	
	Comparison--fractions, mixed numbers	9	
	TOTAL NUMERATION		86
Addition	Mental calculations	12	
	Addition fact tables	5	
	Vertical addition	26	
	Applications of addition	9	
	TOTAL ADDITION		52
Subtraction	Mental calculations	15	
	Subtraction fact tables	5	
	Vertical subtraction	34	
	Applications of subtraction	7	
	TOTAL SUBTRACTION		61
Multiplication	Concepts	6	
	Mental calculations	9	
	Multiplication fact tables	21	
	Vertical multiplication	15	
	Applications of multiplication	11	
	TOTAL MULTIPLICATION		62
Division	Concepts	17	
	Division fact tables	29	
	Vertical division	35	
	Applications of division	19	
	TOTAL DIVISION		100
Noninteger operations	Addition and subtraction of fractions	7	
	Addition and subtraction of decimals	27	
	Multiplication of decimals	9	
	TOTAL NONINTEGERS		43
	TOTAL EXERCISE CLASSES (4th GRADE)		404

The fourth-grade posttest used a matrix-sampling design. It consisted of four forms which were evenly distributed in each classroom. For a discussion of this type of test design see Searle, Matthews, Suppes, and Friend, 1978 (p. 104ff).

As mentioned above, the fourth-grade control group was tested in 1977 and the experimental group in 1978. Due to the irregularities in the 1978 school year in Nicaragua, described in the introduction to this report, the posttest results for the control and experimental groups are not strictly comparable. In 1978 there were several periods in which most schools were not functioning at all for one to three weeks at a time. Even at other times school attendance was much lower than in normal years. On regular school days many schools dismissed classes early, which probably affected the fourth-grade radio group due to the relatively late broadcast time of the fourth-grade lessons. The fourth-grade radio group was also posttested about three weeks earlier in the school year than the 1977 control group because of a threatened early closure of the schools in 1978. These conditions should be considered when interpreting the fourth-grade posttest results.

Results. Fourth-grade pretest results are presented in Table 3. The fourth-grade pretest is the same as the third-grade posttest. (See Appendix A, Table C in Tilson, Searle, Friend, & Suppes, 1978) The radio group scored slightly higher (not significant at the $p < .05$ level) than the control group. In addition, both the urban and rural radio groups scored higher than their control counterparts. The rural radio group had the highest score of any of these groups.

The slightly better performance of the radio group on the pretest seems to be due to the presence of students with various amounts of previous radio experience in many of the radio classes. Table 4 indicates that performance on the pretest by students in the radio classes generally increases with the amount of prior radio experience. (In Table 4 only individual items from the test are used due to the small number of classes in some of the groups.) Students in radio classes who had no prior radio experience scored slightly lower than the control group of students.

Table 5 presents the results of the fourth-grade posttest. (The fourth-grade posttest is shown in Appendix A.) Contrary to results for the first through third grades (see Tilson et al., 1978 and Searle, Matthews, Suppes, & Friend, 1978), the radio group did not score significantly higher than the control group on the fourth-grade posttest. In fact, as the regression results presented in Table 6 indicate, when pretest score is controlled for, the radio group performed relatively worse than the control group on the posttest. Thus, the regression coefficient for PRIOR RADIO is negative and just misses significance at the .05 level. The regression coefficient for NO PRIOR RADIO is not different from 0 (that for the CONTROL group).

It is not clear how much of this disappointing performance by fourth-grade radio students is due to the disruption of the school year and how much may be due to shortcomings in the radio programs. Table 5

Table 3

Results of Fourth-grade Pretest[a]

Group	# of classes	# of students	Mean % correct	S.D.	Range
1977 control	21	318	47.8	27.5	0 - 95.8
urban	8	154	48.3	28.3	0 - 100
rural	13	164	47.4	27.9	0 - 96.2
1978 radio	30	486	51.1	27.6	0 - 94.0
urban	12	305	51.0	28.9	0 - 96.2
rural	18	181	52.4	27.6	0 - 100

[a]128 items, with each student taking 32.

Table 4

Results of 1978 Fourth-grade Pretest[a]
by Years of Previous Radio Experience

Group	# of classes	# of students	Mean % correct	S.D.	Range
No experience	8	111	45.1	17.4	0 - 100
Previous experience	22	375	54.0	19.6	0 - 93.2
1 year	11	156	51.5	20.4	0 - 100
2 years	5	88	50.5	21.3	0 - 100
3 years	6	131	59.5	17.7	0 - 96.9
TOTAL	30	486	51.9	19.4	1.1 - 91.7

Note. Difference in mean scores for no experience and previous experience groups, $t = 2.80$, $p < .01$.

[a]Results based only on 68 individual items.

Table 5

Results of Fourth-grade Posttest[a]

Group	# of classes	# of students	Mean % correct	S.D.	Range
1977 control	19	283	34.1	26.3	0 - 90.1
urban	7	139	35.0	27.5	0 - 97.1
rural	12	144	33.3	26.0	0 - 91.9
1978 radio	29	450	34.5	27.1	0 - 92.9
urban	12	257	35.3	28.1	0 - 92.2
rural	17	193	33.3	26.3	0 - 93.8

[a]144 items, with each student taking 36.

Table 6

Regression of Prior Radio Experience on Posttest

Determining variable	B	t
PRETEST	.907	19.17
PRIOR RADIO	-1.706	-1.57
NO PRIOR RADIO	.195	.13
URBAN	1.576	1.55
SEX	-.214	.21
CONSTANT	-8.615	
R^2	.429	

also indicates that there are no significant differences between urban and rural groups, and no difference within urban and rural groups between the radio and control classes.

2. OTHER EVALUATION ACTIVITIES

One of the many research activities of the project in Nicaragua has been a series of diagnostic tests to discover and classify sources of student error in elementary mathematics. Results from some these tests and other evaluation activities have been used extensively to aid in curriculum planning for the project's radio lessons.

A. Numeration Test

As part of the project's ongoing research program, a special numeration test was designed. It was administered in all six grades to about 1500 students in the Managua public schools in August 1978. The test had been field tested in two schools in the Masaya area during July.

The numeration test was designed to test virtually all topics related to numeration; knowledge of counting, reading and writing numerals, order of numbers, comparison of numbers by size, sequences, and place value. Most of these topics were tested by several different kinds of tasks. For example, counting was tested by four different tasks:

1. Circle N objects of M given objects.

2. Draw N objects.

3. Count objects and write the number.

4. Count packaged objects (2s, 5s, 10s, and 1s, etc.).

The format of the numeration test was similar to the usual project mathematics achievement tests, that is, a matrix sample design with pretaped oral instructions. The data from the numeration test are presently being analyzed at Stanford University and will be published in a future report.

B. Addition-subtraction Test

In July 1978 the project administered an addition and subtraction test, the purpose of which was to analyze student skills in addition and subtraction. This test was a refined version of a test given earlier in Nicaragua. (See Searle et al., 1977 and Tilson et al., 1978.) The present version was designed to determine the relative rates at which the various skills that enter into addition and subtraction are learned by children. Another of the interests in giving this test was to make cross-cultural comparisons in learning rates for these skills. Thus the test was also given in the Philippines and is to be given in the U.S. by the Educational Testing Service. (These latter activities are not supported by the AID contract.) In Nicaragua, the addition and subtraction test was given to children in Grades 2 through 6 in Managua. About 3200 children took the

test, approximately evenly divided among the five grades. Results from this test being reported separately.

Jamesine Friend presented the results of previous administrations of the addition and subtraction test at the annual meeting of the American Educational Research Association (AERA) in San Francisco in April 1979. Friend's paper has been added to the Educational Research Information Clearinghouse (ERIC) collection, and will be published in Children's Mathematical Behavior.

