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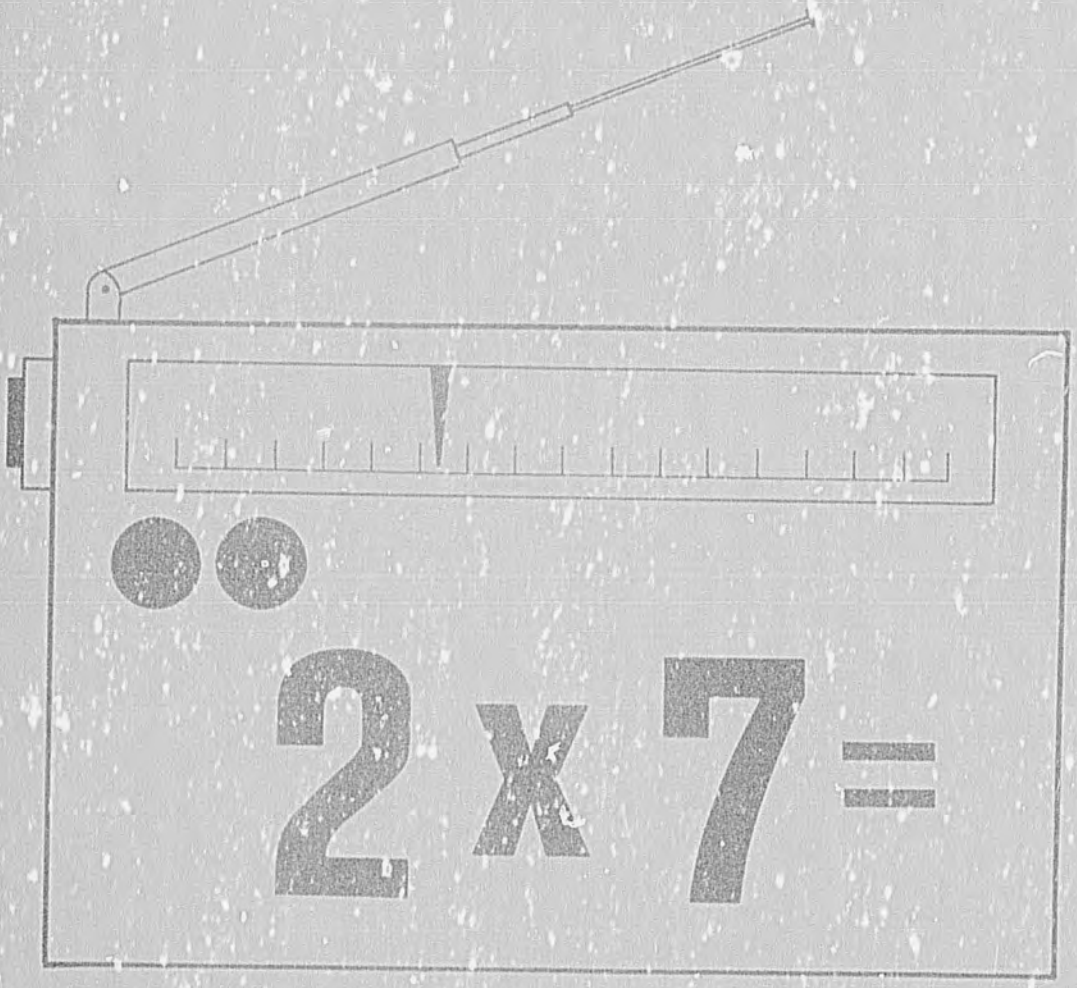

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THE RADIO MATHEMATICS PROJECT:

Introduction and Guide

INSTITUTE FOR MATHEMATICAL STUDIES

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STANFORD UNIVERSITY

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CONTENTS

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THE NICARAGUA RADIO MATHEMATICS PROJECT 1

1. Radio Mathematics in Nicaragua 1

The Design of Radio Mathematics Lessons / 2
The Evaluation of Radio Mathematics Lessons / 9
Resources for Radio Mathematics / 12
Summary / 14

2. Potential Utilization by Other Countries 15

Use of Project Curriculum Materials / 15
Use of Project Methods and Findings / 16

THE RADIO MATHEMATICS PROJECT BIBLOGRAPHY 17

A GUIDE TO THE RADIO MATHEMATICS SAMPLE LESSONS 23

General Lesson Features 23

Music / 23
Lesson Segments / 24
Reinforcement / 24
Radio Teachers / 24

Discussion of Individual Lessons 24

Lesson 25, Grade 1 / 24
Lesson 171, Grade 2 / 26
Lesson 27, Grade 3 / 28
Lesson 160, Grade 4 / 28

THE NICARAGUA RADIO MATHEMATICS PROJECT

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1. RADIO MATHEMATICS IN NICARAGUA

DURING the past quarter of a century, governmental and private agencies have made great efforts to improve the educational systems of the developing countries. Most of these countries lack many of the components of a good educational system—sufficient school buildings, adequately trained teachers, textbooks and other educational materials, and well-designed school curriculums. These deficits are most evident at the primary-school level, where potential enrollments are large and teachers are expected to teach all subjects.

Educational technology is often proposed as a solution to some or all of these problems. In the past few years, many projects employing different media and combinations of media have helped to demonstrate the potential benefits of these approaches. During the 1960s and early 1970s, television was widely heralded as the appropriate medium for educational programs, despite a cost that many developing countries cannot afford. Recent evidence shows that radio can teach many subjects at least as effectively as television and at a much lower cost.

The Radio Mathematics Project, recognizing the difficulties experienced in many countries with teaching primary-school mathematics effectively, has researched the possibilities of improving the quality of instruction in the classroom through radio lessons. The project began in 1973, when the United States Agency for International Development (AID) became interested in experimenting with radio programs for teaching primary-school subjects. Stanford University's Institute for Mathematical Studies in the Social Sciences (IMSSS) was

asked to develop a prototype of such an instructional system. Although the system was to be developed in a single country—Nicaragua was chosen as the experimental site—the objective was to create a program that could be applied with minor modifications almost anywhere in the world. In the process, the project explored the conditions that contribute to the effective use of radio as an instructional medium.

The Radio Mathematics Project began operations in Nicaragua in 1974. During 1974 and 1975, the first-grade radio programs were developed; after that, lessons for one grade were developed each year until the end of 1978, when the lessons for the fourth grade were finished. In 1979, Nicaraguan staff members were producing the fifth-grade lessons until civil war disrupted their work. Although the future of the project in Nicaragua is in doubt, other countries are beginning to apply the results of the work.

The Design of Radio Mathematics Lessons

Curriculum. From the outset it was understood that the Radio Mathematics Project would use the curriculum of the host country. Thus, project lessons are based on the official mathematics curriculum of the Nicaraguan Ministry of Public Education. This curriculum had recently been revised extensively to bring it into agreement with worldwide trends in mathematics education.

Although the lessons generally follow the official curriculum, they do not strictly adhere to it. Certain topics are given less emphasis than in the official curriculum, for example, geometry, which is difficult to teach with the very limited amount of visual material our lessons use, and multiplication, which we consider too difficult for first-grade children. In addition, because the program is directed primarily to rural students, some of the "modern mathematics" topics are given less attention in our programs than they are in the official curriculum. We substituted for these a large amount of work with concrete materials, a greater emphasis on basic arithmetic skills, and mathematics problems that Nicaraguans might be expected to encounter in their daily lives.

The extreme care with which the curriculum material for each grade was prepared by the project contributed substantially to the pedagogical success of the lessons. For each grade, curriculum preparation began about six months before radio production. As a first step, the mathematical content of the curriculum for the year was divided into many different topics, called *strands*. Some examples of strands are oral addition (of integers), vertical addition, integer comparison, and measurement of lengths. Next, objectives were established for each strand. Students are expected to attain these objectives

by the end of the school year. For example, in the second-grade curriculum, an objective for the vertical-addition strand might be to add two two-digit numbers with carrying as part of the process. Each objective is broken into many subobjectives that are appropriate for instruction. One subobjective for the objective mentioned could be, for example, that after the 10th lesson a student should be able to add in vertical format two integers whose sum is less than 10. A homogeneous group of exercises, called *exercise classes,* is associated with each subobjective.

The exercise classes for a given grade level were put into an appropriate sequence by the curriculum specialist. Some of the ordering was established a priori, as certain exercise classes are clearly prerequisite to others. For example, mastering single-column vertical-addition exercises is clearly a prerequisite to doing two-column exercises. Other decisions in the ordering process were based on experience, some of it obtained over the years at Stanford, where several mathematics courses have been developed for computer-assisted instruction.

In making decisions about order, the interactions of the different strands must be considered. For example, it is desirable that oral-addition exercises precede similar vertical-addition exercises and that both of these precede similar exercises in vertical subtraction.

All of these considerations were involved in preparing the master curriculum plan for each grade. The master plan for a grade was completed before the beginning of the school year in which that grade's instructional program was being developed. It was used to prepare the lesson outlines during the year and to specify the exercise classes to be taught in each lesson. In most cases, we stayed with the master plan, unless the feedback system (described later in this paper) indicated that revisions were needed. A detailed discussion of the curriculum and related topics is found in the book *The Radio Mathematics Project: Nicaragua 1974–1975* by Searle, Friend, and Suppes (1976).

Lesson design. The radio mathematics lessons consist of two parts—a radio (or broadcast) part and a postbroadcast part. The radio part of each lesson (henceforth referred to as the lesson) averages about 25 minutes in length, although some first-grade lessons last only 20 minutes. Lesson length tends to increase with grade level. Lessons are divided into segments, some of which teach mathematics, others of which provide entertainment. The segments generally flow into each other with the help of transition music. Students are not distracted by the segmentation of the lessons.

Several pedagogical principles guide the presentation of mathematical concepts. These include the following.

1. Instruction is more effective when children respond actively. (In fact, our experience indicated that when the children are actively doing exercises or solving problems, they often maintain a higher level of interest than during many of the entertainment segments. Contrary to many people's expectations, children, when given mathematical instruction in a form in which they participate, seem to find mathematics intrinsically interesting.)
2. Children's thinking progresses from the concrete to the abstract. (The project lessons use physical objects, especially in the lower grades. These are usually things available to all children, such as stones, sticks, bottle caps, and seeds.)
3. Practice is more effective when distributed over many sessions. (Rather than teach a topic for a period of a few weeks and then ignore it for the rest of the year, instruction begins with a few intensive lessons that introduce a new topic, emphasizing the concepts and elementary skills. The lessons gradually develop the necessary skills during the rest of the year with large numbers of segments involving more practice and refinement of the skills. In fact the most important skills are taught over periods of several years.)
4. Reinforcement by being informed of the results increases the rate of learning. (In most exercises, the radio teacher asks the children to give oral or written responses, and immediately thereafter gives them the correct answer.)

