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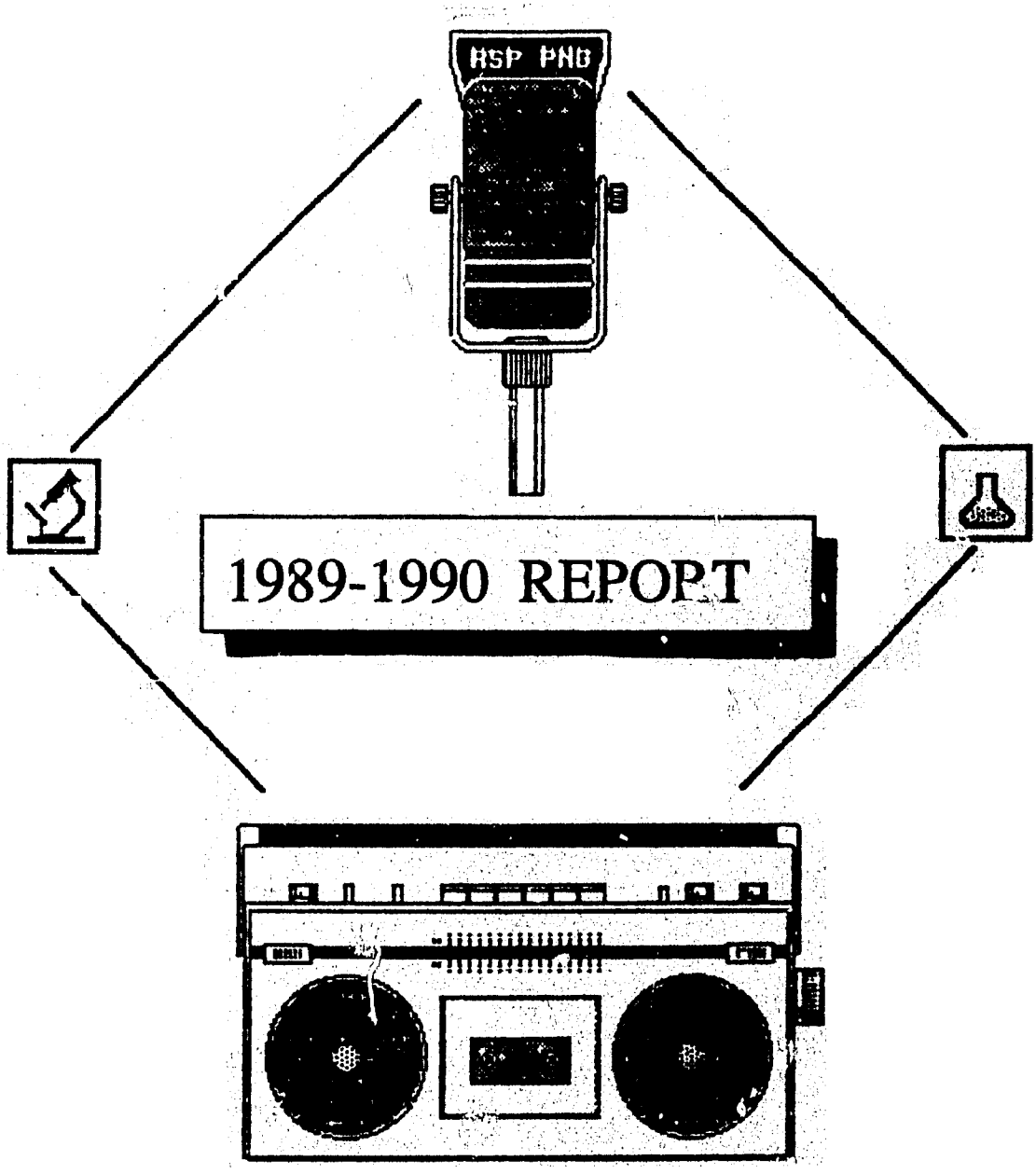
RADIO SCIENCE PROJECT

PAPUA NEW GUINEA



1989-1990 REPORT

EDC

Education Development Center, Inc.

PD-ABB-993

RADIO SCIENCE PROJECT

1988-1990 REPORT
TO THE
AGENCY FOR INTERNATIONAL DEVELOPMENT
BUREAU FOR SCIENCE AND TECHNOLOGY
OFFICE OF EDUCATION

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Radio Science Project Report 1989-1990

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I. INTRODUCTION

The Radio Science Project (1984-1990) is funded by the United States Agency for International Development (AID) under a contract with the Education Development Center (EDC), Newton, Massachusetts. The Project began working in Papua New Guinea (PNG) in 1986 under an agreement signed between the Papua New Guinea National Department of Education (NDOE) and EDC. The purpose of this Project is to develop and test a radio-based science program for children in grades 4-6 attending community (elementary) schools in Papua New Guinea. At a time when the standards of education are perceived to be declining, the Project aims to develop a method for providing systematic, high quality instruction in primary science -- a subject for which many teachers consider themselves to be inadequately prepared. The Project also seeks to improve the capabilities of classroom teachers to teach science. Because severe budget cuts require greater efficiency in the delivery of education, the Project aims to develop a highly cost-effective program of distance education for primary science.

The radio programs are based on the official community school curriculum in science and also include aspects of health, agriculture and community life. The lessons teach the core science curriculum; they are not designed as supplementary material. The radio science lessons for Grade 4 were broadcast and evaluated in 1989; the Grade 5 lessons were developed and field-tested in 1989 and will be formally evaluated in 1990. The Grade 6 lessons are being developed and tested in 1990.

The radio science lessons are based on the concept of interactive radio instruction (IRI) that calls for maximum student participation during the broadcasts. The lessons are presented in a lively and engaging fashion that hold the children's attention and stimulate participation in the lessons. The scripts for the lessons are written specifically for the children in PNG, using Papua New Guinea nationals as writers and actors as well as indigenous sound effects and examples. However, adaptation of these lessons for use in other countries is possible.

Since 1973, A.I.D.'s Bureau of Science and Technology/Office of Education has supported the development of IRI, and the work of the RSP is an extension of this effort. The first version of IRI was created to improve mathematics instruction in Nicaragua in 1974. A set of educational materials was produced that resulted in significantly higher achievement scores for participating children compared to children in control groups. Since the application of IRI to teach mathematics in Nicaragua, the methodology has been used to teach English, Spanish, health and science. Teaching science through IRI has proven to be a challenge because the discipline requires more hands-on activities and instructional materials than the other subjects as well as an inquiry-based approach.

Each week for thirty weeks, children in PNG participate in two thirty-minute lessons. Each lesson consists of a 20-minute broadcast during which the classroom teacher participates in a supportive role. After the radio portion of the lesson, the classroom teacher conducts specific, complementary, post-broadcast activities as outlined in a teachers'guide. Both broadcast and post-broadcast portions of a lesson are supported by worksheets and science materials.

II. EDUCATIONAL SYSTEM OF PAPUA NEW GUINEA

Papua New Guinea is an independent nation of over three and a half million people. The country is located on the eastern half of the island of New Guinea, north of Australia and slightly south of the equator, in the South Pacific Ocean. Most of the country is remote and rugged with high mountains and great rivers. Even with modern techniques, communication and transportation remain difficult in the country.

During the period that Papua New Guinea was governed by Australia (1917-1975), a system of primary and secondary schools was established in many parts of the country. Before 1975, many of the teachers and administrators in these schools were expatriates. Since independence, the development of schools has been carried on by the Papua New Guinea National Department of Education (NDOE). Presently all the teachers and administrators in the community (primary) schools are nationals. The official language of education in the country is English, although there are more than 700 languages in the country.