Among the generalizations regarding addition skills that Friend makes on the basis of her analyses are the following:

1. The number of columns in an addition exercise does not affect the difficulty level when there is more than one column.

2. More addends do not increase exercise difficulty.

3. If there are zeros in an exercise, the exercise is significantly more difficult.

4. Carrying is a major contributor to difficulty.

5. Carrying a number greater than 1 is more difficult than carrying 1.

6. Passing (exercises in which the leftmost column has a two-digit sum) is less difficult than carrying.

The data base has been used by Dr. John Seely Brown of Xerox Palo Alto Research Center in the design of a computer program that diagnoses student computation errors.

C. Stanford Mental Arithmetic Test

In 1976 the project gave a version of the Stanford Mental Arithmetic Test to a number of control classes in the experimental area. The design, administration, and results of this test are described in Sachar (1978). In order to compare the mental arithmetic ability of radio students with that of control group students, the same test given in the control schools in 1976 was given to radio students in grades 2 through 4 in 1978. The times of test administration were carefully chosen so that each grade was tested at the same time of the year in both 1976 and 1978. The test was not given to the first-grade radio due to the political situation at the time that the test administration was planned.

Table 7 compares the results for the 1976 control classes in grades 2 through 4 with those for the 1978 radio classes. Although the radio classes scored slightly higher in grades 3 and 4, the differences are not statistically significant at the .05 level. Due to the disruption

Table 7

Results of the Stanford Mental Arithmetic Test

Grade	Group	Year	Mean % correct	S.D.
2	Control	1976	40.5	18.7
2	Radio	1978	40.1	28.0
3	Control	1976	53.5	21.0
3	Radio	1978	56.4	26.7
4	Control	1976	65.9	17.7
4	Radio	1978	71.1	28.9

of the 1978 school year, the two test years are not strictly comparable, limiting the validity of inferences made from these test results.

D. Logic Test

A logic test was given to about 1500 Nicaraguan children in August 1978 as part of a series of cross-cultural comparisons conducted by the project in Nicaragua during the past few years. The logic test given in Nicaragua is a translated and slightly modified version of a test developed at Stanford and given to California school children some years ago (Hill, 1960).

The test uses a number of examples of elementary logical arguments drawn from situations familiar to primary school children. A taped, individually administered version was given to children in Grades 1 through 3; a written, group administered version was used in Grades 4 through 6.

The test was given in a fairly wide spectrum of Nicaraguan schools, including public and private schools in Managua and a number of schools in the project experimental area. In order to test the hypothesis that the radio mathematics lessons help to improve logical reasoning skills, both control and radio schools in the project area were tested. Results from the test are still being analyzed at Stanford and will be published in a separate report.

E. Spanish Test

One of the possible criticisms of the Radio Mathematics Project is that perhaps the lesson broadcasts are increasing mathematics achievement at the expense of achievement in other school subjects. In order to refute this criticism completely it would be necessary to design and administer an entire battery of tests (based on the official Nicaraguan curricula for the various school subjects) to radio and control classes. Unfortunately no such tests exist and a major effort would be required to design them. The project staff decided that it would be worthwhile to at least begin a study of this issue.

A test was designed by the project evaluation department to measure achievement on those topics included in the official second-grade language arts curriculum. The format of the test is similar to the taped mathematics achievement tests used in the formal evaluation of the project mathematics programs. The language arts test is an oral taped test using a matrix sampling design. There are three forms of the test, randomly distributed among all of the second-grade radio and control classrooms.

The test was administered at approximately the same time as the regular mathematics posttest. Table 8 presents the number of classrooms taking the test according to the various stratifications. The classes used are the same as those taking the 1978 second-grade mathematics

Table 8

Results of Language Arts Test

Type of school	# of classes	# of students	Mean % correct	S.D.	Range
Urban	20	456	61.6	28.2	4.0 - 99.0
Rural	20	223	54.9	28.2	5.0 - 99.0
Radio	20	331	58.5	29.5	4.0 - 99.0
Control	20	348	59.5	27.2	9.0 - 98.0

posttest. Table 8 also presents the results for the Spanish test for the various groups. The difference between the control group and the radio group is not statistically significant. In contrast, the radio group scored significantly ($p < .001$) higher in 1978 on the mathematics posttest than the second-grade control group. This result indicates that, at least in this case, the radio mathematics broadcasts increase mathematics achievement without apparently affecting other school subjects.

3. RIO SAN JUAN IMPLEMENTATION

The Fifth Annual Report (Tilson et al., 1978) discusses the plans and preliminary activities of the project in relation to the implementation of the radio lessons in the Department of Rio San Juan, a poor and isolated region near the border with Costa Rica. The Ministry of Education assigned two of its staff members to supervise the implementation of the radio mathematics lessons as part of their overall duties in Rio San Juan. The two supervisors, after receiving training by the project, developed and carried out a brief teacher training program for teachers in Rio San Juan during February 1978. They then continued to oversee the implementation of the project there. More than 1500 second- and third-grade students in 39 schools (of the 45 in the department) utilized the radio mathematics lessons in Rio San Juan during 1978.

4. OTHER 1978 RESEARCH ACTIVITIES

A. Worksheet Experiment

Two of the main objectives in establishing the Radio Mathematics Project in 1974 were to develop a system with low operating costs and one that could function easily with a minimum of administrative problems. The use of worksheets in the first-grade radio lessons substantially increases the operational costs of the first-grade programs and introduces a number of logistical problems in the creation and distribution of project materials. It seems desirable, if at all possible, to eliminate the worksheets. However, it is not known to what extent the effectiveness of first-grade lessons depends on the use of individual student worksheets.

In order to investigate the relationship between posttest scores and the use of worksheets the project staff conducted an experiment in 1978 in which a subset of the first-grade lessons was rewritten to eliminate their dependence on worksheets. In the time that had elapsed between writing the original first-grade lessons in 1975 (revised in 1976) and 1978, the project staff had gained considerable experience in devising alternative and effective means for presenting the mathematical content of the radio broadcasts. In particular, second-grade lessons use (with apparent effectiveness) the teacher and the blackboard to eliminate dependence on supplementary materials.

Ideally the project staff wanted to revise the complete set of first-grade lessons in such a way as to minimize or completely eliminate the use of worksheets. However, material and time constraints made a revision of that magnitude impossible. Consequently, it was decided to rewrite only the last 40 first-grade lessons, that is, Lessons 111-150. Revision of these late lessons would be easier to accomplish than a comparable revision of the early lessons because their content is similar to that of the early second-grade lessons that had already been written without the use of worksheets. Of the 40 first-grade lessons involved in the experiment, 37 actually involved the use of worksheets; the other 3 were not revised. Of the approximately 370 mathematical segments in the 40 lessons, about 65% used worksheets; the remaining segments did not. More than 60% of the segments using worksheets were in the radio broadcast portion of the lessons; the others were in the teacher directed post-broadcast portion.

The project staff considered two different methods for accomplishing the revision. The first of these was to do a complete revision, possibly improving the quality of the lessons, that would utilize all the experience that the project had gained in writing radio mathematics lessons. The second alternative was to keep the content and instructional strategies of the lessons essentially the same, and simply substitute the use of student notebooks and the blackboard for student worksheets. The second alternative was chosen for two reasons: to increase the precision of the experimental comparison and to minimize the resources needed to accomplish the changes.

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A complete list of the changes needed in the 37 lessons is given in Appendix B. Only the major types of changes are outlined here. These can be broadly classified into the following six types:

1. children copy exercises from the blackboard instead of being given the exercises on the worksheets;

2. children write answers to oral exercises in their notebooks instead of on the worksheets;

3. the teacher draws simplified illustrations on the blackboard and children write numerical answers in their notebooks;

4. a very few segments are completely eliminated;

5. some radio segments are changed to post-broadcast activities;

6. some exercises are presented in a different format.