In writing mathematics lessons for radio, the precise wording of instructions is extremely important. The project lessons provide the children with almost no visual aids, and therefore must rely almost entirely on aural stimuli. One of the most difficult parts of producing lessons is writing them in language that is completely precise, easy for the children to understand, and interesting. The project experimented with different formats for instructional dialogues and slowly formulated a large number of principles for scriptwriters to follow in writing lessons. Some of the more important and most widely applicable of these are the following.

1. Keep the number of words in any instruction to the minimum necessary for comprehension. (Instructions that are too wordy, which might be advocated as being in a more *natural* style, generally turn out to bore or distract children from the important point. Small children have a notoriously short attention span. There is a danger in misapplying this principle—instructions should not sound stilted.)
2. Arrange the parts of the instructions in exactly the order in which the children should carry them out. (The children are expected to carry out instructions step by step immediately after they are given; consequently, one should not confuse the order. Occasionally this may lead to a slightly unusual word order for sentences, and not always the *natural* order. Once again, there is a danger of misapplication in that

the sentences may sound too unfamiliar. In that case, it is often preferable to use a number of very short sentences.)

3. Use only words and grammatical constructions that the children can easily understand. (This seems obvious, but scriptwriters perpetually violate it. Once again, a series of simple sentences is usually preferable to a compound or complex sentence.)

In the classroom. Radio mathematics lessons elicit a high level of student involvement. Long explanations usually bore students and are frequently not understood. Consequently, the radio lessons attempt to have children learn by doing, presenting material in short, easy steps. Student involvement or response generally takes one of three forms. The first is a physical response. An example is using the fingers to count and manipulate objects to illustrate mathematical principles or exercises. This kind of response is used frequently in first and second grade and only occasionally thereafter, although physical responses can be useful later, for example, in learning fraction concepts in fourth grade.

Second, students are asked to respond orally, most frequently in simple fast-drill exercises and in introducing a concept. Students answer in unison and then the correct answer is given immediately by the radio teacher. Oral responses may be either immediate or delayed, depending on the difficulty and purpose of the question. In delayed responses students are first warned not to answer immediately, are then asked to "think" about the answer, and finally, after a short pause, are asked for their response.

The third form of response is written. In first grade, children write on worksheets provided by the project; in later grades they write in their own graph-paper notebooks. The form in which they are to write exercises and answers is carefully delineated by the radio instructions.

The number of responses per lesson is very high compared with the number that any given student might make during a lesson in a traditional classroom. For example, in a sample of 10 second-grade radio lessons, the number of student responses ranged from 71 to 157 responses per lesson, with an average of 110. This included all three forms of responses—physical, oral, and written. With an average lesson length of about 25 minutes, the average response rate is more than four per minute.

The methods of presenting material and the expected role of the classroom teacher vary from grade to grade. In first grade the children are given worksheets on which all exercises are printed. They are expected to fill in the answers under the supervision of the

classroom teacher. Thus, first-grade lessons rely heavily on the classroom teacher. In second grade, worksheets are not used, primarily for economic reasons. The teachers write exercises on the chalkboard before the lesson begins, and the children copy the exercises into their notebooks.

In third and fourth grades, the children receive all of their instructions directly from the radio. The radio lessons become largely independent of the teacher. This is desirable for several reasons. First, experience indicates that teachers may be unable to carry out successfully the functions assigned to them. Second, and more important, the lessons are specially designed for the rural classroom, which often has several grades taught by a single teacher. During third- and fourth-grade mathematics lessons, teachers can let one group of students work with the radio and turn their attention to children at other grade levels. If the teacher is responsible for only one grade, then the program presents an excellent opportunity for individual tutoring of students having difficulty. Third, minimizing teacher involvement makes it possible for children and even adults to use the lessons outside the classroom.

Entertainment in the lessons. Each program begins and ends with a theme song about mathematics that also helps identify the grade level of the program. In Nicaragua, these songs, and much of the other music in the lessons, was specially composed for the program by leading Nicaraguan folk music composers. After the musical opening, project lessons effectively mix instructional segments with entertainment segments.

The project experimented extensively to find appropriate entertainment for each grade level and for children in different settings in Nicaragua and found songs and physical activities, both of which require active participation, to be most appealing. Some kinds of entertainment, like puzzles, riddles, and certain songs and stories, have mathematical content. However, most entertainment, particularly folk songs and physical exercises, are not related to the mathematical content of the program but are intended for relaxation and enjoyment.

In general, the amount of entertainment is slowly reduced from first grade to fourth grade as the children's attention span increases. Fourth-grade lessons, typically from 27 to 30 minutes long, usually use only two short entertainment segments. In most of these lessons, the entertainment segments consist of a song (frequently a Nicaraguan folk song) and a short physical-exercise session. Nicaraguan children were taught the words to all songs; hence, we taught a bit of

Nicaraguan folklore as well as some physical education in the mathematics programs.

Radio production. The tapes for all of the lessons were produced professionally at a commercial studio. Especially in radio, where the teacher is not seen, the voices are almost as important as the material taught. Therefore, we used professional radio actors who read from prepared scripts and made only minor improvisations. Each grade's lessons use at least two radio "teachers," usually alternating between male and female voices. This helps maintain the children's interest. In the first-grade lessons we used a number of special effects (thinking they would be entertaining), but these did not seem to enhance the lessons and were therefore dropped.

The second-grade lessons include four or five children in the studio. The radio children always answer the questions that children in the classroom are expected to answer. Using radio children eliminates silences that occur occasionally, especially at the beginning of the year, in classrooms where children are slow to respond. The radio children serve as the kind of catalyst that a few good students provide in a traditional classroom; their participation usually stimulates the other children to participate. By the fourth grade, the radio children not only answer questions, but they also help the radio lesson simulate a regular classroom through the limited use of student-teacher dialogues.

In general, the radio lessons are high-quality programs that maintain the interest of the majority of children as well as teach mathematics effectively. One of our programs, Lesson 171 of the second grade, won the Japan Prize for educational radio in 1977.

The role of the teacher. Even when the teachers are not involved in the radio part of the lesson, they are always expected to teach a supplementary lesson, usually immediately after the broadcast. The teacher's supplement to the radio lesson serves two principal functions. First, it provides the children with more practice on exercises and concepts already covered in the broadcast. Second, it teaches concepts that, for one reason or another, are not covered by the broadcasts. These are of two kinds: concepts that rely heavily on visual materials and are therefore difficult to teach by radio alone and concepts included in the official curriculum but omitted from the radio lessons because of time constraints. Furthermore, during the postbroadcast period, teachers have an opportunity to teach material that they feel to be important but that is not included in the radio lesson.

Despite the classroom teacher's small role during the radio part of

the lesson, it is clear that teacher reaction to the program is as important as student reaction. A good teacher interested in the program can greatly enhance the educational value of the lessons; an apathetic teacher or one who reacts negatively can refuse to use the lessons or can greatly reduce their benefits by indifferent or ineffective use.

During our experimental work in Nicaragua, when only a limited number of teachers was involved, it would have been possible to provide extensive teacher training. This might have helped to increase the effectiveness of the radio lessons. However, when the program was expanded nationwide, extensive teacher training would not be a feasible component, partly because of the limited financial resources available for education in Nicaragua and partly because of the difficulties of organizing a nationwide teacher-training program. Consequently, the project provides a minimum of teacher training—a single three-hour session with participating teachers at the beginning of the school year.

Teacher training serves a number of useful purposes. Project materials (principally radios and teacher's guides) and information are distributed to all participating teachers. The methods and purposes of the program are also explained to the teachers, and they are given suggestions about how to use the programs effectively. The teacher-training session also provides a good opportunity to communicate to the teachers their own importance to the success of the program and to deal with any anxiety that they might have about their functions being usurped by the radio. In summary, although a more extensive program of teacher training might be desirable, the format of a single training session seems adequate and in accord with the constraints attending wide-scale usage.

Each grade of the radio mathematics programs is accompanied by a teacher's guide which is distributed at the beginning of the school year. Teacher's guides for the first two grades encourage teachers to supervise the children carefully during the broadcast and to help individual children having difficulties. For each lesson there are several suggestions for postbroadcast activities that illustrate the concepts taught during the broadcast and provide additional practice. Since second-grade lessons use the chalkboard instead of student worksheets, the teacher's guide tells the teachers what to write on the chalkboard before the broadcast and how this material will be used in the radio lesson. The third-grade teacher's guides are more restricted in scope, since the teacher has no tasks to perform before or during the lessons. These guides give exercises for additional practice on concepts developed in the broadcasts. The fourth-grade guides give the teacher even more freedom, as they are written in weekly mod-

ules. They are unrelated to the broadcasts, covering mathematical concepts not taught by the radio lessons.

The Evaluation of Radio Mathematics Lessons

Formative evaluation. Feedback from daily classroom observation and weekly tests played an important role in lesson development. The information gathered daily from the classroom was applied immediately in preparing future lessons. This worked in the following way. Lessons were normally recorded only about one week before broadcasting. The detailed planning for a given lesson took place only about two or three weeks before the lesson was recorded. Of course, the master plan, elaborated before the beginning of the school year, placed each lesson in sequence and largely determined the topics to be taught in that lesson, but even that was subject to modification if necessary. Consequently, the project staff could use information from the classroom to make minor changes in instructions for lessons scheduled for broadcast one or more weeks later or even major changes in lessons that were to be broadcast three weeks or more in the future. Thus, the plan for the year's lessons was in a constant state of change. Each lesson incorporated all the relevant changes that classroom observation and testing showed to be necessary. However, after the end of that year no further revision was made, unless correctable errors were discovered. The tapes of the lessons were then kept for broadcasting in future years. Ideally, the lessons for each grade will be revised every six years, after the entire curriculum is complete, in order to update the lessons and perhaps incorporate some changes that further experience suggests.

The feedback system has two major components, daily classroom observation and weekly testing. At the beginning of the year, about a dozen schools were selected for observation and testing. These schools were representative of all schools that would eventually participate in the programs; some were urban and some rural, including schools with several grades in the same classroom. It should be noted that the summative evaluation of the experimental program (discussed in the next section) was conducted in a different group of schools. Observation schools were not included in the summative evaluation, because such extended contact with these classes might distort the results.