The school system consists of community schools (Grades 1-6), national and provincial high schools (Grades 7-12), and post-secondary institutions. The schools are operated by government and church agencies, but most teachers in the schools are lay teachers. There are over 2,300 community schools with about 350,000 students and 11,500 teachers. Presently, the government is developing plans to implement universal primary education throughout the country by the year 2000.

Children normally enter Grade 1 at the age of seven or eight. At Grade 6, a school leaving exam is given in all community schools. Those that pass have the opportunity to apply for available space in provincial or national high schools. If no space is available, a student can apply to vocational centers or the College for External Studies (a Grade 7-12 correspondence school). Those that fail the exam, leave school or can apply to a vocational center or the College for External Studies. Most of those who fail leave school.

The curriculum for the community schools is developed by the Curriculum Division of the National Department of Education. The Curriculum Division develops syllabi, teachers guides, textbooks, and other instructional materials such as charts and posters. Radio programs are also available from the Unit to supplement many areas of the curriculum. These programs are transmitted by the National Broadcast Commission (NBC) on a regular basis during the school year. Recently, the Curriculum Unit built a television recording studio and upgraded its radio recording studio. Plans are being made to produce television and radio programs for the support of all the curriculum areas.

The community school curriculum consists of the subject areas of English, math, science, the expressive arts, community life, agriculture, health, and physical education. English, mathematics, and science are required subject areas and are scheduled to receive the largest blocks of teaching time.

The Curriculum Division has developed a science curriculum for community schools. The division has also developed support materials including teachers' guides for Grades 1-6, a community school science syllabus Grades 1-6, a guide to science concepts Grades 1-6, and three supplementary radio programs for Grades 4, 5, and 6. In the early 1980's, the division supplied most of the community schools in the country with science charts and posters and a science kit. The science kit had materials necessary to teach many of the lessons outlined in the Teachers' Guide to Community School Science. Many of the science kits are now unusable. The charts and posters are out of print.

Even with this support little or no science is being taught in the community schools. A survey of teachers and headmasters in Community School conducted by the RSP found that teachers thought that science was the most difficult subject to teach. The following are statements from the teachers and headmasters:

- "We have few or no materials, especially science materials."
- "All materials are disorganized and scattered."
- "Even our most reliable teachers have trouble teaching science."
- "Teachers consider teaching science difficult--especially if there are no science materials."
- "The unavailability of materials gives many teachers excuses not to teach science."
- "The science backgrounds of most teachers are inadequate."
- "Science lessons take too much time to set up and to do with children."

III. PROJECT ACCOMPLISHMENTS

The Radio Science Project is addressing the issue of providing quality science education in Papua New Guinea in an integrated and comprehensive manner. The scope of the project is broad, reflecting the complexity of the problem of improving science teaching and learning in the country. The following is a summary of RSP accomplishments from 1988 to mid-1990.

o **Grades 4, 5, & 6 Instructional Packages**

Two complete packages were developed for grades 4 & 5 including the following components for each grade:

60 twenty minute radio lessons

60 student worksheets to accompany the radio lessons

60 Notes for the Teacher to accompany the radio lessons

A similar package of materials for grade 6 is under development. The total package will consist of 50 lessons.

o **Teacher Training**

Produced and broadcast teacher education programs to teachers in the Central Province;

Designed and implemented eight teacher training workshops for teachers using Project materials;

Developed and tested audio cassette-based teacher training lessons.

o **Staff Development**

Developed and implemented training programs entitled, "Writer's Workshop" and "Actor's Workshop" for scriptwriters, actors and other staff;

Developed a stable and consistent team of studio actors, actresses and scriptwriters.

o **Project Development**

Obtained a written agreement from NBC on broadcast of summative lessons during the period 1988-91 in the East Sepik;

Produced a 22 minute video-tape documenting the work of the Project.

- **Evaluations**

  Carried out formative evaluations for grade 4 and grade 5 lessons;

  Refined and approved summative evaluation plan;

  Developed and administered test in 27 control schools in the East Sepik Province for the Grade 4 summative evaluation;

  Developed and administered test in 30 control schools for Grade 5 summative evaluation;

  Designed and administered questionnaire on science teaching and radio programs to experimental and control teachers;

  Completed technical evaluation to assess the condition of the School Broadcast's studio that led to the repair of the major technical problems;

  Mid-term outside evaluation of the RSP conducted.

- **Institutionalization**

  The NDOE has recognized the RSP as an official program that will be made available to teachers on a national basis begining with grade 6 materials in 1991 and the grades 5 and 4 materials during the following two years.

IV. DESCRIPTION OF PROJECT ACCOMPLISHMENTS

A. Instructional Packages for Grades 4, 5, and 6

The core of the Radio Science Project is script development and production activities. In 1988-1989, two sets of sixty twenty-minute radio lessons were written for grades 4 and 5. Lesson content was chosen to reinforce and extend concepts in the existing science curriculum and special emphasis was placed on concepts related to students' everyday life. To ensure that lesson content was presented in as interesting and understandable a way as possible, IRI principles including active student participation, regular reinforcement of answers, repetition and segmented learning were incorporated into each program. Special IRI programming techniques that have been developed for the Radio Science Project lessons are described in detail in Section V of this report entitled "Approach to Teaching Science." The grade 6 materials being developed in 1990 follow the pattern of the first two years, but give more attention to development of critical thinking skills. Approximately 9,000 students are now utilizing the radio science lessons.

To supplement each science lesson, simple one-page worksheets were developed for students' use. The worksheets make extensive use of graphics to help students understand difficult concepts. Radio lessons refer to the worksheets in each program, explaining the meaning of the pictures and asking students questions about what they see.

Notes for the Teacher were also developed for each lesson to supplement the science broadcasts. The purpose of the Notes for the Teacher is to explain difficult science concepts through the use of text and graphics and to suggest activities the teacher can try during the post-broadcast period.

Finally, the Project tested the use of science kits that contain simple materials available in Papua New Guinea such as mirrors or batteries. The kits were developed and delivered to pilot schools to accompany lessons on heat, sound, light and electricity. Although these kits are far less expensive than previous kits provided to the schools, cost and distribution remain significant problems and, therefore, it is not yet determined whether the kits will be used in the future.

B. Teacher Training

The Radio Science Project recognizes the central importance of the teacher in effectively implementing the science program in their classrooms. As a result, the Project has developed a multi-pronged approach to teacher training. When teachers are first introduced to the RSP lessons, they are given a one-day orientation to using the lessons in their classrooms. This session consists of an overview of the RSP and focuses on the role of the teacher before, during, and following the broadcasts. In the workshops, the teachers simulate Radio Science classes using taped lessons and then discuss their reactions and questions with the trainer.

The most significant component, and the one the teachers rely on from lesson to lesson, are the Notes For The Teacher. These teacher's guides of 2 pages per lesson consist of vocabulary, special preparations required before the broadcast, materials that are needed, specific directions for a 10 minute post-broadcast lesson, the science content on which the lesson is based, and an additional activity on each topic. This additional activity is provided for the teachers if he or she would like to reinforce student learning or to pique or accommodate student interest.

Starting in 1988 the teachers in the Central Province have also had the opportunity to listen to a 10-15 minute broadcast the night before each lesson. These broadcasts for the teachers review the key points about the lesson for the children to be broadcast the next day and provide reminders and tips about collecting materials for experiments. These broadcasts cover much of the material presented in the Notes For The Teachers.