All revised lessons were completely re-recorded to avoid editing difficulties and the resulting inferior quality of the revised tapes. As much as possible all extraneous differences between the two versions of the lessons were eliminated. For example, the same actors were used in both versions of the lessons. Finally, a great deal of care was taken so that the speed of speech, length of pauses, etc. were essentially the same in the two versions. Production of the revised lessons began about the middle of June 1978 and was finished in October 1978. Lessons were presented by cassette recorder. In order to keep the use of the revised lessons parallel to the regular radio lessons the teachers were instructed not to stop or replay any portion of the lesson tapes.

There were 48 classes involved in the worksheet experiment; 24 used the regular lessons with worksheets and 24 used the revised lessons. The 48 classes were randomly selected at the beginning of the year in accordance with the usual project stratified random sampling process, and then randomly divided into the two groups. At the beginning of the year the first-grade pretest (TOBE) was administered to both groups (see Searle, Friend, & Suppes, 1976). The results of this test are given in Table 9, which shows no difference in pretest scores between the two groups, indicating that the randomization process had resulted in groups evenly matched in mathematics achievement at the beginning of the school year.

The revised lessons were used starting about the middle of August. There was a short training session for the teachers using the revised lessons to explain how to use the tape recorders, to give a few suggestions on how to use the revised lessons, and to distribute the materials (tape recorders and revised teachers' guides). A few days before the beginning of the experiment the groups were tested using the standard first-grade posttest; this test served as a pretest for the experimental comparison. At the end of the school year we gave the same test again, this time as a posttest for the experiment. The results of these two administrations of the first-grade posttest are given in Table 10. None of the differences

Table 9

Results of 1978 First-grade Pretest
for Radio Classes With and Without Worksheets

Group	# of classes	# of students	Mean % correct
With worksheets	24	549	78.9
Urban	12	310	79.4
Rural	12	239	78.2
Without worksheets	24	589	77.0
Urban	12	356	77.9
Rural	12	233	75.6

Table 10

Results of 1978 First-grade Posttest
for Radio Classes With and Without Worksheets

Group	Mean % correct (August)	Mean % correct (November)
With worksheets	59.3	62.2
Urban	61.7	67.7
Rural	55.6	56.8
Without worksheets	56.7	62.8
Urban	55.7	65.0
Rural	58.5	59.9

between the with-worksheet and without-worksheet groups is significant, supporting the hypothesis that there is no loss of lesson effectiveness when worksheets are eliminated. It is interesting to note in Table 10 that in both groups (with and without worksheets) the urban classes made larger gains on the achievement test between August and November than did the rural classes. We have no explanation for this phenomenon.

The Nicaraguan civil war of 1978 erupted in the middle of this experiment, so it was conducted under atypical conditions. It is likely that some teachers played the tapes at other than the scheduled times and perhaps repeated some of the lessons. Due to the greater flexibility in the use of tapes, the radio group without worksheets may have been at a slight advantage, especially at a time of irregular school attendance.

In general we can say that the experiment was at least a limited success. The test results indicate that the children without worksheets accomplish the objectives of the last part of the first-grade program as well as those with worksheets. As a result of the staff's earlier experiences with other grades it was relatively easy for these lessons to be rewritten so as to eliminate the worksheets. Although the new format required more work on the part of the teachers, they appeared to accept the extra obligations.

One of the drawbacks of the revised lessons (i.e., without worksheets) is that the broadcast time is increased. The lessons using worksheets seem to be more efficient. A comparison of radio broadcast duration of the lessons used in the experiment shows that the lessons using worksheets average 21.8 minutes in length while the same lessons without worksheets average 26.4 minutes. All of the lessons without worksheets were longer than the corresponding lessons with worksheets; the differences range approximately from 1 to 10 minutes.

The results of this experiment are encouraging. It still remains to be determined whether the first part of the first-grade program can also be effectively rewritten to eliminate the use of worksheets.

B. Children's Interviews

In July 1977, Marvin Saballos, a staff psychologist for the Radio Mathematics Project, interviewed 19 radio mathematics students in order to increase the project's understanding of the thinking processes students use while solving arithmetic exercises. In previous analyses of incorrect responses to test items patterns of errors had been found that could be explained by hypothesizing the use of well-defined, but incorrect algorithms. One of the purposes of the interviews was to find out if the children's verbal description of their thinking process confirms these hypotheses. Analysis of errors in written responses can account for only half of the errors with any degree of certainty. Hence, a secondary purpose of the interviews was to provide additional further hypotheses.

The interviewed students were randomly selected from six nonrandomly selected third-grade classes in Masaya. Each child was interviewed privately. The interview consisted of dictating six subtraction exercises which the child copied and then solved, explaining each step of the solution as he did it. The interviewer used the same instruction for each child when dictating the exercises but was free to use whatever phrases he felt useful when it was necessary to prompt a student to verbalize.

The children were quite cooperative and responded well without undue prompting. In some cases the children seemed not to be able to explain their thinking about basic combinations and prompting did not help. The excellent cooperation we received from the children may have been in part because of their participation in the radio mathematics project, either because radio lessons had helped to increase their ability to verbalize, or because they were familiar with the interviewer who had previously visited the classrooms on several occasions. It is possible that children from traditional classrooms would not respond as well.

The errors observed held few surprises and the children's description of the processes confirmed many of the hypotheses. For example, it was found that the greatest difficulty lies in borrowing and specifically that the difficulty is in the decision to borrow and not in the borrowing process. In addition, the radio students adopted some of the phrasing used by the radio lessons, but in general did not seem better able to express themselves than students from traditional classrooms. These findings have clear implications for instructional design, many of which were incorporated into later lessons.

In 1978, follow-up interviews were conducted. The follow-up interviews were refined versions of the earlier ones. Unfortunately results from these interviews were lost during the political disturbances.

C. The World Bank Textbook Experiment

In 1978 the project participated in one of a series of textbook studies supported by the World Bank in various developing countries of the world. The purpose of these experiments is to determine the effect on achievement of providing every student with a textbook.

In Nicaragua, 20 first-grade and 20 fourth-grade classes participated in the textbook experiment. Mathematics textbooks (paid for by the World Bank) were supplied for free distribution to all students. All of the teachers asked to use textbooks participated in a short training session similar to the training session usually received by the teachers using the radio programs.

The standard Radio Mathematics Project pre- and posttests in mathematics were administered to all of these classes. Thus, for Grades 1 and 4 a three-way (control, radio, textbook) comparison for the formal evaluation is possible. In March 1979 project staff members made follow-up

visits to all of the schools in the textbook group to determine the extent of textbook usage and eventual fate of the textbooks. In addition, teachers' comments on the textbooks were collected. The results of the textbook experiment will be published in the near future.

D. Out-of-school Listeners Survey

An informal investigation into the size and other characteristics of the home listening audience of the Radio Mathematics Project was conducted in early 1978. The study was prompted, first, by the many letters received from students in nonparticipating schools and from individuals who, on their own initiative, follow the lessons and, second, by the results of a listener survey that showed Radiodifusora Nacional among the top 10 radio stations for only three programs: a folk music program, a question and answer show, and the Radio Mathematics Project lessons. These two kinds of evidence about informal listening motivated the administrators of the project to investigate the size of the home listening audience and to compare the numbers of listeners in rural and urban communities, in lower and middle class areas, and in communities in which experimental schools were and were not located.