Classes were observed regularly. Each day, teams of observers from the project office visited at least two and usually three classes during broadcast time. Thus, each of the observed schools was visited an average of once a week. However, this was not done according to a regular schedule; consequently, the teachers did not know in advance

on which day to expect a visit. The observers made no comments to the teacher or students during the class period but merely took notes on all aspects of the lesson, using an observation sheet that made suggestions about what to watch for but otherwise left the observers free to make their own comments.[1] After the class period, all observers met to compare notes and prepare an observation report that commented on the lesson and made suggestions for designing future lessons. These reports were distributed to both scriptwriters and curriculum specialists.

Weekly tests, using about 20 minutes of class time, provided the project with measures of student learning. The tests served several functions. Some items tested key prerequisites, that is, concepts that must be mastered before other concepts can be taught. In designing the weekly test, the project staff looked at the material that was to be taught several weeks later and tested all the key prerequisites for that material. If scores were not sufficiently high, the master plan was changed and the future material was delayed until all of the key prerequisites were mastered. Some items tested the content of the next week's lessons, so that the staff had a measure of student achievement on a topic immediately before it was taught; other items tested the previous week's material to assess the level of achievement after a topic was taught. Finally, from time to time, the staff also tested material that was taught several weeks or months earlier to see whether further practice was needed. The test results were discussed each week with the scriptwriters and curriculum specialists.

Weekly test results and classroom observations substantially influenced the final content of the lessons. Often they indicated that a topic needed more attention than had been planned; other times they indicated that the time devoted to certain topics could be reduced, allowing the lessons to focus on more troublesome topics. In general, the project feedback system was one of the main reasons for the success of the mathematics lessons.

Summative evaluation. In 1976, the project staff began an experimental evaluation of the effect of project lessons on student achievement. This experiment employed a randomized field design: First-grade classes were assigned at random to the experimental condition or to the control condition. Although it is often difficult to carry out random assignment of treatments when working in the field

[1] The project experimented with several types of observation sheets over the years, including some very elaborate ones that asked observers to rate all aspects of each segment, such as interest level, participation, and comprehension of instructions, on fixed scales. In general, we found that a loosely structured observation sheet worked best.

(i.e., outside of the laboratory), the outstanding cooperation of education officials in Nicaragua allowed this experimental design to be implemented. The random assignment of treatments ensures that essentially comparable groups of students are compared and increases the certainty that a performance difference between the experimental and control groups can be directly attributed to the treatment.

The evaluation compared the achievement levels of students in control and in experimental classes, where the students in control classes were taught by traditional methods and the students in experimental classes by the radio instructional program. The results are summarized in Table 1. In first grade, the mean posttest item score for the experimental group was 65%; the mean score for the control group was 40%. This difference is highly significant both statistically ($p < .001$) and educationally. Evaluation of the programs for second and third grades showed similar differences in test scores favoring the radio students.

TABLE 1

Comparison of Posttest Scores on Mathematics Achievement Tests

Grade	Control group			Radio group		
	Year tested	Mean % correct	*SD*	Year tested	Mean % correct	*SD*
1	1976	40.6	18.9	1976	65.6	19.9***
1	1978	44.8	20.3	1978	62.6	20.3***
2	1977	59.3	23.3	1977	65.9	21.5*
2	1978	56.1	18.9	1978	66.9	18.7***
3	1976	44.3	25.9	1977	53.6	28.3**
3	1976	44.3	25.9	1978	56.5	25.4***
4	1977	34.1	26.3	1978	34.5	27.1

* $p < .05$.
** $p < .01$.
*** $p < .001$.

In 1978, the project compared student *pretest* results for two groups of fourth-grade students, those with previous radio experience and those without previous radio experience, to look for a cumulative effect of radio instruction. The results, given in Table 2, indicated that even after a lapse of time (at least three months), students who have had radio lessons still had higher mathematics achievement levels than those without the radio lessons.

These results support the conclusion that in the Nicaraguan school setting, the radio instructional program is more effective than the traditional method of mathematics instruction.

A consistent finding of the project was that radio lessons were more beneficial for students in rural areas than in urban areas; that is, when the posttest performance of control and radio groups was compared, rural radio students were farther ahead of comparable control students than were students in urban areas. Table 3 shows this result by displaying the differences between scores for control and radio groups for urban and rural students at different grade levels.

Resources for Radio Mathematics

Staff requirements and training. Project staff handled not only lesson production and implementation but also a heavy schedule of

TABLE 2

Impact of Previous Radio Experience on Pretest Scores for 1978 Fourth-grade Radio Students

Prior experience	Number of classes	Number of students	Mean % correct	*SD*
None	8	111	45.1	17.4
1 year	11	156	51.5	20.4
2 years	5	88	50.5	21.3
3 years	6	131	59.5	17.7
Entire group	30	486	51.9	19.4
Some prior experience	22	375	54.0	19.6

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

TABLE 3

Comparison of Gains
for Urban and Rural Students

Grade	Year	Difference between posttest scores (Experimental – Control)	
		Urban	Rural
1	1976	26.3	30.3
1	1978	17.1	19.2
2	1977	3.3	11.9
2	1978	9.7	14.1
3	1976/77	8.8	10.9
3	1976/78	7.6	12.3

research work, some of which was directly related to the production of lessons and some of which was more peripheral to production but was designed to build a knowledge base about the use of radio for instruction. This research was of particular interest to AID and has importance in decision-making beyond the borders of Nicaragua.

Because the Nicaraguan Ministry of Public Education had never used school broadcasting and, therefore, did not have a cadre on whom the project could draw, all staff members were trained by project personnel. The major staff activities and related approximate training times were as follows:

Curriculum design and development	2 years
Radio production and direction	1 year
Analysis of test data	1 year
Teacher's guide writing	6 months
Script writing	6 months
Classroom observation	6 months
Design of tests	6 months
Teacher training	3 months
Test administration	2 weeks

Project staff members typically were trained to do more than one of these jobs; for example, someone who was hired to administer tests

also learned to observe classes and, depending on interest and talent, advanced to other activities. Most of the staff members were former primary-school teachers.

Costs. The question of the cost of the program must be investigated carefully, because the radio instructional program was an adjunct to the regular instructional program and the usual savings imputed to the use of television or radio do not apply; that is, teachers were not replaced and class size was not increased.

Two questions need answers. First, once the program was developed, what was the additional cost to the Ministry of Education to use the program in the schools? And, second, were any savings realized by using the program?

An analysis by economists working with the project indicated that once the lessons were developed, the cost per student per year for the lower primary grades (Grades 1–3) would range between U.S. $.50 and $.75 (depending on assumptions about the distribution of electricity and the size of the student population). The cost per student increased for the upper grades because the enrollment drops precipitously—in Nicaraguan rural primary schools, half of the children are in the first grade.

Further analyses suggested that the radio instructional program reduced the number of students repeating first grade. If this was the case, the cost to the Ministry of Education of educating a student decreased; this drop would offset the cost of providing radio instruction in the schools. Calculations have shown that if the repetition rate decreased by two students per classroom, the radio program would pay for itself. Thus, although in terms of cash outlay the program is an add-on cost, it provided substantial economic benefit to the government of Nicaragua.

Summary

The involvement of Stanford staff in Nicaragua ended in December 1978, at which time radio lessons for the first four grades were being used in the schools. During 1979, programs for fifth grade were being developed by the Nicaraguan government and the existing programs for first through fourth grade were being broadcast. Both of these activities were interrupted by the outbreak of the civil war in June 1979. It appears that the new government is planning to expand the programs and develop other radio instructional programs.

The Radio Mathematics Project can be evaluated along many dimensions. The tangible results of the project include an instructional program for each of four grade levels that consists of 160–170 taped

radio lessons, a teacher's guide for each lesson, and tests that can be used to evaluate student progress weekly and over the course of a year. The radio scripts alone for the four grades consist of 10,000 printed pages. The major project outcome, increased mathematics achievement, has been amply documented, as attested to in the tables above. The project has fulfilled its major objectives of designing an instructional program that is inexpensive to implement, successful in raising the quality of mathematics instruction, and particularly effective with its prime target audience—children of the rural poor. The major challenge now is the dissemination of these results to other developing countries that face the familiar problem of poor-quality primary-school instruction in the rural areas.

2. POTENTIAL UTILIZATION BY OTHER COUNTRIES

There are two possibilities for using the work of the project. First, a country can use the lesson materials developed by project personnel, adapting them to its own needs. Second, an organization producing its own radio lessons can take advantage of project methods and findings without adopting the specific Radio Mathematics curriculum materials.

Use of Project Curriculum Materials

Mathematics is perhaps the only primary-school subject that one can contemplate transferring from one country to another. Mathematics curriculums throughout the world are very similar, especially at the early primary level. Thus, it is at least theoretically feasible to take a program developed in one country and use it in another. For example, a radio project just getting under way in Thailand plans to use the project lessons, translating scripts into Thai (after making appropriate cultural modifications). However, since there are often strong political objections to the transfer of instructional programs, direct transfer may not be possible in many countries. Nevertheless, the following list of possibilities might be of interest. It indicates for each level of utilization what must be done to put the lessons into usable form.

1. Tapes and lesson materials developed in Nicaragua can be used in another Spanish-speaking country. Although some of the vocabulary in the lessons is specific to Nicaragua, there is no reason that another country cannot simply broadcast the present tapes.
2. An instructional program based on the project scripts can be developed. The scripts can be revised and, if necessary, translated and recorded locally. Translation of scripts in preparation for such usage would be a major undertaking.

3. The project lesson outlines can be used to write entirely new scripts. In this case, the general curriculum would be the same, but the style of the programs would change.

Use of Project Methods and Findings

Many of the principles that have guided development of project lessons can be applied to other subject matter and other settings, both within and outside the formal school setting. For example, the Radio Mathematics model is being used in the development of radio lessons in the Philippines in a pilot project to teach the national language, Pilipino, to fourth-grade students.

The methods and findings of the Radio Mathematics Project are presented in greater detail in project publications, a list of which is appended. Most of these are available free of charge and can be obtained either from the Academy for Educational Development, 1414 22nd Street, N.W., Washington, D.C. 20037 (Att.: Jill Merrick) or from the Institute for Mathematical Studies in the Social Sciences, Stanford University. Further information may be obtained from:

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A GUIDE TO THE RADIO MATHEMATICS SAMPLE LESSONS

Sample lessons from each of the first four grades of primary school are included in this sample package.[1] These lessons were chosen to illustrate, among them, most of the techniques of the radio mathematics programs.