The Project has also experimented with other forms of teacher training. One strategy tested out is an audio cassette-based series supplemented with carefully developed print materials that extensively incorporate graphics. The materials focus on science content and teaching methodology. The cassette tapes are twelve minutes in length, but are designed to be used interactively, with the listeners turning off the tape player at appropriate times to perform activities and discuss questions. The aim of the audio cassettes is to teach science content and pedagogy in an interesting way by incorporating interviews about science concepts, by using a variety of sound effects, and by including a number of hands-on activities.

The audience for the audio cassette-based lessons is teachers who are currently using the IRI science lessons in their class- rooms, but the lessons can potentially benefit all primary science teachers in the country. The science tapes are meant to be used by groups of teachers for inservice training in schools. The tapes could also be used more informally by individual teachers; parts of the tapes could even be used in children's science classes.

Another set of cassette-based materials was developed, but because of funding limitations they were not produced or tried out with teachers. These materials were designed to test the use- fulness of presenting the lessons, both for the children and the teachers, by cassette tape rather than by radio. The teacher training component consisted of cassette tapes to be used indi- vidually by teachers in their home. A more detailed discussion of the potential of these materials is presented on page 29.

C. Staff Development

The actor's workshop and writer's workshops were a unique aspect of the Radio Science Project during 1988 and 1989. Through these programs, staff members received ongoing professional training to improve their skills in a collaborative atmosphere.

The actor's workshop consisted of four half-day long sessions. It was developed and implemented with the goal of improving the quality of acting. Emphasis was placed on typical problems actors face that can affect the quality of their acting and speaking.

Sessions focussed on distractions and pressures common to actors and strategies to ease them. Participants practiced improvisations and storytelling in order to increase their facility in playing different characters in the scripts. The different types of dialogue used in the radio science scripts including conver- sational, informational and directional were discussed and then practiced using segments from science scripts. Finally, participants were asked to create their own script segment including a variety of dialogue styles which were then presented to the Radio Science staff.

Writer's workshops were held on a weekly basis during 1989. Typically two hours in length, the purpose of the workshops was to improve the quality of Radio Science scripts by providing the Radio Science Project scriptwriters with an opportunity to review and expand their writing techniques. Although the sessions included reference to science content, they emphasized writing technique. Examples of workshop activities included practicing writing in the passive and active voices, and writing in free flow, descriptive and dialogue styles.

D. Project Development

In 1988 the process of obtaining a final written agreement from the National Broadcasting Commission for the broadcasting of lessons in the East Sepik was completed. The broadcasting agreement is for the period 1988-91.

During 1988 and 1989, a 22 minute video-tape was produced by Dale Rutstein's First Take Productions to document the work of the Radio Science Project in the community schools. The objectives of the video were as follows:

1) To bring the colorful and interesting story of radio education in Papua New Guinea to a general audience;

2) To demonstrate to government officials around the world that science instruction via radio is a viable and effective exercise;

3) To reduce pessimistic or fearful attitudes toward the concept of radio science education;

4) To demonstrate that science can be taught effectively on radio;

5) To assist teachers by showing effective use of the radio lessons in the classroom;

6) To tie in radio education with the problems of education in lesser developed countries as a whole;

7) To document the Radio Science Project in Papua New Guinea.

The video-tape was completed in February, 1990, and was shown the following month at the World Conference on Education for All in Bangkok as part of EDC's exhibit.

The film was then shown at an international distance education conference in the Philippines. It is also being used extensively to supplement RSP promotion activities.

E. Evaluations

This section summarizes the formative evaluation, technical evaluation of the broadcast studio, and the RSP evaluation. A description of the grade 4 summative evaluation activities and results is in Section VI of this report.

1. Formative Evaluation

Formative evaluation is a cornerstone of the IRI methodology is an important and ongoing part of Radio Science Project activities. The process of formative evaluation of the science lessons resembles the process for other IRI projects - field-testing of each lesson, analysis and modification. The purpose of the formative evaluation is to improve the lessons. The information collected is used to revise the existing lessons and to modify plans for future lessons. The RSP carries out extensive classroom observations, but has not extensively use achievement tests as part of the formative evaluation process.

2. Technical Evaluation of the Studio

The RSP provided some support for technical evaluation of the Schools Broadcasting Unit recording studio. The evaluation consisted of an analysis of existing equipment and a set of recom-mendations to replace or repair broken equipment. As a result of the work, many of the major technical problems that existed in the Schools Broadcast studio were solved.

3. Project Evaluation

In mid-1989 the Radio Science Project was evaluated by an outside, independent evaluator. Micael Olsson, an American who has lived in PNG for about twenty years and who works for the PNG government, was selected to conduct this evaluation. The major purpose of the evaluation was to assess how well the RSP was accomplishing its objectives. He was asked to look at the work accomplished to date and assess the plan for the remaining project period. He examined the quality of the work, the extent to which the Project has learned about teaching science by IRI, the training of the national staff, and efforts to promote institutionalization.

In carrying out this study he observed classrooms and teacher training sessions, interviewed staff members, teachers and education officials, and reviewed Project documents. The following is the summary of his report:

FINDINGS AND CONCLUSIONS

Neither the National Department of Education nor the Radio Science Project staff felt that the radio science broadcasts could or should carry the burden of curriculum. Conversely both agree that the radio broadcasts are providing the kind of assistance, without which, the teacher cannot carry the burden of instruction either. The conclusion is that the RSP has introduced a potentially effective co-teacher in the classroom and that learning gains are already beginning to emerge among science students in PNG schools.

The Project will need to facilitate the recruitment of a science educator sympathetic to the radio science approach within the NDOE if the RSP is to be effectively institutionalized. And while the NDOE is interested in adopting the approach nationwide, there are still unanswered questions regarding add-on costs, the reach of radio and the need for more teacher-directed support materials.

RECOMMENDATIONS

The RSP should be extended by six months to June 1991 with the agreement that NDOE join the program in 1991 to continue supporting the revision of materials, their implementation and the summative evaluation. Add-on costs should be calculated as soon as possible using the model as currently adapted with revised kit materials and flip charts in lieu of worksheets in order to show that the two proposed Public Investment Programs will cover the bulk of the add-on costs.

The RSP should also develop a research model and initiate a survey to determine what percentage of rural schools are likely to benefit from radio broadcasts. The study should aim to determine which areas get an adequate daytime signal, which areas get only a nighttime signal, which schools have radios, which schools require radio antennas and which areas have difficulty obtaining batteries.

Finally, along with workshop materials, more teacher-directed content should be included in the classroom broadcast tape, leaving one easy-to-read teacher-preparation guide and one broadcast tape.

LESSONS LEARNED

That science is different from math and language instruction in that it does not readily lend itself to teacher-independent radio broadcast instruction.

That the materials and distribution costs from RSP materials currently being produced are high for less-developed countries like Papua New Guinea.

That more time is needed to design effective lessons that relate in practical ways to the life situation of the majority of the pupils and yet rely mostly on locally available materials.

The full report lists twenty-eight findings and nineteen recommendations. These can be found in Appendix I.

The evaluation report was very helpful to the Project. It has served as a reference point for many of the activities that followed and several of the recommendations were implemented. For example, the Project has developed summary cost estimates for national implementation, there has been some continued work with developing new teacher training programs and the teachers guides have been improved. Frank Watson, the former Project Director, has been in communication with the field office from the U.S., although the extent of his involvement has not been as much as expected.