The survey was conducted in communities in three departments (provinces) of Nicaragua--Masaya, Granada, and Managua--that were chosen because of their accessibility and the project staff's familiarity with them. A different type of comparison was made in each department. In Masaya a comparison was made of communities in which there is an experimental school and those in which the school did not use radio lessons; all of these communities are rural and lower class. Also in Granada communities with and without experimental schools were compared, but these communities were all urban and mixed middle and lower class. In Managua, where there are no communities with experimental schools, the comparison was between middle class and lower class neighborhoods.

Of the 476 households sampled, 37% of the households surveyed reported listening (at some time) to the Radio Mathematics Project lessons. This is a sizable audience for an educational radio program, and its size is particularly surprising in view of the fact that the project does not advertise its lessons and uses a station with a generally small listening audience. Almost half the households listening to radio lessons do so regularly, with the majority of these households listening every day of the week. Although the remaining households do not listen regularly, almost all are familiar enough with the program to be able to identify the grade levels of the lessons they listen to.

The study found that rural and lower class households are more likely to listen regularly than urban and middle class households and that, at least in rural areas, the presence of a school using the radio lessons stimulates listening.

Evaluation studies (Searle, Matthews, Suppes, & Friend, 1978) have shown that the Radio Mathematics Project lessons significantly raise the

achievement levels of the school children using the program. The effectiveness of the lessons for the home audience has not yet been demonstrated, but the popularity of the program suggests that the lessons could serve to reach the large rural, lower class adult population that has not in the past received an adequate primary education.

A more complete and detailed discussion of the results of the out-of-school listener survey will be presented in the forthcoming project book.

E. Teacher's Promotion Practices Survey

For the last several years, the Radio Mathematics Project has been investigating the patterns of promotion, repetition, and dropout among primary-school children in Nicaragua. In 1978 the project investigated two possible determinants of educational wastage, the strategies used by classroom teachers in making promotion (pass-fail) decisions and the teacher and student characteristics influencing these decisions. By surveying first- through fourth-grade teachers, this investigation attempted to describe more completely the student and teacher characteristics influencing pass-fail decisions.

The teacher promotion practices survey extended previous work (Searle, Sheehan, Gonzalez, & George, 1978) in three ways:

1. more grade levels are included,

2. teachers are specifically asked about their promotion policies and practices,

3. teachers are asked to make a promotion decision for each of a set of hypothetical students presented to them.

In particular, first- through fourth-grade teachers were invited to respond to a pair of survey instruments -- a five-part questionnaire and a set of three lists of hypothetical students. Both instruments were presented to the teachers in a single package of materials and at a single session. The five-part questionnaire was administered before the three lists of hypothetical students. Part A of the questionnaire collected demographic data from each teacher: grade, region, sex, age, years of education, teaching experience, etc. Parts B through D asked the teachers about their policy regarding final examinations, their promotion criteria, the Ministry of Education promotion requirements, and the influence of attendance on their promotion decisions. Part E asked them to provide recent promotion, dropout, and repetition data from their school records.

The first list of hypothetical students presented to each teacher was in the form of a class register. The teachers were told that these students represented the marginal members of a classroom. Each teacher was asked to recommend promoting (passing) or failing each of the students.

The teachers were given the following information about each student; sex (implicitly given in the name of the student), age, repetition history, attendance record (in days), and achievement record. In order to maximize the plausibility of the hypothetical students presented to each teacher in the class registers not all possible combinations of age and repetition history were included. (Of course, this is also the case in an actual classroom.) In order to disentangle the relative effects of a student's age and repetition history, two additional lists of students were presented to the teachers. The students presented in these lists varied only with regard to their sex (not explicitly stated, but implicitly given in the name of the student), age, and repetition history. All of these students had identical attendance and achievement records. By forcing teachers to pass some of these students and fail the rest we hoped to differentiate between the relative effects of age and repetition, which are generally seen as one compound effect.

In summary, student achievement was found to be the primary factor influencing the promotion decisions of Nicaraguan first- through fourth-grade teachers. Teachers seem to have specific and objective criteria relating achievement to promotion. Attendance "requirements", however, are flexible and subjectively applied.

Both attendance and achievement criteria are formulated in ignorance of (or ignoring) the official Ministry of Education promotion regulations. Indeed, only two of the 96 teachers surveyed applied the Ministry of Education promotion regulations to the hypothetical class register. One-third of the teachers surveyed exhibit no identifiable individual promotion strategy.

Apart from achievement, a student's age is the other student characteristic which significantly influences teacher promotion decisions. Older students are promoted significantly more often than younger students. In this respect the findings of Searle et al. (1978) using data from actual classes are verified using hypothetical student lists. In addition, the effect of age on teacher promotion decisions was found to be significantly greater than that of repetition.

Three teacher characteristics were found to be related to student promotion. Rural, upper-grade, and male teachers make relatively more pass decisions than urban, lower-grade, or female teachers. In addition, certain student variables interact with some teacher or school variables. For example, the effect of student age is different in urban and rural regions. The selective promotion of older students was found to be more markedly a rural phenomenon.

A more complete and detailed discussion of the results of the teacher's promotion practices survey will be presented in the forthcoming project book.

5. STANFORD EXIT FROM NICARAGUA

On January 1, 1979 the project was placed entirely under Nicaraguan administration. On January 6, 1979 Klaus Galda, the last expatriate with the project, left Nicaragua ending direct Stanford involvement with the Nicaraguan project.

A. Project Office Move

At the beginning of February 1979 the project office was moved from Masaya to offices in Managua built for the Ministry of Education with USAID support. The present location is near Km. 8 of the North Highway. The move was made in the course of about a week, but the large items were all hauled by a large truck on the same day. There seemed to have been some damage to typewriters and tape recorders occasioned by the move.

At present the project is occupying four large offices (each one about the size of a classroom). One of these, the only one that is air conditioned, is used as a production studio and small conference room. Desks are distributed among the other three offices. The building is fairly new but not very pleasant. There seems to be adequate space and light. However, the buildings are quite hot, which seems to be affecting work adversely.

Administratively the project is under the auspices of CENEC (Centro Nacional de Educacion y Ciencias), although for 1979 the operating funds are still being channeled through the Ministry's Department of Planning.

B. 1979 Follow-up Nicaragua Visit

A follow-up visit to Nicaragua was made by Klaus Galda between March 19 to March 27, 1979. The project office in CENEC in Managua was visited briefly on Monday afternoon, March 19, all of Tuesday and Friday afternoons of that week, and the entire day on Tuesday March 27. Reports received by the Stanford staff that essentially nothing had been accomplished during the month of January and the beginning of February 1979 were confirmed by the Nicaraguan project staff. However, a great deal of progress had been made in the month prior to Galda's arrival.

Lessons for Grades 2, 3, and 4 (developed in previous years) were being broadcast daily over Radio Nacional at 8:30, 9:00, and 10:30, respectively. Since March 5, when broadcasting began, no days had been missed. However, the radio station frequently started the programs 10 to 15 minutes behind schedule.

The radio mathematics lessons were being used officially in selected schools in the departments of Managua, Masaya, Granada, and Carazo, as well as in virtually the entire department of Rio San Juan.

The project staff estimated that approximately 10,000 students were listening to the radio mathematics programs in the schools that had received radios and teachers' guides. There were undoubtedly many more schools and homes listening to the programs independently. The usual three-hour training session had been given to teachers from about 30 schools in Managua, as well as to a similar number from the three departments that had formerly made up the experimental area. Project staff members also trained 6 inspectors from Rio San Juan, who in turn were responsible for training teachers in more than 30 schools in that department.

Pretests were administered in the second-, third-, and fourth-grade Managua classes where materials had been distributed. About 30 afternoon shift schools were being used as control groups in those same three grades. The purpose of pre- and posttesting in these Managua schools was to see whether the results obtained from the formal evaluation in Masaya, Granada, and Carazo are valid for Managua schools as well.