The best way to listen to these tapes is to put yourself in the place of a primary-school student. This will help you experience how a student responds to the lessons. The radio mathematics programs ask the children to participate actively, a technique designed to hold their attention and help them learn. Consequently, the lessons seem to move slowly if you only listen. In fact, lessons that sound lively to the casual listener may move too quickly for the student to follow.

If you plan to play the role of a student you will need the following materials:

First grade — the student worksheet;

Second grade — the teacher's guide and a graph-paper notebook (or sheet of graph paper);

Third grade — a graph-paper notebook (or sheet of graph paper);

Fourth grade — a graph-paper notebook (or sheet of graph paper), and three sheets of plain white paper, one divided into halves with one half shaded, another divided into fourths with one fourth shaded, and the other divided into eighths with one eighth shaded.

As you listen to the lessons, you should remember that they appear here out of context. The entire set of radio mathematics lessons forms a unified whole; some parts of these lessons might seem inappropriate if you forget that the students have been slowly preparing for the mathematics exercises in these lessons in the course of listening to many broadcasts.

General Lesson Features

Music. Each lesson begins and ends with a musical theme. This

[1] The tapes included in this sample package were produced for demonstration, not broadcast, purposes. Therefore, they are not of professional quality.

helps students and teachers identify the lesson's grade level. Similarly, transition music introduces and concludes segments within the lesson. The same music is usually used for every instance of the same kind of activity. For example, all mathematical segments requiring only oral answers are introduced with the same melody, as are all segments that students work in their notebooks. Background music fills pauses longer than three seconds. There is a great deal of disagreement about the use of background music. Educators generally feel that it distracts students; radio producers abhor broadcasting silence. In Nicaragua, the first-grade lessons and most of the second-grade lessons did not use background music. A policy change led to its inclusion in all third- and fourth-grade programs. (All of the demonstration tapes use background music.)

Lesson segments. Each lesson is divided into a number of segments, each of which concentrates on a particular mathematical concept and activity (e.g., oral addition). The kind of activity changes every 2 to 5 minutes. This is done for two reasons. First, short segments are better suited to children's relatively short attention span. Second, the radio mathematics programs use a type of distributed learning in which important concepts are presented frequently and in small doses.

Reinforcement. Correct answers are provided for every exercise by either the radio teacher or another character. Giving the children the correct answers immediately after their responses helps them learn the lesson material.

Radio teachers. The radio lessons use more than one radio teacher. The use of two or three teachers provides variety and helps to hold the children's attention. For contrast, male and female voices are alternated.

Discussion of Individual Lessons

Lesson 25, Grade 1. This lesson occurs near the beginning of the second month of school. It illustrates a particular style of programming in which a whole lesson is placed within one fictional setting, in this case, a day at the circus. This is not a typical lesson, however. Project scriptwriters stopped using fictional settings after classroom observation suggested that the technique increased neither the pedagogical nor the entertainment value of the lessons. Children seemed to enjoy the participatory aspects of the lessons rather than their story context.

Because this lesson is presented early in the school year, the speed of speech in the instructional segments is quite slow. In addition, the

mathematical material is elementary, involving basic numeration concepts and simple vertical addition which build a foundation for later work. This lesson, like all other first-grade lessons, uses no children's voices. There is merely a short pause when the children in the classrooms are expected to answer.

The instructional part of the lesson (apart from a brief review of counting inserted in a circus scene) begins on page 5 of the script. The segment illustrates how the radio broadcast guides the children in using the accompanying worksheet. Children at the beginning of first grade have difficulty finding the appropriate place on the printed page. For this reason, the worksheets have been carefully designed to make it easy to orient the children. The worksheets are divided into squares, each marked with a picture. The radio teachers refer to these pictures to make sure that all of the children in the classroom are at the proper place on the worksheet. Since this is an early lesson, the radio teachers carefully describe the content of some of the squares to make sure that the children understand the meaning of the symbols used.

Since first-grade children write numbers very slowly, this lesson gives them a relatively long time (8 seconds) to write each single-digit number. Compare this with the 12 seconds given in the next segment (p. 6); four seconds is added there to give the child time to find the correct place on his or her worksheet to write the number.

Word order is very important in giving instructions to small children. On page 5 we find the instruction, "Under the line write the number two." A more natural English wording is, "Write the number two under the line." However, classroom observation indicated that as soon as children hear the phrase, "Write the number," they begin to follow the first half of the instruction without listening to the second half. Consequently, many of them write the number in the wrong place.

As indicated above, instructions in this lesson are extremely explicit and are worded simply and carefully. However, as illustrated by the segment on number comparison and by the segment on number successors (pp. 6–7), instructions become more concise and less explicit as we move through a segment.

Finally, the technique used on page 9 is designed to allow children time to think about answers before responding orally. Naturally, some children respond aloud faster than others. If these children are permitted to answer first, the other children will be discouraged from working out the answer. To avoid this, the lesson provides a specified period of time during which the children are discouraged from volunteering the answer; then, upon a prearranged signal, they are

invited to answer together. The segment on page 9 is preparing the children for this type of delayed oral response.

Lesson 171, Grade 2. This lesson, winner of the 1977 Japan Prize for educational radio, comes almost at the end of the second-grade curriculum. The segments in this lesson review a large number of topics; no new concepts are introduced. Hence, the instructions are, for the most part, concise, as all the children are accustomed to working these kinds of exercises with the radio broadcasts.

This lesson has a rather lengthy introduction and entertainment segment before instruction begins. Instruction is delayed because children of this age usually take some time to quiet down. Important points made at the beginning of the lesson may be lost in the confusion at the start of the class period. In addition, most schools using the program in Nicaragua have only one radio that must be transported from one classroom to the next. This may cause the class to miss the very beginning of a lesson.

Several important points are illustrated in this lesson. Note the homogeneity of the exercises within a given segment. For example, the segment on measuring time (pp. 17–18) has just two kinds of exercises—those comparing various periods of time with an hour and those comparing time periods with a half hour. The oral-addition segment (p. 18) has only exercises of the type a0 + b (e.g., 40 + 8, 60 + 3). This feature can also be seen in the other segments of the lesson and is, in fact, one of the characteristics of all the radio mathematics lessons. The curriculum was very carefully analyzed and divided into classes of essentially similar exercises. A great deal of care was used in deciding exactly when and how often to teach each class of exercise. Instruction is more effective when exactly the same point is made in a number of exercises consecutively, reinforcing newly acquired skills in this manner.

Worksheets, expensive and difficult to distribute, do not accompany the second-grade lessons. Instead, the second-grade lessons use two techniques to present exercises: Teachers write some exercises on the chalkboard before the broadcast (following instructions in the teacher's guide), and children write some exercises from dictation in their graph-paper notebooks. Graph paper makes it much easier for children to keep columns aligned when copying exercises, whether from the chalkboard or from radio dictation. (Such notebooks are readily available in Nicaragua; all the children were encouraged to buy them.) The importance of this can be appreciated by observing, for example, an addition-subtraction segment (pp. 21–23) and a multiplication segment (pp. 28–29).

In the second grade (as well as in subsequent grades), a group of

children in the studio helps the programs simulate a real classroom. This technique has a number of advantages. It tends to liven up the programs. Rather than a pause after a teacher asks a question, there is a dialogue between the radio teacher and the children in the studio. Moreover, in many classrooms, children are hesitant at the beginning about participating orally. Including the voices of children in the lessons helps to stimulate such children to answer aloud. However, the answer of the radio children is usually delayed long enough to allow the children in the classroom to answer first.

The oral subtraction segment on pages 20–21 provides examples of the delayed oral responses mentioned in the discussion of the first-grade lesson. The children in the classroom have learned that when they hear the phrase "Think of . . ." they should not answer until they have been explicitly asked a question. A pause gives all the children time to work out the answer. When asked "How much is it?" they answer together with the radio children.

The addition-subtraction segment on pages 21–23 illustrates two points. First, instructions for carrying and borrowing are carefully worded. Even after many lessons with these concepts, many children continue to make mistakes. Therefore, even though this is a review lesson, explicit instructions for performing the carrying and borrowing operations are still given. Second, the students are allowed only 3 seconds to write a one-digit number. Observation has shown this to be adequate, compared with 8 seconds in the first-grade lesson.

The game "Simon Says" (pp. 23–24) illustrates an important point about entertainment segments. In Nicaragua (and we suspect in most countries), children enjoy most the forms of radio entertainment in which they can participate actively. Consequently, the great majority of the entertainment segments involve the active participation of the children in the classroom.

The division segment on pages 25–27 exemplifies how the radio lessons use simple illustrations (done by the students) to teach abstract concepts. A similar segment will be found in the third-grade lesson discussed below. The differences between the two segments should be noted. In the second-grade lesson the children have done similar exercises in previous lessons. Hence, the instructions are less detailed than in the third-grade lesson, the first instance of this kind of exercise in the third grade.

Pages 27–28 illustrate the use of sound effects and real-life situations for problem solving.

The final segment (pp. 28–29) dictates multiplication exercises for the students to solve after the broadcast. The instructions are given carefully so that the students will write the numbers in the proper

columns. Third- and fourth-grade lessons depend almost entirely on dictation rather than on having the children copy the exercises from the chalkboard. The last lessons of the second grade were used to experiment with this approach and to help prepare children for the kinds of activities they would encounter in later grades.

Lesson 27, Grade 3. Several general techniques used in third grade are illustrated in this lesson. In general, there are fewer "gimmicks" (e.g., the number monster in second grade and the wolf, clowns, and magician in first grade). Experience indicates that the mathematics segments, if they involve enough activities for the children in the classroom, can teach the material effectively in a relatively straightforward manner. Another aspect of the third-grade (and fourth-grade) lessons is their decreasing dependence on outside teaching aids (e.g., worksheets, chalkboard). The lessons also rely less on the direct involvement of the classroom teacher, who is left free to tutor students having difficulties or, in the case of many rural schools with more than one grade in the classroom, to work with other grades. The teacher's guide for the third grade mainly describes postbroadcast activities that give additional practice on concepts taught during the broadcast.

The segment teaching division concepts (pp. 39–42) is essentially the same as the one in the second-grade demonstration lesson. However, because many classes are new to the programs each year and students forget some of what they have learned over the vacation period, concepts introduced at the end of the previous year are taught as if they were being introduced for the first time.