In part because of unexpected budget restrictions, a number of the recommendations were not implemented. Regarding the curriculum, for example, Tom Roy, the Project Director as of September, 1989, in consultation with others in PNG, recommended making a few changes in the Grade 6 curriculum to try to better meet the needs of children in rural schools, and to reduce the requirement for special equipment and materials. These changes were subsequently approved by the Science Subcommittee. Another example concerned the recommendation that flip charts be introduced. Subsequent analysis showed that it was more cost effective to continue using student workbooks than to switch to flipcharts. Budget restrictions have not permitted implementing some of the recommendations including an extension of the Project to mid-1991 and a study of radio reception. Finally, the Project was not been able to identify a well qualified host country science educator to work with the Project to help promote a smooth transition to full NDOE control and support.

Given that a new Project Director had to be hired for the last fifteen months of the Project (because the previous one had to return to his university), and that there was a significant short-fall of funds, the RSP has done well to meet its basic objectives and to implement many of the recommendations of the evaluation report.

V. APPROACH TO TEACHING SCIENCE

The RSP approach to teaching science takes into account the current state of science teaching in community schools. Most of the teachers are hard working and dedicated, and they do the best they can with the training they have and with the available materials. Yet there are serious limitations that impact on what can be accomplished in a science class such as the following:

- Most teachers are poorly trained in science. They lack both information and laboratory skills.

- Books and supplies are in very short supply. Adequate storage is often not available, materials get stolen or broken and are not replaced. It is unlikely that a kit of science materials will be usable after two years.

- In some schools, materials are available but they are not used either because they are locked up in a storeroom or teachers are not trained sufficiently in how to use them.

- Frequently no one feels responsible for science materials.

- Teachers may be transferred from school to school on short notice.

- Teachers are frequently assigned to villages of tribes to which they don't belong and the resulting distrust prevents teachers from making good use of parents and local resources.

- Many teachers have relatively poor command of English, and their students have even less command. Oral responses by students, therefore, tend to be short and monosyllabic; often a single word uttered softly. Rarely does one hear reasoned statements.

- Teachers have a limited repertoire of pedagogic techniques:

  - The questions they often ask require only a one-word answer.

  - Their questions rarely invite a reasoned, thoughtful response from children. Speculation by children is rare.

  - Teachers have difficulty turning a "wrong" answer into useful discussion.

  - Teachers do not know how to take advantage of an unexpected occurrence. Since unexpected occurrences are common in scientific investigations, this shortcoming can rob many laboratory activities of their potential and interest.

A major task of the Radio Science Project has been to develop and refine a strategy for the effective teaching of science by radio. This strategy must take into account the conditions in the classroom which are summarized above, the existing science curriculum, and a philosophy about what comprises good science education for children in Papua New Guinea.

There is a great deal of disagreement among educators about which is the most appropriate philosophy of science education; however, most science educators agree that science should include hands-on activities for the learner and the course should be inquiry-based in nature. The Radio Science Project acknowledges that first-hand experiences with natural phenomena is important; the RSP also believes that science is an important discipline for developing inquiry skills. The Project believes that science education should help children understand the world in which they live. Hands-on experiences and inquiry-based learning can enhance the learning and understanding of science concepts, but clearly, many learning objectives can be taught without these experiences. Depending on the topic to be taught, it may not be possible to provide appropriate hands-on experiences, or it may be more efficient to teach the children directly without the use of materials.

The Radio Science Project curriculum is based on the official syllabus for grades 4-6 in PNG. The PNG curriculum is composed of a syllabus and teacher's guide for each grade. The opening pages of the syllabus reflect the objectives of the U.S. project entitled "Science: A Process Approach," a curriculum that emphasized a highly structured approach to teach science process skills. The remainder of the document is devoted to science content and draws upon another U.S. project entitled the "Elementary Science Study" (ESS) which was developed by EDC in the 1960s. ESS stresses a hands-on, inquiry approach to teaching science. But in adapting this type of approach to PNG, the science educators removed much of the open-ended and inquiry nature of the activities. When Project staff examined how the science was actually being taught in the schools, they discovered that in many classes science was not being taught and, where it was taught, there was little hands-on, inquiry-based teaching.

The official Teacher's Guides list the activities that are to be done, along with instructions and the required materials. As is the case with the ESS materials, the PNG curriculum does not stress a tightly structured scope and sequence for the topics. For every broad topic, there are suggested activities, each one mostly independent of other activities. The curriculum is not developmental, nor is there a flow from one topic to another. The level of some of the activities does not reflect the findings of research in human development in terms of what is appropriate for children of a certain age.

Many educators in PNG recognize the need to revise the science curriculum, but this work has not begun. Thus, the RSP curriculum has been largely confined to a syllabus that is due for a major revision. Fortunately, the RSP has had enough latitude in developing its programs to incorporate some revisions including the addition of certain topics or activities. The RSP team has sought to provide a greater continuity in the lessons, both within topics and across topics and grade levels. In addition, the

Project has been able to "cover" the official syllabus and still have several lessons to incorporate extra topics.

The guidelines for the Project set by the National Department of Education are that the RSP syllabus should be based upon the official curriculum, it should not require extensive retraining of teachers, nor require materials beyond what is recommended in the kit that each school was provided with many years ago.

LESSONS LEARNED ABOUT TEACHING SCIENCE BY RADIO

A. Background

The Radio Science Project has expanded our understanding of how interactive radio can teach children. The RSP is different from earlier IRI projects in four ways--it teaches older children (grades 4-6); it incorporates to a greater degree simple instructional materials; it places greater emphasis on open-ended questions and the development of inquiry skills; and it involves the classroom teacher to a greater extent. In this section we describe what we have learned in each of these areas.

The evolution of the IRI methodology is summarized in the following selection from Jamesine Friend's paper "Interactive Radio Instruction: Developing Instructional Methods".[1]

The Radio Mathematics Project in Nicaragua had several characteristics including the following:

- *The radio lessons were scripted as a 'conversation' between the radio characters and the listening groups. Student responses were frequent and varied in form, with oral responses predominating. (It is this feature that led to the term 'interactive.')*

- *Because most of the teachers were in one-room or two-room schools where they taught two, three, or even more grades, the radio lessons were written so that minute-by-minute supervision by the teacher was not necessary. Thus, during the radio broadcasts, teachers were free to work with students in other grades.*

- *To keep costs to a minimum, support materials were few and inexpensive.*

The Radio Language Arts Project (RLAP) in Kenya extended the IRI approach used so successfully with the Radio Mathematics Project.

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[1] Friend, J., "Interactive radio instruction: developing instructional methods," British Journal of Educational Technology, Vol. 20, No. 2, May 1990.

- *Recreational segments were integrated into the instructional content. Songs were used frequently and effectively for instruction. Game-like physical activities were often used to teach the vocabulary of body parts and actions verbs.*

- *The classroom teachers became partners with the radio teachers. For example, because of the cultural diversity in Kenya, teachers were asked occasionally to translate words or phrases into the local language. Teachers were also asked to point to words or sentences on the chalkboard as the radio teachers read them.*

- *The teachers' ability to work with the children during the radio lesson permitted the development of an entirely new radio teaching technique: the 'one-child' response. This way, everyone must be prepared, although only one child is called on to answer. Using this device the responses given by the children can be quite varied in both form and content, permitting the use of open-ended questions.*

The next project to take the interactive radio methodology further was the Radio Science Project. Although science can be taught as facts and vocabulary to memorize, a true understanding of the underlying concepts can be attained only if children are allowed to explore, observe, discuss, and think for themselves. In this way the important principles of science are internalized. For this kind of instruction in science, children must be given more latitude in what they do and how they express themselves.

One of the differences between the Radio Science Project and the RLAP lessons is that the answers to the science questions tend to vary much more. This presents two special problems to scriptwriters and to classroom teachers. First, it is difficult to allow an appropriate pause for the answer when one child might give a one - or two - word answer while another might give one or more complete sentences. To some extent, the length of the answer is determined by the phrasing of the question, so this is a challenge to the scriptwriters.