In spite of a late start, work was also underway on developing the fifth-grade programs. The fourth-grade posttest was given as a pretest to 17 experimental classes. However, it appeared that there would be no formal evaluation of fifth grade this year, since there was no control group. Of the 17 fifth-grade classes, 12 were in Managua, and the remainder were in Masaya (3 urban and 2 rural). Production began about two or three weeks late and the first fifth-grade lessons were not broadcast until two weeks after the other grades. At the time of the visit, production seemed to be on schedule.

The fifth-grade lessons were not being broadcast on the radio, but distributed on cassette tapes to the experimental classrooms. This was creating a number of problems. Lessons had to be recorded almost two weeks prior to broadcast in order to have time for the reproduction and distribution of the cassette copies. Some of the tape recorders were malfunctioning and it was likely that there would be a shortage of functioning recorders. Apparently the decision to use tapes was motivated by two factors. One was so that control schools (of which there seemed to be none yet) would not listen to the programs; the other was uncertainty about being able to obtain vehicles for classroom observation exactly at the same hour every day. The schools using tapes staggered their mathematics classes so that it was possible at any hour of the morning to observe some fifth-grade class.

All of the first twelve fifth-grade lessons had been observed. Weekly testing had not begun yet, but was scheduled to begin the week after Holy Week (the middle of April). It appeared that planning for the tests was progressing reasonably well. The master plan for fifth grade and the curriculum were also discussed in some detail. The master plan seemed to be reasonably complete, although disorganized.

The project organization was changed slightly after Stanford's departure. Alicia Cordillo and two assistants were producing the weekly tests and the fifth-grade pretests. Marvin Saballos and two assistants

were responsible for the remainder of the testing program. Juan Jose Montenegro was in charge of the observations, teachers' training, reproduction of materials (tapes, etc.), and teachers' guides. He had three professional people and a secretary working with him. The teachers guides were being written by Montenegro, David Cardoza, and Francisco Herrera, using the same weekly format as the fourth-grade guides. Norma Guadamuz was in charge of script writing and radio production, with four staff assistants, one of whom is part-time. Of these, two had previous script writing experience; the other two were being trained. The tapes were delivered each morning to Radiodifusora Nacional by the project driver, who also delivered the fifth-grade tapes and teachers' guides weekly to the 17 schools using them. Elba Garcia was in charge of curriculum development. She also participated in some of the script writing. There were 26 people working for the project at the time of Galda's visit, including the professionals already mentioned and 4 secretaries, a driver, a maid, an office boy, and William Binns (formerly the project bookkeeper) who worked in the CENEC administration office and performed some work for the project.

Not surprisingly, the project has encountered a large number of problems since the departure of the Stanford staff. The list of major problems given below was drawn up jointly by Galda and the Nicaraguan staff. The problems are not listed in order of importance. Although the problems are stressed here, one should not overlook the impressive amount of work accomplished since February.

1. Materials and equipment -- vehicles, cassette recorders, and office equipment, are not maintained properly or replaced when required.

2. The curriculum -- only one staff member, not an expert in curriculum, was working in this area at the time of Galda's visit. The project curriculum expert was too busy with administrative matters to contribute in this area.

3. There is a general lack of direction within the project, a general lack of coordination among the project activities.

4. There is a feeling that the interests of the project were not being represented in CENEC or within the Ministry of Education and that the project would soon be swallowed up.

5. There was a cut in the budgeted operating funds for 1979.

The Stanford staff felt that it would be interesting and useful to get suggestions from the Nicaraguan project staff members as to what might have been done in Nicaragua that would have contributed to a smoother transition of the project to Nicaraguan control. Many suggestions were received. Among these were the following:

1. The project should have built its own studio at the inception of operations instead of relying on rented facilities, and

that project staff members should have been trained to operate the necessary equipment.

2. The project should have used the radio more extensively for teacher activities (and training) and relied less exclusively on the teachers' guides.

3. More should have been done to actively involve the teachers in the radio mathematics programs.

4. Project staff members should have rotated so that at least every senior staff member would be familiar with all aspects of the program.

5. More should have been done, especially in 1978 but also in previous years, to define the position of the project within the Ministry of Education.

6. The project staff should have been more concerned in the past four or five years with informing government officials, inside and outside of the Ministry of Education, academic officials, and the general public about what the project was doing and could do for the future of Nicaragua.

7. The project should have encouraged expansion of the programs while still in the development stage.

8. The Stanford staff members should have begun shifting responsibility to the Nicaraguans somewhat earlier and more gradually rather than leaving it all to 1978.

Finally, the project was planning to slowly expand and serve as a nucleus for work in radio programs in other curriculum areas in primary education, adult and perhaps secondary education (especially in mathematics), and teacher training programs. A concrete result of Galda's visit was the agreement to start immediately on a publicity campaign for the Radio Mathematics programs, especially to inform schools and out-of-school listeners that third and fourth grades could be used even though they did not have the project materials. There seems to be a lot of interest in using the programs.

C. Materials Received

Fifth-grade materials have regularly been received at IMSSS since the March 1979 follow-up visit to the project office (described above). The following fifth-grade materials have been received from Nicaragua:

1. Tapes of Lessons 6 through 32.

2. Scripts for Lessons 1 through 40.

3. Teacher's guides for Lessons 4 through 9.

4. Daily observation sheets for Lessons 1 through 24 and 26 through 37.

5. Results for the first weekly test.

6. Pretest results for the experimental schools in Managua and the Masaya area.

Due to the intensification of the Nicaraguan civil war in June the office has apparently ceased regular production of program materials.

6. WORK PLANS FOR 1979 AND 1980

The Institute for Mathematical Studies in the Social Sciences will continue the work of the Radio Mathematics Projects by engaging in a series of replication and dissemination activities. These activities fall into 5 separate components. The components are described below.

A. Replication in Thailand

The project will assist the Thai Ministry of Education in adapting the second-grade Radio Mathematics lessons for use in Thailand as part of their World Bank Radio Education project. The Thai school year starts in June. The field trial will occupy the very end of the first project year and most of the second project year (June 1980 to March 1981). The first project year will be occupied with translating lessons and providing technical assistance to the Thai MOE, which will be preparing lesson tapes. The project will assist the MOE in evaluating the field trial. To this end, the pretest and posttest will be field tested near the end of the 1979-1980 school year (January 1980) using appropriate student populations. At this time about ten lessons will also be tried out in a dozen schools.

B. Seminars About Work of the Radio Mathematics Project

The Project staff will conduct two types of dissemination activities in LDCs. First, we will make short country visits during which a staff member will make a brief presentation (using the film or slide tape show as appropriate) and will be available for consultations with interested people. Each such visit is anticipated to last one or two days. The second type of activity will consist of a return visit for consultation in depth with countries that show a more sustained interest in using the results of the Radio Mathematics Project in a local effort.

C. Preparation of Sample Lesson Tapes in Various Languages

The project will produce sample lessons in four different languages. The product will be multiple copies of tapes of two lessons in Spanish, English, French, and Arabic. The lessons will be selected from second and fourth grade. The second-grade lessons illustrate typical classroom use of the project lessons. The fourth-grade lessons are designed for use both in and outside of classrooms and hence can serve as models for project lessons in a nonformal educational setting.

D. Translation of Radio Scripts into English

The project will translate all lesson scripts into English to make them more readily available for use in non-Latin American countries. The lessons for Grade 2 will be translated as part of the replication in

Thailand. (Part of this work is already underway.) Lessons for the other three grades will be translated and lessons for all four grades will be printed for distribution.