The segment on page 42 gives a geometric interpretation for multiplication of numbers using the area of rectangles.

Lesson 160, Grade 4. Two principal features distinguish the fourth-grade lessons from those of other grades. First, while the lesson is still segmented (although the segments are usually a little longer), each lesson revolves around one general topic. Each of the lesson segments treats the topic, fractions in this lesson, in different ways. The fourth-grade lessons still use the theory of distributed practice in that all the topics are taught throughout the year. However, rather than distributing practice on several topics within a single lesson, two or three lessons concentrate on a single topic. These lesson blocks are alternated throughout the school year.

Second, the teacher's guides are not connected with the daily lesson. (For this reason, no teacher's guide for this lesson is included in this sample package.) The fourth-grade teacher's guide is written in weekly units, which the teachers are free to use as fits their schedules. The guides usually deal with topics that complement the radio lessons

(i.e., those that are less important or particularly difficult to teach by radio).

The first segment of the lesson (pp. 50–51) shows how homemade materials are used to teach abstract concepts. The students make their own fraction sheets in a previous lesson; the same sheets are used in a number of subsequent lessons. In the second segment (pp. 52–54), the students draw figures illustrating fractions and mixed numbers in their graph-paper notebooks. Finally, the third segment exemplifies how the radio is able to give careful instructions leading students through relatively complicated exercises involving addition and subtraction of fractions with different denominators. Students can follow quite complicated sequences of instructions without visual aids by the end of the school year.

THE RADIO MATHEMATICS PROJECT:

Sample Lesson Materials

INSTITUTE FOR MATHEMATICAL STUDIES

IN THE SOCIAL SCIENCES

STANFORD UNIVERSITY

Stanford, California

1980

THE RADIO MATHEMATICS PROJECT

Lesson 25, Grade 1

DURATION: 18:30
DATE OF RECORDING: November 26, 1979
RECORDED AT: Music Annex, Menlo Park, California

VOICES:	EFFECTS:
Charles	**MUSIC:** Theme
Judy	**MUSIC:** Circus
Wolf	**MUSIC:** Background
Harry	**MUSIC:** Trapeze
Bozo	**MUSIC:** Clown
Magician	**MUSIC:** Hypnotic
	SOUND: Drum
	SOUND: Applause
	SOUND: Laughter

MUSIC: Theme

fades to

MUSIC: Circus *(Remains under)*

WOLF: *(at distance — lively)* Everybody come in to the greatest show on earth. See the trapeze artist in his death-defying triple super somersault. Come and laugh with the world's greatest clowns. Don't miss the last show! The ladies can come in free. Bring your sister, your wife, your mother. One ticket does it all. All for the price of one. Buy your tickets here.

JUDY: *(laughing)* Come on, Charles. Buy a ticket and I can get in for nothing.

CHARLES: All right . . . I'm coming.

WOLF: Judy, Charles . . . Hello, hello. Come on over here.

JUDY: Wolf! Is that you in the circus? *(laughs)* And dressed up like a clown. *(laughs)*

WOLF: Of course, I'm a clown and also the announcer. You'll see. Come in this way. It's going to start.

MUSIC: *(Fades in and out — stays in background)*

CHARLES: Look, Judy, look at the parade.

JUDY: *(admiring)* All those animals! What beautiful horses! Look at the monkey riding a dog. Oh, there's an elephant! He's huge!

CHARLES: Look, Judy, the dwarf is waving at us. This is fun.

MUSIC: *(Fades out)*

MUSIC: Trapeze *(Tape)*

WOLF: Attention, attention everybody. This circus is proud to present the world's greatest trapeze artist. He defies death from the highest point in the circus tent.

MUSIC: Trapeze *(Tape — repeats)*

JUDY: Oh dear, Charles. Look up there. He's way at the top.

WOLF: Ladies and gentlemen, the great moment has arrived. Our trapeze artist is going to defy death one more time. We ask everybody to pay close attention. Let's start counting . . . counting from ten to twenty. Everybody count!

JUDY: Let's count, Charles. Children, let's all count together.

CHARLES: Okay, children, count from ten to twenty. Ready? *(Pause:02)*

SOUND: Drum *(In time with counting) (Studio)*

Ten . . . eleven . . . twelve . . . thirteen . . . fourteen . . . fifteen . . . sixteen . . . seventeen . . . eighteen . . . nineteen . . . twenty.

SOUND: Drum *(Faster and louder) (Studio)*

continues to

SOUND: Applause *(Studio)*

WOLF: That's it, let's have a big hand for the great death-defying trapeze artist.

JUDY: *(frightened)* That was scary, Charles. I thought he was going to get killed!

CHARLES: *(frightened)* Yeah, me too!

WOLF: Ladies and gentlemen . . . the thrills go on. The great trapeze artist is going to do it again. There he is, up on the ropes again. Let's all help him by counting from twenty to thirty.

JUDY: Let's count, Charles. I hope the children count too.

CHARLES: Yes, children, count together with us. Ready?
(Pause:02)

SOUND: Drum *(In time with counting) (Studio)*

Twenty . . . twenty-one . . . twenty-two . . . twenty-three . . . twenty-four . . . twenty-five . . . twenty-six . . . twenty-seven . . . twenty-eight . . . twenty-nine . . . thirty.

SOUND: Drum *(Faster and louder) (Studio)*

continues to

SOUND: Applause *(Studio)*

WOLF: *(happy)* How exciting! Let's have another hand for the death-defying trapeze artist.

CHARLES & JUDY: *(applauding)* Children, you applaud too . . . give a hand for the trapeze artist.
(Pause:03)

SOUND: Drum *(Faster and louder) (Studio)*

WOLF: *(laughing)* Children . . . pay attention. Now we can laugh with the clowns Bozo and Harry . . . the clowningest clowns in the world!

MUSIC: *(Tape)*

HARRY: *(clowning)* Hello . . . Bo bo bo bo . . .

BOZO: *(clowning)* I already told you, don't play with I. *(laughs)*

HARRY: Not with I . . . with me.

BOZO: *(laughs)* I'm not playing with yous.

HARRY: Ah, you don't even know how to talk. Tell me, what do you have in your hand?

BOZO: In my hand? I have some rolls.

HARRY: *(interrupting)* Let me see. It doesn't smell like a bakery. *(smelling)* These aren't rolls, Bozo.

BOZO: *(laughing)* But of course they are, Harry. Look, they're rolls . . . rolls of paper. *(laughs)*

SOUND: Laughter *(Fades in and out) (Studio)*

HARRY: I know already . . . I know what you're going to do with the papers.

BOZO: *(laughing maliciously)* I'm not asking you. Attention, everybody! I need a volunteer to help with these pieces of paper.

WOLF: Me . . . me.

BOZO: *(frightened)* Oh dear, a wolf . . . no . . . no . . .

SOUND: Laughter *(Fades in and out) (Studio)*

WOLF: Don't be scared, my friend. I'll help you.

HARRY: *(interrupting)* Bozo, I'll help you read what it says in the part with the flags.

BOZO: It says . . . I can't see, I need my grasses.

HARRY: Not grasses, Bozo. You need your glasses, your glasses.

SOUND: Laughter *(Fades in and out) (Studio)*

And that says . . . two plus one.

BOZO: I don't see where it says that . . . no sir. I don't see it.

HARRY: Don't be silly, Bozo. It's very clear. Put on your glasses and look at it.

JUDY: Charles, let's look at that in the worksheet.

CHARLES: Children, let's go to the worksheet. To side one, the side with your name on it.
(Pause:03)

JUDY: Now look at the flag with the **house**. Put your finger on it. In this square the first number is **two**. The cross means **plus**. The second number is **one**.

CHARLES: So we read this exercise like this: two plus one.

JUDY: Two plus one. Children, repeat it with me . . . two plus one. Very good. Now tell me, how much is two plus one?
(Pause:02)
Three . . . that's right. Now write the **three** below the line.
(Music:08)

CHARLES: Now children, read the exercise together with me. **Two** plus **one** is **three**. Again! **Two** plus **one** is **three**. Very good!

JUDY: Move your finger down to the flag with a **leaf** in it. Look very carefully, there it says . . . **one plus one**. Tell me, how much is one plus one?
(Pause:02)
Under the line write the number **two**.
(Music:08)
Now let's go to the flag with a **ball** in it. There it says **three plus one**. How much is three plus one?
(Pause:02)
Below the line write the number **four**.
(Music:08)
Let's move to the flag with a **hand** in it. There it says **two plus two**. How much is two plus two?
(Pause:02)
Write down the answer.
(Music:08)

CHARLES: All right, Judy, let's do some more.

JUDY: Children, let's go on. Let's go to the part of the worksheet with the cars. Do you see them?
(Pause:02)
Very good, now tell me, the little girl has how many cars?
(Pause:02)

The little boy has how many cars?
(Pause:02)
Circle the person who has **more** cars.
(Music:05)
Below that there is a man and a woman with baskets full of pineapples. How many pineapples does the woman have in her basket?
(Pause:02)
How many pineapples does the man have?
(Pause:02)
Now pay attention. Tell me, who has **more** pineapples?
(Pause:02)
Who has **fewer** pineapples?
(Pause:02)
That's right. The woman has **more**, the man has **fewer** pineapples. Now circle the person with **more** pineapples.
(Music:05)
Now look at the tables. Look carefully. Circle the table that has **more** cups.
(Music:05)
Look! There are also some coconut trees. Circle the tree with **fewer** coconuts.
(Music:05)

CHARLES: Good. Now look for the part with the boxes. Put your finger on the box with a bird. Here you see a number. What number is it?
(Pause:02)
Four. Now we have to think of the number that comes **after** four.

JUDY: *(thoughtful, in a low voice)* One, two, three, four, five . . .

CHARLES: Tell me, what number comes **after** four?
(Pause:02)
Five. That's right. Write the number five after the four.
(Music:12)
Move your finger down to the box with the **shoe**. What number do you see here?
(Pause:02)
Eight. Let's think of the number that comes **after** eight.