Second, reinforcement of the answer is difficult when there are many correct and nearly-correct answers to a question. With questions that are directed to one child at a time, the radio can provide only sample correct answers.

Another major challenge for the Radio Science Project is to develop methods for using materials and science equipment during the radio broadcast. Although some supplementary materials have been used by previous projects, their use has been limited, partly to reduce costs and partly because of the logistic problems that arise in the classroom when children are trying to work with concrete materials during the broadcasts. The wording of instructions for such activities and the timing of pauses for student participation are very difficult, and require much thought and field testing.

A useful technique used by the RSP is the sharing of scarce physical resources among several students. Instructions for such sharing are contained within the radio

programs, with clear identification of which student is to use the resource at a given time and when it is to be passed on the next student.

Although we usually think of science equipment and materials as things that are specially purchased and provided to classrooms, much science can be taught from simple materials that are found all around us. One variant is simply to ask the children to use their immediate environment as a resource--observing their own muscles and joints or looking at light coming through a window. What makes these exercises so challenging is that the immediate environment may vary so much from class to class, requiring great care in drafting scripts.

Another teaching technique used by the RSP is the simultaneous demonstration given by the classroom teacher. Although teachers have been asked in other projects to demonstrate simple actions, the science demonstrations used are more complex (and consequently more difficult to script) and require even closer teamwork between radio and teacher.

B. Teaching Science Content

Radio can do a good job of teaching science content to children. Content can be taught in interesting ways if programming is creative and well planned. The RSP explored the use of the following formats to teach content or information drama, riddles, songs, puzzles, story telling (Siba, the wise old science teller from the village), science activities done by the radio science teachers and the children, and conversations that include the radio science teachers and the radio children. These conversations are best when they involve some type of problem or investigation that the children or teachers are working on. The conversations can take many forms and can serve to introduce the listeners (both the children and the teachers) to ideas that can be carried out during the postbroadcast lessons. The conversations can include posing questions, talking about an activity, talking about what they have found, planning for an activity, and discussions while doing an activity.

C. Open-ended Question and Inquiry

One of the most challenging and interesting aspects of the Radio Science Project has been to develop ways of incorporating open-ended questions into the radio lessons. Open-ended questions are an important part of science teaching; these questions encourage students to think and to help them recognize that there may be more than one correct answer to a particular question.

The Radio Science Project has approached the challenge of encouraging inquiry among students by incorporating open-ended questions into the scripts. This has been done in three ways:

1. Thinking Questions With Response

The radio teacher asks the class to think about a question he or she has posed. The radio teacher then asks the classroom teacher to choose individual children to respond. The following is an example of this type of scripting technique:

Grade 6 Script Excerpt from Unit on Solutions

Mr. Tore: *Now children, think of something that we can list under insolubles.*

Thinking Music (:04)
Teacher Cue (:01)

Mrs. Poro: *Teacher, choose some children to name something they have thought of.*

Pause (:15)

Mrs. Poro: *Very good. You may have named things like; sand, sawdust, stones, wood or clay.*

This type of question asks children to pull together information. Earlier in the lesson, the students were taught the meanings of soluble and insoluble substances and were asked to give new examples of soluble substances after some examples were provided by the radio teacher. Then, the lesson asked the children what the opposite of soluble was and to give examples as shown in the above script segment. The students had to think about what they had learned about soluble and insoluble substances and to apply that information in order to generate examples.

2. Thinking Questions Without Response

Children can also be asked to think in their heads during a radio lesson and, instead of asking them to respond, the radio teachers and radio students model the process of inquiry.

Grade 6 Script Exerpt from Unit on Solutions

Mrs. Poro: *If you looked into this cup, you could see that all the sugar didn't dissolve in the tea.*

Mr. Tore: *Children, think about why all the sugar didn't dissolve. . Think about what will happen to the sugar that didn't dissolve...*

Pause (:04)

John: *Mrs. Poro why didn't all the sugar dissolve in the tea?*

Mrs. Poro: *John, that's a good question. You see John, there is more sugar and less water. That also means more sugar particles and less water space. When sugar particles had filled all the spaces, there isn't any more space left to dissolve any more sugar particles.*

Mary: *So what happens to the sugar that doesn't dissolve?*

Mrs. Poro: *Well, the sugar that doesn't dissolve gets wet but it just stays in the cup.*

In this lesson, the radio children show interest in the experiment and wonder out loud about what happened. The teacher takes the time to explain what happened. The emphasis here is on questions and answers that have more than a one-or two-word answer. The classroom children are asked to think about the problem, but are not asked to give an answer.

3. Quiet Discussion Among Pairs

A third technique for incorporating open-ended questions into the radio scripts is now being tried out in the grade 6 lessons. For this, the radio teacher asks students to discuss a concept quietly together in pairs. After an extended pause, the radio teacher then comes back and asks the classroom teacher to call on the different groups to report on their discussions.

It is very important for each of the above techniques, that instructions for students and teachers are simple and clear.

D. Using Hands-on Materials

Science education should include opportunities for children to learn from working with simple materials. The extent to which materials form the basis of the curriculum can vary considerably from one approach to another. The Radio Science Project believes that experience with hands-on materials is important, but that it need not dominate the lessons. Ideally, programs should ensure that opportunities for children to learn from materials should occur both during and following the radio broadcast.

1. Using Materials During Radio Broadcast

Although simple materials have been incorporated into the radio lessons in earlier IRI projects, this has been done only occasionally. For example, the Radio Mathematics Project in Nicaragua had the grade 1 children use simple counters (such as bean seeds) to help them learn simple arithmetic such as counting, and basic addition and subtraction. A challenge for the RSP has been to increase the complexity and sophistication of activities that incorporate simple materials.

We have found that it is possible to incorporate a wide variety of experiences with hands-on materials. The radio can give instructions directly to the children; the radio can give the classroom teacher instructions on demonstrating materials; and the radio can help teachers give step by step instructions to the classroom children. The following scripts provide examples:

a. Pairs of children with mirrors

Grade 4 Script Excerpt from Unit on Light

Mrs. Laka and Mr. Vagi are the Radio Science teachers. Pairs of children have mirrors.

MRS. LAKA: *Children, in this exercise you will continue to use your worksheet. You will also need your mirrors. Get your mirrors now.*

PAUSE (:03)

MRS. LAKA: *Now you're going to work in pairs. You are going to work with your partner.*

PARTNER SONG (:15)

MRS. LAKA: *Partners, place your worksheet between you.*

PAUSE (:02)

MRS. LAKA: *The child on the left of the worksheet is Partner A... The child on the right of the worksheet is Partner B. Partner A, raise your hand.*

PAUSE (:02)

MRS. LAKA: *Put your hand down... Partner B raise your hand.*

PAUSE (:02)

MRS. LAKA: *Put your hand down. Partner A, say after me: I'm on the left side.*

PAUSE (:04)

MRS. LAKA: *Partner B, say after me: I'm on the right side.*

PAUSE (:04)

MR. VAGI: *Partner A you will use the mirror first. Partner B your turn will be next... Partner A, look at yourself in the mirror... Smile... Make a funny face... Close your left eye... Open it... Now close your right eye... Open... Look at yourself and touch your right ear with your hand... now touch your left ear... Put your hand down.*

At this point, Partner B tries the exercises and the lesson continues as follows:

MR. VAGI: *Partner A, look at the mirror Partner B is holding... Can you see Partner B in the mirror?*

PAUSE (:02)

MR. VAGI: *Put your mirrors down.*

PAUSE (:03)

MRS. LAKA: *We can see each other in the mirror because light bounces off the mirror. The light then goes to our eyes from the mirror.*

Discussion

There are a couple of interesting aspects of this example. First, one mirror is supplied to every two children in order to minimize the cost of equipment. Second, we are able to script the lesson so that the two children actually collaborate on an activity.

b. Open ended activity with electricity

Grade 4 Script Excerpt from Unit on Electricity #1

Mrs. Poro and Mr. Tore are the Radio Science teachers. Pairs of children had a torch battery, bulb, a piece of bare copper wire, and a page from the Radio Learning Book.