E. Book on How to Write Radio Lessons

The project will publish a field guide to the important aspects of the operation of the project, focusing particularly on how radio lessons were written and produced by the project.

Although not part of the formal agreement between IDSS and USAID, the project staff will continue analysis and reporting of the data collected in Nicaragua regarding student performance and determinants of dropout and repetition.

7. DISSEMINATION AND UTILIZATION OF RESEARCH RESULTS

A. Project Information Recipients

The project has received many inquiries from all parts of the world, particularly since the project won the Japan Prize in 1977. Representatives from the following 67 countries have been sent project publications or materials since January 1977.

EUROPE	AFRICA	SOUTH AND CENTRAL AMERICA
Belgium	Botswana	Bolivia
Denmark	Egypt	Brazil
England	Ethiopia	Chili
France	Ghana	Colombia
Germany	Ivory Coast	Costa Rica
Greece	Kenya	Ecuador
Holland	Mozambique	El Salvador
Italy	Nigeria	Guatemala
Scotland	Saudi Arabia	Haiti
Spain	Sierra Leone	Honduras
Sweden	South Africa	Jamaica
Switzerland	Sudan	Nicaragua
	Tanzania	Paraguay
	West Africa	Peru
	Zambia	Venezuela
		West Indies

NORTH AMERICA	FAR EAST ASIA AND OCEANIA	MIDDLE AND NEAR EAST
Canada	Australia	Bangledesh
Mexico	Hong Kong	India
	Indonesia	Iran
	Japan	Iraq
	Korea	Israel
	Malaysia	Jordan
	Nepal	Pakistan
	New Guinea	Syria
	Philippines	Turkey
	Samoa	
	Singapore	
	Taiwan	
	Thailand	

In addition to the requests from abroad, there have been many inquiries from within the United States -- universities, public school systems, and radio and television stations. Project publications and materials have been sent to libraries and individuals in all 50 states.

B. Project Papers and Publications

A full list of the papers and publications prepared under the auspices of the Radio Mathematics Project are listed in Appendix C.

C. Script Translation

The following lessons have been translated as of June 30, 1979:

Grade	Lessons
1	37, 62, 96, 116
2	1 - 10, 30, 60, 90, 116
3	21, 60, 90, 120
4	32, 65, 84, 160

The second-grade lessons have been sent to Thailand for use in a World Bank sponsored radio education project.

D. Third Summary Volume

A third summary volume is presently being prepared for publication in the fall of 1979. It will report on the work of the project during 1978 and 1979. The following chapters are being written for the summary volume:

1. Administrative History of the Radio Mathematics Project.
2. Formal Evaluation of the Radio Mathematics Project: Grades 1 through 4.
3. The Radio Mathematics Project Curriculum.
4. The Radio Mathematics Project's Formative Evaluation System.
5. Survey of the Out-of-school Listening Audience of the Radio Mathematics Project.
6. Teacher Promotion Practices in Nicaraguan First through Fourth Grades.
7. Student Dropout and Repetition Patterns.
8. Nonobtrusive Measures of Project Effectiveness.

E. Conferences Attended

Project staff members prepared a number of presentations for various interested organizations, provided consultation and participated in the following international conferences:

Fifth Interamerican Conference on Mathematical Education, Campinas, Brazil, February 13-16, 1979

Klaus Galda participated in the Fifth Interamerican Conference on Mathematical Education, presenting a paper about the Radio Mathematics Project. The conference was attended by approximately 1000 people, primarily Portuguese- and Spanish-speaking with about 20 to 30 Americans, Canadians and Europeans. General sessions were held in the mornings featuring presentations and panel discussions on the following four general topics:

1. Geometry teaching in light of new developments in mathematics education.

2. The impact of calculators and computers in mathematics education.

3. Nontraditional methods of teaching in mathematics education.

4. New tendencies in mathematics teaching and evaluation.

Galda's presentation on the Radio Mathematics Project was given on February 13. It was attended by about 50 to 60 people. Although the paper was in English the oral presentation was in Spanish due to the relatively small number of people who were fluent in English. The presentation was received with interest, as there were many questions during and after the presentation. More than a dozen people from a number of different countries in Latin America and Africa requested further information on the project.

Seminar on Broadcasting in National Development
Jamaica, June 2-6. 1979

This seminar was sponsored by USAID and the Jamaican Broadcasting Corporation, in cooperation with the Academy for Educational Development. At the request of the Academy, Klaus Galda participated in the conference. The conference was divided into two parts, corresponding to its two goals. The first part of the conference was held in Kingston and consisted of a number of presentations and workshops concerning the role of communications developing countries. At this part of the conference, Galda presented the Radio Mathematics Project slide-tape show, and a short talk stressing the implications of the project for educational systems and some of the aspects of project work which are applicable outside the radio mathematics framework. An extensive discussion period involving many of the conference participants followed Galda's presentation.

The second part of the conference was held in Mandeville, a small town in central Jamaica. The Mandeville area is the site of an extensive USAID project in rural development, the Pindars River -- Two Meetings Integrated Rural Development Project. A new addition to this project is a local radio station. It will be primarily responsible for agricultural (among other subjects) education necessary to improve the standard of living in the area. Galda conducted a workshop using a working paper specially written for this part of the conference, Instructional Objectives in Agriculture." Using the experience gained in the Radio Mathematics Project, a partial outline for a curriculum in agricultural education programs was developed. Following the conference, Galda and other consultants, together with some of the Jamaican participants used much of the material from the various workshops to develop a detailed operating plan for the radio station.

8. INVOLVEMENT OF MINORITY PERSONNEL AND WOMEN

During the period covered by this report, the project employed three full time and several part time professionals. Of the full time professionals, one is a woman and one has a Spanish surname. IMSSS has, during its entire history, maintained a congenial atmosphere for both men and women of all types of backgrounds. Although the project has no plans for increasing the size of its staff, any replacements will be made within the policy guidelines for Stanford University that call for active recruiting of women and minority personnel.

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APPENDIX A: 1977-78 FOURTH-GRADE POSTTEST

Performance of Experimental and Control Students on Fourth-grade Posttest

Exercise	Item form	Percentage correct → Experimental	Control	Description of exercise
1	I	50.4	60.6	Write one of these symbols (<, >) between the numbers. 1 . . . 9
1	II	44.7	46.4	Write 350 in roman numerals.
1	III	51.8	41 1	Write 2.036 in words.
1	IV	77.7	81.7	Write 6.000 in words.
2	I	21.2	11.3	Circle the largest fraction. 1/4 1/2 1/3
2	II	81.6	84.1	Circle the largest fraction 2/5 4/5
2	III	5.4	19.2	Write 40/100 as a percentage.
2	IV	17.0	16.6	Write four percent using numbers and the percent sign.
3	I	69.9	40.9	Write the number that comes before 400.
3	II	64.0	59.4	5.38 +92.?
3	III	64.3	49.3	4.32 +5
3	IV	68.8	43.7	2/5 + 1/5 =
4	I	27.4	62.0	2/3 x 5/7 =
4	II	25.4	10.1	60.2 - 7.8
4	III	49.1	28.8	1.7 -0.8

Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
4	IV	.9	0	6.5 -3.08
5	I	6.2	29.6	Write 1/10 in decimal form.
5	II	9.7	14.5	Write seven tenths in decimal form.
5	III	16.1	11.0	Write this ordinal in words: 27th.
5	IV	33.0	46.5	Write the number that is the same as this roman numeral. CLIX =
6	I	29.2	36.6	Write the number 0.4 in words.
6	II	6.1	15.9	Write 20% as a fraction.
6	III	17.9	15.1	Circle the smallest fraction. 2/3 4/10
6	IV	88.4	85.9	Circle the largest number. 2.75 6.13 8.47
7	I	26.6	19.7	How many centimeters are there in 4 meters?
7	II	86.0	82.6	35 +78
7	III	79.5	87.7	27 + 62 =
7	IV	74.1	62.0	3.26 +4.1
8	I	23.0	9.9	3005 -1268
8	II	61.4	53.6	5.75 -2.34
8	III	18.8	19.2	700 -584

Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
8	IV	49.1	42.3	613 -207
9	I	32.7	18.3	Write the ordinal 11th in words.
9	II	41.2	20.3	Write 1.9 in words.
9	III	9.8	15.1	Write two and five tenths in decimal form.
9	IV	2.7	0	Write two and seven hundreths in decimal form.
10	I	2.7	2.9	Circle the largest number. 4.05 4.01 4.1
10	II	21.1	26.1	Write five and one half in numbers.
10	III	5.4	24.7	Write a factor of 27.
10	IV	61.6	62.0	Circle the largest number. 11 2/10 2
11	I	70.8	73.2	340 x 3
11	II	54.4	36.2	7.6 +5.9
11	III	73.2	65.8	695 + 8
11	IV	20.5	18.3	51 + 23
12	I	9.7	7.0	60.05 -59.29
12	II	15.8	13.0	4023 -2375
12	III	43.8	37.0	425 -279

Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
12	IV	25.9	14.1	402 -236
13	I	11.5	21.1	Write a diviser of 2340.
13	II	75.4	66.7	Write the number that comes after 349.
13	III	24.1	15.1	Write 4.32 in words.
13	IV	0	16.9	Write 26/100 in decimal form.
14	I	72.6	76.1	Write two thousand nine hundred ninety-nine in numbers.
14	II	0	0	Write 216 in words.
14	III	75.0	76.7	Circle the largest number. 3.21 2.67 1.91
14	IV	27.7	31.0	Write three and two thirds in numbers.
15	I	82.3	77.5	64 +71
15	II	85.1	79.7	26 + 3
15	III	55.4	34.3	53.7 - 2.4
15	IV	91.1	84.5	6 +40
16	I	71.7	62.0	2.5 +4.3
16	II	64.0	68.1	82 -59
16	III	4.5	2.7	1/3 + 1/6 =

Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
16	IV	29.5	29.6	4.3 -2.8
17	I	85.0	85.9	84 + 6 =
17	II	1.8	1.5	4 -2.8
17	III	49.1	61.6	5/10 - 2/10 =
17	IV	75.0	76.1	539 126 +217
18	I	79.7	80.3	376 - 56
18	II	21.9	31.9	431 x100
18	III	55.4	34.3	2.3 x 5
18	IV	12.5	11.3	639 x 70
19	I	30.1	40.9	35 x47
19	II	43.0	56.5	95 ÷ 5
19	III	30.4	41.1	560 ÷ 7
19	IV	2.7	8.5	0.64 x 0.2
20	I	15.9	15.5	293 ÷ 14
20	II	36.8	39.1	375 ÷ 4
20	III	12.5	17.8	378 ÷ 17
20	IV	10.7	12.7	6.4 ÷ 2

Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
21	I	68.1	59.2	18 + 4
21	II	7.9	8.7	7.4 + 2
21	III	25.0	8.2	60.2 -57.4
21	IV	30.4	19.7	64.2 - 8.8
22	I	73.5	62.0	5.3 -2.1
22	II	34.2	40.6	503 x 28
22	III	19.6	31.5	20 x50
22	IV	0	2.8	3/5 - 2/6 =
23	I	.9	4.2	4.2 x0.5
23	II	24.6	13.0	6 x 2/5 =
23	III	57.1	52.1	49 + 4
23	IV	40.2	54.9	488 + 6
24	I	6.2	8.5	272 + 42
24	II	22.8	13.0	643 + 32
24	III	8.0	12.3	1165 + 23
24	IV	46.4	35.2	804 + 4
25	I	20.4	33.8	32 x50
25	II	0	0	1/2 + 1/3 =

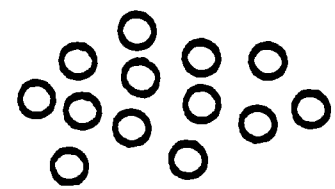
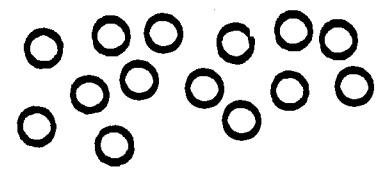
Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
25	III	45.5	50.7	4375 x 4
25	IV	92.9	90.1	98 21 +10
26	I	59.3	50.7	8.43 -2.2
26	II	26.3	50.7	74 x 8
26	III	35.7	35.6	43 x12
26	IV	57.1	49.3	507 x 2
27	I	47.8	52.1	899 ÷ 8
27	II	27.2	20.3	2.4 x0.3
27	III	25.0	20.6	2/3 x 4 =
27	IV	29.5	18.3	71 ÷ 7
28	I	0	0	2.75 ÷ 4
28	II	48.3	43.5	357 ÷ 2
28	III	0	0	2.48 ÷ 4
28	IV	3.6	2.8	6987 ÷ 34
29	I	48.7	47.9	Carlos has C$570 in his savings account. Friday he deposited C$93. How much does he have now?
29	II	40.4	46.4	Feline makes C$546 a week. He spends C$127 on food. How much does he have left for other things?

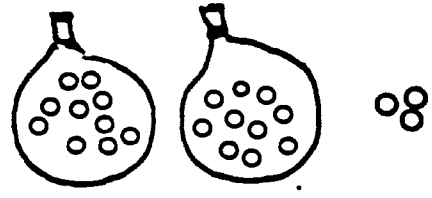
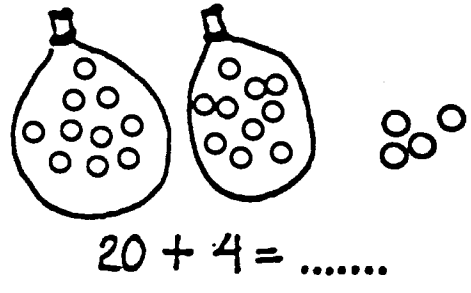
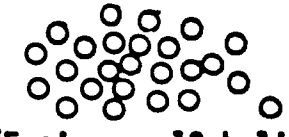
Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
29	III	67.9	76.7	Julio had 72 stamps in his album. Yesterday he pasted 29 more stamps in his album. How many stamps does he have now in his album?
29	IV	55.0	63.4	Mrs. Lila went shopping. When she asked for the bill they told her it was C$265. Since she asked for a discount she only paid C$243. How much discount did they give her?
30	I	2.7	0	2/3 + 1/2 =
30	II	69.3	79.7	5 + 13 + 1 + 20 =
30	III	47.3	58.9	9497 8 675 + 83
30	IV	2.7	5.6	Solve 14936 ÷ 37
31	I	30.1	22.5	2912 ÷ 1
31	II	71.1	63.8	Circle the largest number. 2341 1694 989
31	III	25.0	19.2	Write next to the name of each country the name of its currency. Honduras Costa Rica Nicaragua Guatemala El Salvador
31	IV	5.4	11.3	Jose bought 3 arrobas and 17 pounds of rice at the market. Later he bought 2 arrobas and 20 pounds of beans. How much does everything he is carrying weigh?

Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
32	I	0	0	Circle all the fractions less than 1. 1/2 9/7 4/3 5/9 10/12
32	II	8.8	7.3	Circle the fraction that is equal to 2 1/4. 3/4 3/6 9/4 7/4 6/4
32	III	9.8	16.4	Circle the fraction equal to 2/4. 3/4 2/3 1/2
32	IV	.9	1.4	Circle all the fractions that are equal to 4. 4/4 8/2 1/4 12/3 20/5
33	I	43.4	50.7	1761 6583 9894 +2662
33	II	9.7	2.9	5863 ÷ 25
33	III	58.9	54.8	Circle the largest number. 4 3/4 7 1/2 7
33	IV	.9	4.2	Write 94.1 + 5 vertically and solve it.
34	I	0	4.2	3/5 - 2/10 =
34	II	4.4	4.4	1491 ÷ 43
34	III	2.7	5.5	31841 ÷ 53
34	IV	13.5	21.1	From one piece of cloth 375 yards long, a store clerk cut pieces measuring 4 yards each. How many pieces did she cut?
35	I	27.4	26.8	A school principal has 602 pieces of chalk for five classrooms. How many pieces of chalk is he going to give to each class?

Exercise	Item form	Percentage correct		Description of exercise
		Experimental	Control	
35	II	74.6	87.0	Marcos bought a pair of socks for C$10, a pair of shoes for C$62, and a shirt for C$55. How much did he pay all together?
35	III	31.3	34.3	Rosita gave 51 dolls to her four children. How many dolls did she give to each one?
35	IV	35.1	28.2	I had one tortilla. I divided it into five equal pieces. I ate two of those pieces. Write the fraction that represents the amount I ate.
36	I	8.0	7.0	In order to frame some pictures I bought a piece of wood 7 yards and 2 feet long. Since that wasn't enough I bought another piece 2 yards and 2 feet long. How much did I buy all together?
36	II	8.8	5.8	Mrs. Rosaura had 7 quintales and 2 arrobas of rice. She sold 4 quintales and 20 pounds. How much rice does she still have?
36	III	1.8	4.1	In order to decorate some dresses I bought 19 yards of ribbon. I only used 10 yards and 2 feet. How much did I have left over?
36	IV	5.4	8.5	Answer these questions using the information in the graph. What Central American country produced the most coffee in 1973? What country produced the least?

APPENDIX B. CHANGES TO FIRST-GRADE LESSONS (W/O WORKSHEETS)

Type of exercise	No. of Segments	Present Format	Change required
ADDITION AND SUBTRACTION			
1. Printed exercise.	R:49 T:64 113	24 +15 3+2=..... 7-1=.....	Children will copy exercises from blackboard.
2. Horizontal addition with tally marks.	R:3 T:1 4	5+6=	Children will use sticks or seeds for counting.
3. Oral exercise, written answer.	R:23 T: 0 23	"Escriban la respuesta de 9 menos 4."	Children will write answer in notebooks instead of on worksheet.
COUNTING			
4. Circle 10 balls of 10+N, orally add 10+N.	R:1 T:1 2	 "Encierren 10 de esas bolitas."	Children will group objects into 10 plus N.
5. Count objects, write answer.	R:3 T:2 5		Children will count objects.

6. Count by 5's, write answer.	R:1 T:0 1	 "En cada caja hay 5 lápices. Contemos de 5 en 5."	Pictures will be drawn on blackboard by teacher. Children will write answer in notebook.
7. Count by 10's, write answer.	R:0 T:1 1	(Similar to above.)	(Same as above.)
8. Count by 10's and 1's. write answer or give answer orally.	R:10 T: 0 10	 "En cada bolsa hay 10 bolitas, y 3 afuera. Piensen cuántas bolitas hay por todo."	(Same as above.)
9. Count by 10's and 1's, with horizontal addition.	R:3 T:1 4		Illustration will be drawn on blackboard by teacher. During broadcast children will copy exercises.
10. Circle groups of 10, count, write answer.	R:2 T:7 9	 "Encierren 10 bolitas... Encierren otras 10... Contemos de 10 en 10."	The 2 radio segements will be changed to postbroadcast activities. The children will use objects instead of pictures.

ORDER OF NUMBERS

11. Circle greatest (least) number.	R:14 T: 0 14	35 45 "Encierren al número mayor."	Children will copy numbers from blackboard.
12. Write successor.	R:1 T:1 2	25 ___ 36 ___	Children will copy exercises from blackboard.
13. Write successor, then circle greatest (least) number.	R:4 T:0 4	59 ___ "Escriban el número que va después de ese... Encierren el número mayor."	Children will copy exercises from blackboard.
14. Write predecessor.	R:0 T:2 2	___ 35	Children will copy exercises from blackboard.
15. Write successor and predeccessor, then circle greatest (least) number.	R:2 T:0 2	___ 34 ___	Children will copy exercises from blackboard.

FRACTIONS

16. Circle the named fraction.	R:4 T:0 4	$\frac{1}{2}$ $\frac{1}{3}$ "Encierren donde dice un medio."	Fractions will be written on blackboard for children to read. "Miren el primer número. Léanlo. Miren el otro número. Léanlo. Ahora miren donde dice un medio. Díganme, ¿qué es el número de abajo."

17. Circle the fraction that corresponds to the shaded figure.

R:3
T:0

$\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$

"Encierren el número que dice cual parte está pintada."

Teacher will draw illustration on blackboard. Children will answer orally. In Lesson 143 children will copy correct fraction.

18. Write fraction, given shaded figure.

R:1
T:1

"Escriban cuánto está pintado."

Illustration will be drawn on blackboard. Children will write answer in notebooks.

19. Copy fraction.

R:1
T:2

$\frac{1}{3}$

"Copien ese número."

Fractions will be written on blackboard. Children will copy them in their notebooks.

20. Write fraction from dictation.

R:2
T:0

"Escriban el número dos tercios."

Children will write fraction in their notebooks instead of on worksheet.

21. Circle the appropriate figure, given oral

R:2
T:0

"Encierren el círculo que está divido en medios."

Illustration will be drawn on blackboard. Children will answer orally."primero" or "segundo."

LINEAR MEASUREMENT

22. Measure figure, write length.

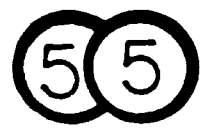
R:3
T:4

Radio segments will be changed to post broadcast activities. Children will measure objects such as pencils, barrettes, or chalk, instead of pictures.

TIME

23. Tell time, oral.	R:3 T:0 3		Illustrationswill be drawn on blackboard.
24. Circle clock, given time orally.	R:0 T:0 2	 "Encierren el reloj que marca las nueve."	Illustration will be drawn on blackboard. Children will answer orally "primero" or "segundo".
25. Write time, given picture of clock.	R:0 T:1 1	Las _____ 	Illustration will be drawn on blackboard. Children will write answer in notebooks.
26. Draw short hand on clock.	R:2 T:0 2	 "Dibujen la aguja corta señalando las cuatro."	Eliminate segments.

MONEY

27. Write value of a set of coins.	R:4 T:2 6	 "¿Cuál es el valor de esas monedas juntas?... Escriban el diez:"	Illustration will be drawn on blackboard. (in simplified form). Children will write answers in their notebooks.
28. Write value of a set of bills.	R:2 T:0 2	 "Escriban el valor de esos dos billetes juntos."	(Same as above.)

29. Circle set of coins, most or least.	R:3 T:0 3	 "Encierren el grupo de monedas que vale más."	Illustration will be drawn on blackboard (in simplified form). Children will answer orally "primero" or "segundo."
30. Circle set of bills, most or least.	R:3 T:0 3	 "Encierren el grupo de billetes que vale más."	(Same as above)
ORDINALS			
31. Circle Nth object.	R:4 T:0 4	 "Encierren el segundo hombre."	Change radio segments to post-broadcast activities. Use children standing in line instead of pictures.
TEST			
32. Test	R:1 T:0 4	(mixed mode)	Eliminate.

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