JUDY: *(in low voice)* One, two, three, four, *(fading)* five, six . . .
(Pause:02)

CHARLES: What number comes after eight?
(Pause:02)
Nine. Write a nine after the eight.
(Music:12)
Move your finger down to the box with a **pencil**. What number do you see there?
(Pause:02)
Five. Think of the number that comes after five.
(Pause:04)
What number comes after five?
(Pause:02)
Six. Write it after the five.
(Music:12)
Move down to the box with a **banana**. What number do you see there?
(Pause:02)
Seven. Think of the number that comes after seven. Everybody think . . .
(Pause:04)
What number comes after seven?
(Pause:02)
Eight. Write it down.
(Music:12)
Move down to the box with the **tree**. Think of the number that comes after this.
(Pause:04)
What number is it?
(Pause:02)
Seven. Write the number seven.
(Music:12)

SOUND: Applause *(Studio)*

fades to

HARRY: Thank you, children, thank you . . . oh, you're very kind . . . you've helped me a lot. And now we're going to say good-bye to everybody. Let's go, Bozo. *(both clowns exit, shouting)*

MUSIC: Clown *(Fades in and out) (Tape)*

WOLF: Ladies and gentlemen . . . specially for you we have the great circus magician. Let's give him a hand.

SOUND: Applause *(Studio)*

JUDY: Children, you give him a hand too.

SOUND: Applause *(Fades out) (Studio)*

MUSIC: Magician *(Fades in and out)*

MAGICIAN: Thank you, ladies and gentlemen. First, let me pull out my handkerchief.

SOUND: Laughter and applause *(Studio)*

JUDY: *(laughing)* Look, Charles, instead of a handkerchief he pulled out a bird.

MAGICIAN: Oh boy, now I can't find my handkerchief. Maybe it's in my hat. Pay close attention.

SOUND: Laughter and applause *(Studio)*

CHARLES: *(laughing)* And now, kids, he pulled out a rabbit. *(laughs)*

JUDY: What fun!

MAGICIAN: And now . . . the most important magical act of the day. I'll ask Mr. Wolf to help me.

WOLF: *(laughing)* Here I am . . . glad to help.

MUSIC: Hypnotic *(Under)*

mixed with

MAGICIAN: Now sit down here . . . that's right. Now you're going to sleep . . . sleep . . . sleep . . . sleep . . . think . . . think. Friends, you think too. Children . . . you think . . . think . . . without saying anything . . . without saying anything until I say the words "now tell me."

CHARLES: Children, think without saying anything until the magician says the words "now tell me." All right, are you ready?
(Pause:02)
Mr. Magician, the children are ready.

MAGICIAN: So think of the number that comes afte three.
(Music:08)
Now tell me.
(Pause:02)
Think . . . what number comes after two?
(Music:08)
Now tell me.
(Pause:02)
That's right. Now, think . . . what number comes after four?
(Music:08)
Now tell me.
(Pause:02)
Correct. Now think . . . what number comes after one?
(Music:08)
Now tell me.
(Pause:02)

SOUND: Applause *(Studio)*

Thank you very much. Thank you everybody. And now Mr. Wolf, when you wake up you're going to repeat all those numbers for me and then you're going to bark like a dog. One, two, three . . . *(claps)* Wake up!

WOLF: *(yawning)* Ahh . . . four . . . three . . . five . . . two . . . *(barks)*. Ladies and gentlemen that's the end of our show *(barks)*. We'll be with you again *(barks)*. Look, Mr. Magician *(barks)*, don't go away . . . don't leave me like this *(barks)*. Get rid of this magic *(barks)*. Take it away.

MUSIC: Circus *(Fades in) (Tape)*

CHARLES & JUDY: *(laugh)*

CHARLES: Judy, it's time for us to go. Come on.

JUDY: You're right, Charles. Good-bye, children, see you soon.

CHARLES: Good-bye, children, see you soon.

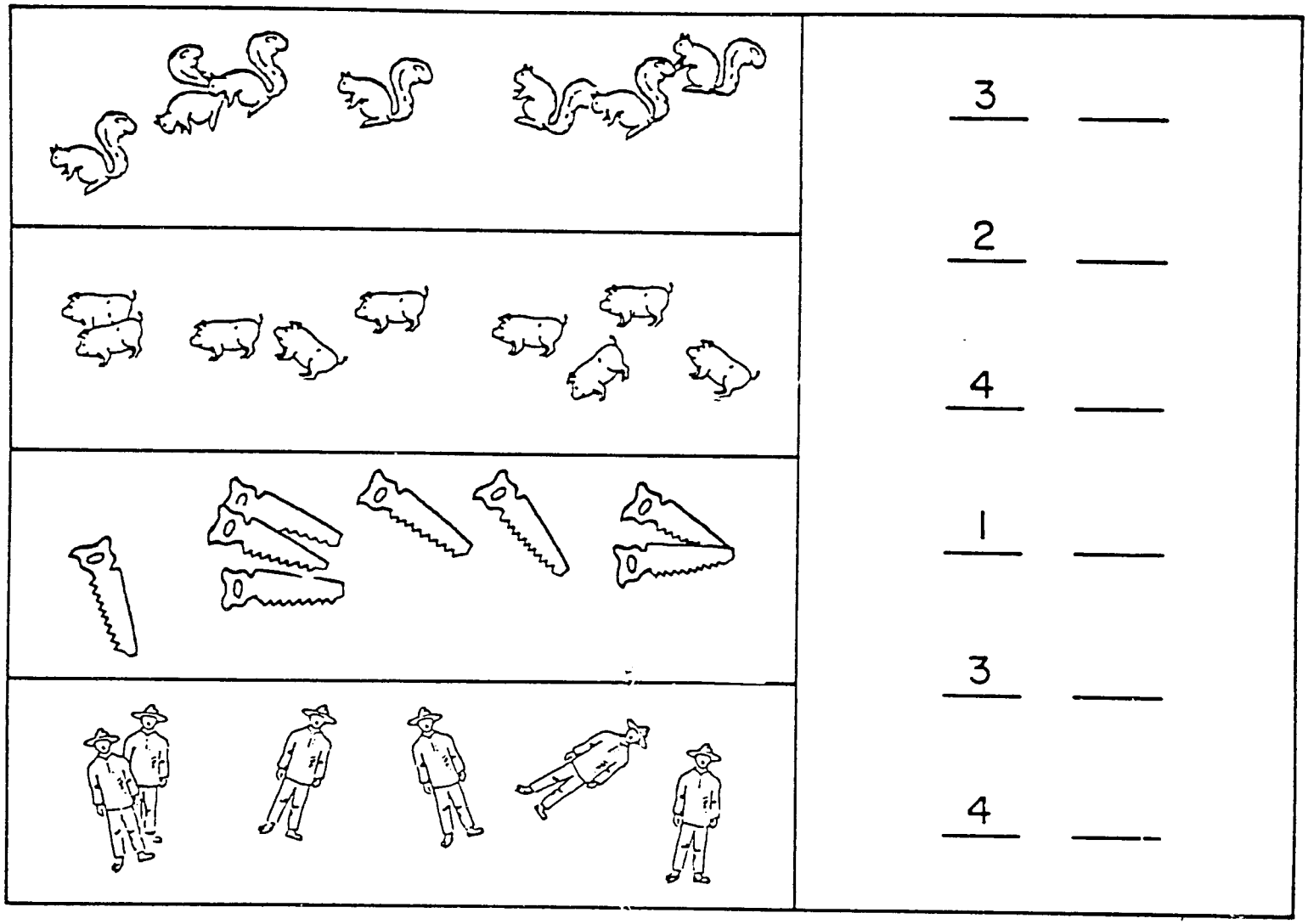
MUSIC: Theme *(Tape)*

25 Name

Number

2 + 1 = ___		4 ___ ___
1 + 1 = ___		8 ___ ___
3 + 1 = ___		5 ___ ___
2 + 2 = ___		7 ___ ___
		6 ___ ___

25



THE RADIO MATHEMATICS PROJECT

Teacher's Guide

Lesson 25, Grade 1

MATERIALS:

Worksheet number 25

BEFORE THE BROADCAST:

Distribute copies of worksheet number 25 to all of the children. Tell them to write their names on the worksheets. Get the children ready to participate actively during the broadcast.

AFTER THE BROADCAST:

a. *Counting with written answer on side 2 of the worksheet.* Say to the children: "Let's count the squirrels in the first square. How many squirrels are there in the first square? Under the squirrels write the number of squirrels. Count the number of pigs and write that number under the pigs." Tell the children to do the same with the saws and the people.

b. *Successors of numbers from 1 to 4.* Say to the children: "Look at the square with numbers and lines. Do you see the number three? What comes after three? Very good. On the line write the number that comes after three." Tell the children to do the same with the other numbers. Observe their work and help those children who are having problems. Collect the worksheets and make sure that they have all written their names on them.

THE RADIO MATHEMATICS PROJECT

Lesson 171, Grade 2

DURATION: 30:40
DATE OF RECORDING: November 26, 1979
RECORDED AT: Music Annex, Menlo Park, California

VOICES:	EFFECTS:
Monster	**MUSIC:** Theme (Jamaican Rhumba)
Little Girl 1	**MUSIC:** Frère Jacques
Little Girl 2	**MUSIC:** The Minute Hand March
Children	**MUSIC:** Transition to oral segment
Lita	**MUSIC:** Every Hour Has 60 Minutes
Raymond	**MUSIC:** Transition to joke
Little Boy	**MUSIC:** Multiplication
Little Girl	**MUSIC:** Transition to game
Announcer	**MUSIC:** Background
	MUSIC: Transition to notebooks
	MUSIC: Transition to riddle
	MUSIC: Transition to chalkboard
	SOUND: Trumpet
	SOUND: Voices
	SOUND: Motorcycles
	SOUND: Harp
	SOUND: People running
	SOUND: Drum
	SOUND: Guitar
	SOUND: Piano
	SOUND: Trumpet
	SOUND: Harp and voices

MUSIC: Theme *(Fade in and under)*

ANNOUNCER: The Radio Mathematics Project presents Lesson 171 of the series "In the Land of Numbers." This mathematics program is specially designed for second grade of primary education. Today Lesson 171.

MUSIC: Theme *(Fade up and under)*

ANNOUNCER: Now we'll give time for the class to prepare for Lesson 171.

MUSIC: Theme *(Fade up and under)*

ANNOUNCER: Today Lesson 171.

MUSIC: Theme *(Fade up and under)*

ANNOUNCER: Attention, you have ten seconds left before we start Lesson 171. 10 . . . 9 . . . 8 . . . 7 . . . 6 . . . 5 . . . 4 . . . 3 . . . 2 . . . 1 . . . . Go!

MUSIC: Theme *(Fade up and out)*

MUSIC: Frère Jacques

CHILDREN: Hi, good morning, hi, good morning,
How are you, how are you?
We are very happy,
We are very happy,
We are fine, we are fine.