Mrs Poro: *Children, now we're going to do a group activity. Take out your Radio Science Book page fifty three... Look at Box One...You will see a wire, a torch bulb and a battery.*

Mr. Tore: *You should have a wire, a torch bulb and a torch battery in your groups.... Use the torch battery and wire to light the torch bulb. See if you can get the torch bulb to light with the torch battery and wire. Take your time, share and help each other.*

WORK MUSIC (:45)

Mr. Tore: *Children stop... Hands up for the groups that got their bulbs to light.*

PAUSE (:02)

Mr. Tore: *Hands down... Let's try again. Be sure to work together. Help each other. See if you can get the torch battery and wire to light the bulb.*

WORK MUSIC (:45)

Discussion

The response to this activity is typical of the response to many of our activities, and illustrates a major problem area. The children quickly become so engaged trying to solve the problem with the materials, that they stop paying attention to the radio. One of the difficulties is that there is a great variation in the time it takes different children to complete the activity; this makes it extremely difficult to script well. Yet the scriptwriters time their pauses taking into account their best estimates (based in part on field tests) of the time it takes for most of the children to complete the activity.

Using audio-cassettes instead of radio broadcast lessons would be one way to solve the problem of children who need extra time to solve problems. See the discussion on page 29 for ideas on how audio-cassettes could help to address these problems.

c. Structured approach with electricity

Grade 4 Script Excerpt from Unit on Electricity

The following example shows a more structured approach towards lighting the bulb with the teacher giving a demonstration.

Mrs. Poro: *Look at your teacher. Teacher, you should have a torch battery, a wire and a torch bulb.*

TEACHER CUE (:03)

Mrs. Poro: *Teacher, wrap one end of the wire around the torch bulb like Letter A in Box Two of the Radio Science Book.*

PAUSE (:10)

Mrs. Poro: *Put the bulb on top of the torch battery like Letter B in Box Two.*

PAUSE (:05)

Mrs. Poro: *Teacher, touch the other end of the wire to the bottom of the battery, like in Box 2, Letter C.*

PAUSE (:05)

Discussion

The script continues by having the children follow the teacher once again as lighting the bulb is demonstrated. There is less discovery in this approach, but greater structure seems to work better with the radio in this case. Also, this example illustrates another important methodology of the IRI that the classroom teacher is a full partner with the radio teacher.

d. "Dry lab" technique

Recognizing that the cost and distribution of materials may be prohibitive for many schools, the grade 5 lessons use what the Project refers to as a "dry lab" approach to presenting science activities and experiences. Activities from the grade 5 community school teacher's guide for science were scripted into the radio lessons. The radio science teachers and the radio science children participated in the activities during the broadcast lesson and the classroom teacher was directed to repeat the activity in the postbroadcast lesson. This "dry lab" approach reduced the potential problems of conducting materials-based activities during the class when some teachers may not have those materials, yet it gives the classroom children and teacher the opportunity to mentally practice the activity before actually carrying it out after the broadcast. The approach often worked well, but there remained a problem of getting teachers to do the activities during the postbroadcast period, usually because they did not have the materials.

Grade 5 Script Excerpt from Unit on Soils

MRS PORO: *Mary, earlier we were looking at your garden soil. Now I want you to put some of it back in the jar.*

FX: SOIL PUT INTO A JAR

MRS PORO: *That's enough Mary.*

MR VAGI: *Now Peter, pour water into the jar until the jar is almost full.*

FX: POURING WATER INTO A JAR

MR VAGI: *Ok stop.*

MRS PORO: *Now put the lid on the jar.*

FX: NOISE OF PUTTING THE LID ON THE JAR (:05)

MRS PORO: *Now John, shake the jar.*

FX: SOIL SHAKING IN A JAR

MR VAGI: *Stop. Now put the jar on the table and watch carefully to see what happens inside the jar.*

FX: PUTTING JAR ON THE TABLE
TIME MUSIC BRIDGE

MRS PORO: *We've been watching the jar for about seven minutes. What did you observe, Mary?*

MARY: *Wow! Look at that... The soil came apart in the water. And then it made layers below the water.*

MR VAGI: *That's right, you can see layers of different things.*

MRS PORO: *John, what can you see in the jar?*

JOHN: *I see plants floating on top of the water in the jar.*

MRS PORO: *That's right John. Those pieces of dead plants are called plant matter. Children, say: Plant Matter.*

PAUSE (:03)

MR VAGI: *What do you see Mary?*

The script continues with John and Mary discussing in more detail what they see in the jar. As the lesson ends, the radio teachers ask the class to continue the activities after the broadcast.

MRS PORO: *Children, you will continue working with your teacher after the broadcast by collecting different soils outside.*

MR VAGI: *You will test your soil like Peter, John and Mary did with Mrs Poro and me.*

Discussion

The series of lessons on soils presents increasingly more sophisticated "dry lab" activities including the use of graphs to represent their data. The radio characters can demonstrate to both the classroom teachers and children just how an experiment is to be done. These lessons provide a model to help ensure a successful postbroadcast activity.

2. Using Materials with Post-broadcast Activities

The RSP relies on teachers to conduct post-broadcast activities. Sometimes these activities just review the content of the radio lessons. At other times the activities are a direct extension of exercises begun during the broadcast. Other times the suggested activities are different from what is included in the broadcast. We would rely on the post-broadcast period, for example, to do activities that must be done outside the classroom or to do experiments that require materials or equipment that might not be readily available and, thus, not appropriate for inclusion during the broadcast.

The following excerpt from the Notes for the Teacher is from Grade 5, Lesson 17, the same lesson referred to in the previous section. This is an example of an activity that is a direct extension of the radio lesson.

CONCLUDE THE POST-BROADCAST LESSON:

1. Collect different kinds of soils and let the children examine them. Ask them to see what they can find in the soils.

* *Are there living things in the soil?*
* *Are there things which were once alive in the soil?*
* *Are there things that were never alive in the soil?*

2. Do the activity outlined on pages 100-101 of the Teacher's Guide For Grade 5 Science. You can start the activity during the postbroadcast lesson and let the children make observations of the jars and soils later.

3. Use of Science Kits

One problem with virtually all hands-on activities is that, at times, the classroom teacher may not provide the required materials. Sometimes teachers even had difficulty providing locally available materials. For example, the right kinds of grasses might not be found or it may be difficult to make hot water. Even when the materials are available, the teachers may fail to distribute them. Project staff have also observed that

when materials are distributed, sometimes teachers don't help the children use them correctly.

The RSP would like to develop a science kit for the units on sound, light, heat, and electricity. The cost of this kit would be about $35 per classroom, well below the existing kits that costs about $230. The kit is important because many of the activities in these units require special materials. Even if the activities during the radio broadcast do not require the materials, the RSP wants to encourage teachers to carry out the activities during the post-broadcast period.