MONSTER: *(continues singing)* We are fine . . .
We are fine . . .
ladi da da.

LITTLE GIRL 1: Stop, Numbermonster! The song is over.

MONSTER: What a shame! I like to sing so much.

LITTLE GIRL 2: Yes, we all like to sing . . . but I think it's all right if we sing some more.

CHILDREN: *(not together)* Yes, yes . . . let's sing some more.

MUSIC: The Minute Hand March *(Taped)*

MUSIC: Transition to oral segment

MUSIC: Every Hour Has 60 Minutes *(Taped)*

MONSTER: The clock, the clock
It goes tick tock.
One hour, sixty minutes
Sixty minutes, one hour.
One hour, sixty minutes
Sixty minutes, one hour.

ALL: Let's get to work.

LITA: Boys and girls, pay attention because we're going to measure **time.**

RAYMOND: Listen carefully . . . think before you answer.

LITA: Remember, one hour has **sixty** minutes.

RAYMOND: Yesterday, Mary mended socks for **sixty** minutes.

LITA: Boys and girls, Mary mended socks for one hour or more?

CHILDREN: One hour.

RAYMOND: Yes, one hour. Because one hour has **sixty** minutes.

LITA: Joe has been doing his homework for **fifty** minutes.

RAYMOND: Boys and girls, has he been working for one hour or less?

CHILDREN: Less.

LITA: **Less** than one hour. Because one hour has **sixty** minutes.

MONSTER: The clock, the clock
It goes tick tock.
A half hour thirty minutes
Thirty minutes is a half hour.
A half hour thirty minutes
A half hour thirty minutes.

RAYMOND: Let's talk some more about the half hour.

LITA: Remember, a half hour has **thirty** minutes.

RAYMOND: Boys and girls, Charles studied for **forty** minutes.

LITA: Tell me, did he study for . . . a half hour or more?

CHILDREN: More.

RAYMOND: Yes, **more** than a half hour. Because a half hour has **thirty** minutes.

LITA: A gardener took **thirty** minutes to water the garden.

RAYMOND: Did the gardener take a half hour or less?

CHILDREN: A half hour.

LITA: Yes, a half hour. Because a half hour has **thirty** minutes.

MUSIC: Transition to oral segment

LITA: *(enthusiastically)* Boys and girls, now we're going to do oral addition exercises.

RAYMOND: Be ready to answer out loud together.

LITA: Let's start. How much is **forty** plus eight?

CHILDREN: Forty-eight.

RAYMOND: Forty-eight.

LITA: And . . . **sixty** plus three?

CHILDREN: Sixty-three.

RAYMOND: Sixty-three.

LITA: And . . . **ninety** plus two?

CHILDREN: Ninety-two.

RAYMOND: Ninety-two.

LITA: And . . . **seventy** plus five?

CHILDREN: Seventy-five.

RAYMOND: Seventy-five. Right!

MUSIC: Transition to notebooks

CHILDREN: *(lively)* Hurrah . . . Hurrah . . . Rah, Rah, Rah!

MONSTER: To the notebooks, to the notebooks.

ALL: Here we go.

(Everybody laughs)

RAYMOND: Now we're going to do the exercises in Part **One.**

LITA: Look at the first exercise. Read it out loud.

CHILDREN: One-third plus one-third.

RAYMOND: Tell me, **one**-third plus **one**-third . . . how much is that?

CHILDREN: Two-thirds.

LITA: **Two**-thirds.

RAYMOND: Good. After the equal sign write **two-thirds.** *(Music:08)*

LITA: Tell me, did you write **two** over **three**?

CHILDREN: Yes.

RAYMOND: Good. That's how we write **two-thirds**. Let's go to the next exercise. Tell me, what are you going to add?

CHILDREN: Two-fifths plus one-fifth.

LITA: And **two**-fifths plus **one**-fifth . . . how much is it?

CHILDREN: Three-fifths.

RAYMOND: **Three**-fifths. Next to the equal sign write **three-fifths**.
(Music:08)

LITA: Tell me, how did you write it?

CHILDREN: Three over five.

RAYMOND: **Three** over **five**. That's how we write **three-fifths**.

LITA: Look at the next exercise. Read it.

CHILDREN: Four-tenths plus one-tenth.

RAYMOND: And **four**-tenths plus **one**-tenth . . . how much is it?

CHILDREN: Five-tenths.

LITA: **Five**-tenths. Next to the equal sign write **five-tenths**.
(Music:08)

RAYMOND: How did you write it?

CHILDREN: Five over ten.

LITA: **Five** over **ten**. That's how we write **five-tenths**. Look at the last exercise. Read it.

CHILDREN: One-fourth plus two-fourths.

RAYMOND: And **one**-fourth plus **two**-fourths . . . how much is it?

CHILDREN: Three-fourths.

RAYMOND: **Three**-fourths. Write it.
(Music:08)

LITA: How did you write it?

CHILDREN: Three over four.

RAYMOND: **Three** over **four**. That's how we write **three-fourths**.

MONSTER: *(singing)* Fractions, fractions, fractions. Easy to write.

(Everybody laughs)

RAYMOND: Boys and girls, put your notebooks to one side because you're going to hear a joke.

MUSIC: Transition to joke

VOICE: A mother and her child are talking.

CHILD: Mommy, mommy. Give me a dollar.

MOTHER: Again? But . . . what have you done with the one I gave you this morning?

CHILD: I gave it to an old man.

MOTHER: I'm glad you're so generous. Well, here's another dollar . . . but let's see, tell me, you won't give this other dollar to the old man, will you?

CHILD: Yes, mom, because he's the one who sells candies.

(Everybody laughs)

MONSTER: That's awful!

MUSIC: Transition to oral segment

CHILDREN: Let's go on working.

RAYMOND: Boys and girls, listen to these **subtraction** exercises and think of the answer.

MONSTER: Answer when we ask, "How much?".

RAYMOND: Let's begin. Think of **twelve** minus **four**.
(Music:05)

LITA: How much is it?

CHILDREN: Eight.

RAYMOND: Eight. **Twelve minus four . . . eight.**

LITA: Let's go on. Think of **seventeen minus eight.**
(Music:05)

RAYMOND: How much is it?

CHILDREN: Nine.

LITA: Nine. **Seventeen minus eight . . . nine.**

RAYMOND: Think of **eleven** minus **five.**
(Music:05)

LITA: How much is it?

CHILDREN: Six.

RAYMOND: Six. **Eleven minus five . . . six.**

LITA: And last of all, think of **fifteen minus eight.** *(Music:05)*

RAYMOND: How much is it?

CHILDREN: Seven.

LITA: Seven. **Fifteen minus eight . . . seven.**

MUSIC: Transition to notebooks

LITA: Boys and girls, let's do some more work in our notebooks.

RAYMOND: We're going to do the exercises in Part **Two.**

LITA: Look carefully at the first exercise. What sign does it have?

CHILDREN: Plus.

RAYMOND: Plus. Then what are you going to do?

CHILDREN: Add.

LITA: Yes, you're going to add. You'll add **forty-five** plus **twenty-seven.**

RAYMOND: Let's begin. In the first column, what are you going to add?

CHILDREN: Five plus seven.

RAYMOND: And five plus seven, how much is that?

CHILDREN: Twelve.

LITA: Twelve. Then, are you going to carry?

CHILDREN: Yes.

RAYMOND: Of course, we **have** to carry. Tell me, below the seven, what are you going to write?

CHILDREN: Two.

LITA: Two. And above the four, what are you going to write?

CHILDREN: One.

RAYMOND: One. Write the numbers. *(Music:06)*

LITA: In the other column you have **one** plus **four** plus **two.**

RAYMOND: Think how much it is and write the answer. *(Music:08)*

LITA: Look at the answer. Read it.

CHILDREN: Seventy-two.

RAYMOND: Seventy-two.

LITA: Let's go on to the next exercise. What sign does it have?

CHILDREN: Minus.

RAYMOND: Minus. Then, what are you going to do?

CHILDREN: Subtract.

LITA: Subtract. You are going to subtract **fifty-two** minus **seventeen**.

RAYMOND: Let's begin. In the first column, look carefully at the **two** and the **seven**. Think if you need to borrow.
(Pause:03)

LITA: Are you going to borrow?

CHILDREN: Yes.

RAYMOND: Yes, you are going to borrow because the bigger number is below.

LITA: Now, borrow . . . don't do anything else yet.
(Music:08)

RAYMOND: Now, you have **twelve** minus **seven** . . . and twelve minus seven, how much is it?

CHILDREN: Five.

LITA: Five. Write it **below** the **seven**.
(Pause:03)

RAYMOND: Finish this exercise.
(Music:08)

LITA: In this exercise, what answer did you get?

CHILDREN: Thirty-five.

RAYMOND: Thirty-five. That's right.

LITA: Look at the next exercise. What sign does it have?

CHILDREN: Plus.

RAYMOND: Plus. Then, what are you going to do?

CHILDREN: Add.

LITA: Add. Add **seventy-six** plus **nineteen**. You know how to work it by yourselves. Do it.
(Music:15)

RAYMOND: Boys and girls, tell me, did you carry?

CHILDREN: Yes.

LITA: Yes, you carried. Read the answer.

CHILDREN: Ninety-five.

RAYMOND: Ninety-five. Very good.

LITA: Let's go on to the last exercise. Tell me, what sign does it have?

CHILDREN: Minus.

RAYMOND: Minus. Then, what are you going to do?

CHILDREN: Subtract.

LITA: Yes, subtract. You are going to subtract **eighty-two** minus **forty-five**. Do this exercise.
(Music:15)

RAYMOND: Boys and girls, did you borrow?

CHILDREN: Yes.

LITA: Of course. Read the answer.

CHILDREN: Thirty-seven.

RAYMOND: Thirty-seven. Right.

LITA: Fine. Now, put down your notebooks and pencils for a while because . . .

MONSTER: . . . Ladies and gentlemen . . .

CHILDREN: It's time to play a game.

MUSIC: Transition to game

RAYMOND: Today we are going to play "Simon Says." Here we go. What Simon says . . .

CHILDREN: . . . we obey.

RAYMOND: Simon says that everyone should play the piano. Let's go. Play the piano.

SOUND: Piano *(Tape)*

Stop. What Simon says . . .

CHILDREN: . . . we obey.

RAYMOND: Simon says that everyone should play the drum. Let's go. Play the drum.

SOUND: Drum *(Studio)*

Stop. What Simon says . . .

CHILDREN: . . . we obey.