The RSP believes that it is appropriate to include activities that require simple, locally available materials. But given the unreliability of maintaining science kits, activities that require materials that are not readily available should not be required during the radio broadcasts. Such activities should be restricted to the post-broadcast period. The experience of the Project shows that radio lessons can be written that involve children in hands-on materials (involving either children or the teacher). Yet even when simple materials are called for, the teachers in Papua New Guinea had problems collecting them for the lessons. The problem of involving children with hands-on science activity by radio is not the writing of lessons (although good scripts are not easy to prepare), but it is the supply and distribution of materials that support the activities in the lessons.

As another safeguard for situations in which the materials are not available, the Project has generally provided backup support in the form of drawings on the student worksheets as well as in the Notes for the Teacher.

The worksheets and Notes (see examples in Appendix III) can be useful in several ways to assist in science teaching. They can provide details about a particular science activity that supplement the radio broadcast, and give students and teachers a clear visual picture of something they are unfamiliar with. The worksheets and Notes can also provide graphics to help students make comparisons between similar objects or living things. Finally, the worksheets are often referred to in the lessons by the radio teacher so that students can follow along with explanations.

E. Potential Use of Audio Cassettes

Throughout the history of IRI, the relative advantages of cassettes vs. radio have been argued. It seemed that there might be pedagogical advantages to presenting science lessons by cassettes; thus, the RSP developed outlines for eight lessons on electricity, plus three scripts of radio lessons for children and three scripts of radio training lessons for teachers.

As noted earlier in this report, one of the problems encountered when we ask children to use materials during the broadcast is that the children become so engrossed in the activity that they stop paying attention to the radio. In addition, the amount of

time it takes the children to solve a problem with the materials varies greatly, so it is difficult to establish the length of the pause during which the children try to carry out the activity. Further, the Project would like to present children with some activities that require a much longer time to carry out than can reasonably be allowed in a radio broadcast. An activity that addresses all of these issues would be to give the children a torch battery, a bulb and some wire and ask the children to light the bulb.

The main advantage of using cassettes for this type of activity is that the teacher can turn off the cassette recorder once the children have received their instructions. After most of the children have discovered how to light the bulb, the teacher can then turn on the tape again so that the lesson can continue. The following is an excerpt from a draft script on batteries and bulbs. The task for the children is to light the bulb. The lesson begins with preparation activities including organizing and naming the materials, and getting the groups of children ready to begin the first task.

SEGMENT 1 - MAKING A BULB LIGHT

Mr. Tore: *The first activity will be to light the bulb using only the materials in the bag. I am not going to show you how to do it. You will have to figure that out for yourselves. I will give you plenty of time. When the first person has lit the bulb, pass the materials to the person on the right so that person can try lighting the bulb. As each person lights the bulb, pass it to the next until the materials come back to the first person again.*

TEACHER CUE

Mr. Tore: *Teacher, turn off the machine and let the children begin to light the bulbs. They may find it difficult, but give them time and encourage them to help each other.. be sure that each child passes the materials on to the next person. You should walk about the room to encourage and to help them. When all the children have lit the bulb, turn the machine back on. If the children are still having trouble after five or six minutes, turn the machine back on, even if not everyone has had a turn. Start now.*

PAUSE

This lesson continues with many other activities, each a bit more sophisticated than the last one. Many of the activities that follow are more structured than the one excerpted above.

Cassette tapes also offer several advantages for teacher training. For example, in the sample lessons on batteries and bulbs for the teachers, teachers are asked to carry out the same activities as those included in the children's broadcast. The teachers need ample time to try the experiments and should not be pressured. Thus, they can turn off the recorder, complete the exercise at their own pace, and then continue the lesson when they are ready.

A key element of these training lessons is that the suggestions and activities are directly related to what the teachers and children are to do in the classroom. The lessons encourage teachers to try out many of the experiments that would be asked of the children, for example, lighting a torch bulb using a battery, bulb and wire. Not only will teachers be given the opportunity to try out some of the activities ahead of time, they will also be given some guidance in pedagogy. The training lessons alert the teachers as to what to expect of the children, the kinds of problems and questions that are likely to arise, and how the teachers can respond. Some of the factual information is to be provided by a short booklet to accompany the cassette tape. The scripts attempt to provide models for how to:

- give clear directions
- organize materials and establish procedures to promote efficient work by groups of students
- anticipate what children will do and respond appropriately
- focus the attention of a class on one particular issue
- promote the willing participation of students
- use hands-on experience as the basis for didactic lessons
- alternate hands-on and didactic lessons
- determine if children understand directions
- correct children's errors in ways that are supportive
- encourage children to take intellectual risks, to speculate, guess, etc.

An advantage of using cassettes is that the teachers can choose the time and place that is most convenient to listen to the lesson. Also, the lessons can be written in a way to permit each teacher to turn off the recorder for a period of time while he or she carries out the activity.

The following is from the first lesson for the teachers on batteries and bulbs.

SEGMENT 2 - MAKING A BULB LIGHT

Announcer: *Lesson #1 introduces students to electricity by asking them to light a bulb using only one battery and one piece of wire.*

They love doing this, but many find it difficult at first. As you might expect, there is a good deal of talking and noise, but as long as this talking is about lighting a bulb, we think it is appropriate. It is important that all students get a chance to do each activity, not just the most aggressive or assertive students. You can help make this happen by seeing that each group has adequate space in which to work, that groups are separate from each other and don't bump into each other, and that you give them clear directions before the lesson starts.

Your directions should emphasize that you want them to cooperate with each other, help each other, and take turns. As you know too well, when children are excited, they will often forget these things. You should not hesitate to turn off the tape and provide more direction if you think it is needed. You can do this at any time during the lesson when you wish to answer childrens' questions, quiet them down, or draw their attention to something interesting that has happened. You are still the teacher of your class. The cassette in only your assistant.

Many teachers wonder why we are emphasizing a style of teaching that requires students to do these activities rather than just read about them or hear about them. After all, these activities take considerable time, and the needed materials are expensive and troublesome to obtain, store, distribute and maintain.

Teachers who have used these methods in many countries say that when the children actually do science and carry out their own activities, they remember much better. Their improved remembering is probably because students find doing science more interesting; they are involved and participating, not merely listening. Furthermore, teachers who have used these methods say that children begin asking interesting questions and, if encouraged, they begin trying to find the answers by themselves. As a teacher, you know how important such results are and also how hard it is to achieve them. Because science is essentially the asking of questions and the seeking of answers, teaching children to do science is the best way to teach them science.

PAUSE

Announcer: *The first activity will be to light the bulb, so you must be sure that each group of children has the needed materials. Some students may not know the words bulb, battery, and wire.*

Without telling them the words, hold up the materials in front of the children and ask them to name the materials. .....(The lesson goes on briefly to give suggestions re. the new words and obtaining the necessary equipment)

In the actual classroom lesson, the radio teacher Mr Tore will say to the class "With the materials you have in the bag, make the bulb light."

You should try doing that now with your own bulb, battery and wire. Turn off the machine and try. When you are ready to resume, turn the machine back on.