RAYMOND: Simon says that everyone should play the guitar. Play the guitar.

SOUND: Guitar *(Tape)*

Stop. What Simon says . . .

CHILDREN: . . . we obey.

RAYMOND: Simon says that everyone should play the trumpet. Let's go. Play the trumpet.

SOUND: Trumpet *(Tape)*

Stop. We're done.

MUSIC: Transition to chalkboard

LITA: Boys and girls, let's continue working. Look at the chalkboard . . . at Part **Three**.

RAYMOND: Look carefully at Row **A**. There you see some numbers.

LITA: Look at the first number. How do you read it?

CHILDREN: Two hundred fifty-eight.

RAYMOND: Two hundred fifty-eight. Look at the second number. How do you read it?

CHILDREN: Five hundred eighty-two.

LITA: Five hundred eighty-two. And the last one?

CHILDREN: Eight hundred twenty-five.

RAYMOND: Eight hundred twenty-five.

LITA: Look carefully at those numbers and think about which is the **biggest**.
(Music:05)
Which one?

CHILDREN: Eight hundred twenty-five.

RAYMOND: Eight hundred twenty-five is the biggest.

LITA: Let's go on to Row **B**. Look at the first number. How do you read it?

CHILDREN: Seven hundred six.

RAYMOND: Seven hundred six. And the next one, how do you read it?

CHILDREN: Six hundred seventy.

LITA: Six hundred seventy. And the last number, how do you read it?

CHILDREN: Six hundred seven.

LITA: Six hundred seven. Look carefully at those numbers and think which is the **biggest**.
(Music:05)
Which one?

CHILDREN: Seven hundred six.

RAYMOND: Seven hundred six is the biggest.

LITA: Let's go to Row **C**. The first number, how do you read it?

CHILDREN: Three hundred forty-one.

RAYMOND: Three hundred forty-one. And the next one, how do you read it?

CHILDREN: Four hundred thirteen.

LITA: Four hundred thirteen. And the last one?

CHILDREN: One hundred thirty-four.

LITA: One hundred thirty-four. Okay, now think which number is the biggest.
(Music:05)
Which one?

CHILDREN: Four hundred thirteen.

RAYMOND: Four hundred thirteen is the biggest.

MUSIC: Transition to notebooks

LITA: Boys and girls, open your notebooks again.

RAYMOND: Find an empty part because you are going to draw some marbles.

LITA: Yes, you're going to draw marbles to solve some division problems.

RAYMOND: First you are going to solve **thirteen** divided by **five**.

LITA: Tell me, how many marbles are you going to draw?

CHILDREN: Thirteen.

RAYMOND: Thirteen. Draw them.
(Music:15)

LITA: The exercise is **thirteen** divided by **five**, so circle **five** marbles.
(Music:08)

RAYMOND: Circle another **five** marbles.
(Music:08)

LITA: Tell me, how many marbles are **not** circled?

CHILDREN: Three.

RAYMOND: Three. Now, tell me, how many groups did you make?

CHILDREN: Two.

LITA: Two. Look carefully at the drawing.

RAYMOND: Tell me, how much is thirteen divided by five.

CHILDREN: Two and three left over.

LITA: Two and three left over.

RAYMOND: Let's do another exercise. **Fifteen** divided by **five.**

LITA: Tell me, how many marbles are you going to draw?

CHILDREN: Fifteen.

RAYMOND: Fifteen, draw them.
(Music:17)

LITA: Since the exercise is fifteen divided by **five**, how many marbles are you going to circle in each group?

CHILDREN: Five.

RAYMOND: Five. Make groups of **five**.
(Music:15)

LITA: How many groups did you make?

CHILDREN: Three.

RAYMOND: Three. Look at the drawing.

LITA: Tell me, how much is **fifteen** divided by **five**?

CHILDREN: Three and zero left over.

RAYMOND: Three and zero left over.

LITA: Let's do another exercise. **Ten** divided by **three.**

RAYMOND: How many marbles are you going to draw?

CHILDREN: Ten.

LITA: Ten. Draw them.
(Music:12)

RAYMOND: For the exercise **ten** divided by **three**, how many marbles are you going to circle in each group?

CHILDREN: Three.

LITA: Three. Make groups of three.
(Music:12)

RAYMOND: How many groups did you make?

CHILDREN: Three.

LITA: Three. Look at the drawing.

RAYMOND: Tell me, how much is **ten** divided by **three**?

CHILDREN: Three and one left over.

LITA: Three and one left over.

MUSIC: Transition to oral segment

SOUND: Trumpet

MONSTER: Friends . . . something is happening there . . . what can it be?

LITTLE GIRL: Come . . . let's see what's happening.

ALL: Let's go.

SOUND: Harp and voices

LITTLE GIRL: Oh! It's the central stadium.

LITTLE BOY: Yes, they just announced the races for today.

MONSTER: Let's get closer to see the motorcycle races.

LITA: Boys and girls, listen quietly to find out **how many** motorcycles stay in the race.

SOUND: Motorcycle *(Tape)*

ANNOUNCER: Welcome to today's races. The motorcycle riders are ready. In a few moments they will begin. On the track there are **forty-two** racers. There they go!

SOUND: *(Repeats)*

GEORGE: There are a lot of motorcycle riders in today's race!

LUIS: Yeah. There are forty-two.

SOUND: *(Repeats)*

GEORGE: *(startled)* Look! Two motorcycles crashed!

LITA: Boys and girls, tell me, how many motorcycles stay in the race?

CHILDREN: Forty.

RAYMOND: Yes, forty.

SOUND: Harp

ANNOUNCER: And now we are going to the first foot race of the day. The runners are getting ready. They're ready! They're off!

SOUND: People running *(Studio)*

ANNOUNCER: Look, there are **fifty-six** runners!

LITTLE BOY: They're really moving.

LITTLE GIRL: Look! Look! Six runners have already finished.

LITA: Boys and girls, **six** runners have finished. How many have **not** finished yet?

CHILDREN: Fifty.

RAYMOND: Yes, fifty runners.

MUSIC: Transition to notebooks

continues to

MUSIC: Multiplication *(Recorded)*

RAYMOND: Boys and girls, let's go on working in the notebooks. We are going to dictate some multiplication exercises.

LITA: But you are not going to work them yet. You're only going to write them. Let's begin.

RAYMOND: You're going to write the exercise **one hundred sixty-eight times four** like this: first, write the number **one hundred sixty-eight.**
(Music:09)
Below the **eight** write the **four.**
(Pause:03)
A little to the outside write the **times** sign.
(Pause:02)
And draw a line underneath.
(Pause:02)

LITA: Write this other exercise. Always write the first number above. Write one hundred sixty-nine times three. I'll repeat it. **One hundred sixty-nine times three**. Write it.
(Music:16)

RAYMOND: Let's go on. Write four hundred six times two. **Four hundred six times two**. Write it.
(Music:16)

LITA: Last of all, write one hundred fifty-three times five. **One hundred fifty-three times five.**
(Music:16)

RAYMOND: Quietly, do these exercises by yourselves.

LITA: Yes, boys and girls, because we are going now.

MUSIC: Theme *(Fades in and stays under)*

CHILDREN: Bye little friends.

LITA: See you soon.

RAYMOND: Behave yourselves.

MUSIC: Theme *(Fades in)*

ANNOUNCER: We have presented Lesson 171. The next lesson will be 172.

MUSIC: Theme *(Fades in and out)*

THE RADIO MATHEMATICS PROJECT

Teacher's Guide

Lesson 171, Grade 2

BEFORE THE BROADCAST:

a. Copy on the chalkboard the following groups of exercises (Part One and Part Two), and tell the children to copy them in their notebooks.

Part One

1/3 + 1/3 = ____ 2/5 + 1/5 = ____

4/10 + 1/10 = ____ 1/4 + 2/4 = ____

Part Two

45	52	76	82
+27	−17	+19	−45

b. Copy on the chalkboard Part Three, but tell the children not to copy the numbers in their notebooks.

Part Three

A.	258	582	825
B.	706	670	607
C.	341	413	134

AFTER THE BROADCAST:

a. *Vertical multiplication from dictation.* After the broadcast let the children solve the multiplication exercises that were dictated by radio.

Observe them as they work. If some children have difficulty let them consult their multiplication tables to help them find the answers.

When everyone has finished, have several children go to the chalkboard and give them the exercises to solve. The other children can verify their answers and make corrections where there are mistakes. The exercises dictated by the radio are:

$$\begin{array}{r} 168 \\ \times\ 4 \\ \hline \end{array} \quad \begin{array}{r} 169 \\ \times\ 3 \\ \hline \end{array} \quad \begin{array}{r} 406 \\ \times\ 2 \\ \hline \end{array} \quad \begin{array}{r} 153 \\ \times\ 5 \\ \hline \end{array}$$

b. *Vertical subtraction.* Copy on the chalkboard the following exercises:

$$\begin{array}{r} 540 \\ -286 \\ \hline \end{array} \quad \begin{array}{r} 945 \\ -757 \\ \hline \end{array} \quad \begin{array}{r} 850 \\ -279 \\ \hline \end{array} \quad \begin{array}{r} 562 \\ -173 \\ \hline \end{array}$$

Ask the children to copy and solve these exercises. Observe them as they work. If some children have difficulty, tell them to pay attention to the digits that they are going to subtract, and that when the digit below is greater than that above, they can not subtract and must borrow. When everyone has finished have several children solve the exercises on the chalkboard. The other children can check their work and make corrections if necessary.

c. *Vertical division.* Copy on the chalkboard the following exercises:

$$95\underline{)\,2} \quad 847\underline{)\,4} \quad 68\underline{)\,3} \quad 465\underline{)\,2}$$

Ask the children to copy and solve these exercises. Give help where necessary to the children having difficulty. Afterwards have several children solve the exercises on the chalkboard so that the others have the opportunity to check their answers. The children who made mistakes may correct them. Check the corrections of these children.

d. *Writing numbers by dictation.* Dictate to the children the following numbers to write in their notebooks.

5091 3871 2302 6800 9001 4101

Give sufficient time for the children to write every number. After you have dictated all of the numbers, tell the children: "Look at the number 5091. What digits did you write? (five, zero, nine, one) Now look at the following number, 3871. What digits did you write? (three, eight, seven, one)" Ask the same questions for each number. Have several children come to the chalkboard and give them the same numbers to write so that the other children have a chance to compare and correct their work. Finally point with a pointer to each number written on the chalkboard so all the children can read them aloud.