PAUSE

Announcer: *Welcome back. Were you able to make the bulb light? My guess is you probably did it by putting the bulb, battery and wire together as shown in Box 1. Most people do. But there are other ways to do it too. Why don't you turn off the machine again and see if you can find at least two other ways to put these three things together so that the bulb lights.*

PAUSE

Announcer: *Were you successful? Did you find two new ways or only one? Many people find it easy to discover one new way, but not many find two. Look at Box 3. Did you think of putting the bulb on its side? If you didn't light the bulb in these two new ways, turn off the machine now and do so. While you are at it, see if you can find a fourth way as well. I won't tell you what it is though. You'll have to discover it by yourself. Try it now.*

PAUSE

In spite of the many advantages to using audio cassettes, it should be noted that in every country where the issue has been raised of presenting IRI lessons by cassettes versus radios, the final decision has been to use radios. This is because using radios is less expensive than using cassettes to deliver lessons. To make copies of cassettes for each school is expensive as is the delivery of these materials to the schools. In addition, the tapes may be damaged or may jam the recorder on occasion. Also, cassette recorders require considerably more power than a radio and, thus, the cost for battery replacement is much higher. In terms of pedagogy, radio scripts can break down the broad activities into smaller, more structured components improving lesson effectiveness. Finally, radio may be important in that it imposes a pace to the lessons. The teachers

and children can't get behind as long as they continue to listen to the broadcasts. The teachers know that the broadcast is only given once, and that they don't want to get behind. With cassettes, though, teachers can choose to postpone lessons, with the consequence that they are less likely to complete the full set of lessons in a year.

Nevertheless, the potential pedagogical advantages of tapes are significant, especially in a discipline such as science in which one would like to give children the occasional opportunity to carry out experiments in a semi-structured way. It may be worthwhile to develop a cassette-based series of lessons for a topic and test their use with students.

VI. EVALUATION OF THE GRADE 4 LESSONS

The summative evaluation of the Radio Science Project Grade 4 materials took place in the East Sepik Province (see Figure 1). The East Sepik Province is located in the northwestern section of Papua New Guinea. The province is traversed by a long range of coastal hills that run east to west across the province.

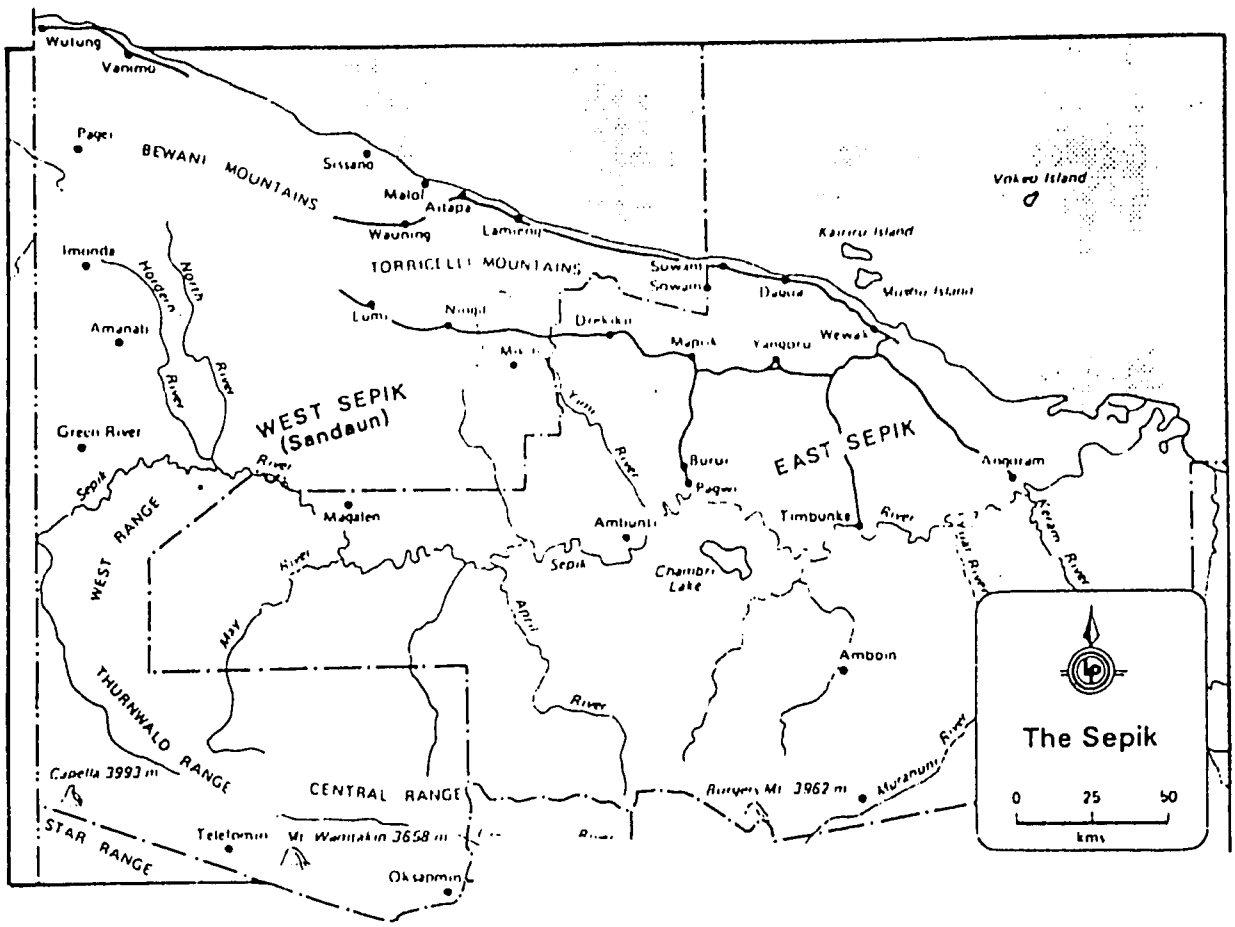

Figure 1

The Sepik

North of the hills is a long coastal plain that bounds on the Bismarck Sea. South of the rolling hills, the land slopes down into the lowlands of the Sepik River basin. The Sepik River is one of the world's largest rivers. Its river basin is the center of artistic activity in the country.

Like many provinces in PNG, the East Sepik is rural in nature. Only along the Bismarck Sea coastline is there a fair-sized town which is Wewak, the capital. Also, like many other provinces, the rural population is very diverse. They speak a number of languages and are organized into many tribal groups.

The Radio Science Project selected the East Sepik Province for its summative evaluation because of several factors including its economic status, diversity of population, rural nature, and educational situation.

The economic condition of East Sepik is poor compared to other provinces in the country. This is due in part because early Australian administrators ignored the province because it was so remote and had little economic appeal. Further, the occupation of the area by the Japanese during the Second World War stopped economic growth during the war years and for many years beyond the war. Since independence, more attention has been given to the province, but economic growth is still slow. Related to the poor economic situation in East Sepik is a law-and-order problem and below average achievement scores in the schools.

Of late, however, educational authorities in PNG have been willing to investigate the use of innovations to improve educational quality in the East Sepik. In November of 1987, the Assistant Secretary for Education approached the RSP requesting that the Project consider using schools in the province as test sites. After a series of discussions with the Assistant Secretary and other education officers, Project staff decided that the province would be a good place to conduct its summative evaluations.

The first year of summative evaluation in the East Sepik Province went very well. The education officers in the East Sepik Department of Education were helpful in making arrangements to aid Project staff in the testing of children, operation of training sessions, and the distribution of materials. There was a high level of excitement and enthusiasm from the teachers during the training workshops. This commitment was also noted when the Project did the grades 4 and 5 testing in the schools in November of 1989.

Radio East Sepik was very cooperative in the scheduling and broadcasting of the summative programs. Radio reception in the province, however, still remains a problem. The construction of antennas helped reception somewhat, but most schools still had problems. Despite these problems, most schools continued to use the lessons. Only one school reported not using the programs at all because of poor reception.

A. School Selection

Selection of schools for the evaluation was based on the following considerations:

- Geography of the region: ease of access to schools
- Network of roads: related to geography and weather
- Weather: wet and dry season

- All schools with established grades 3 and 4 classes in 1988
- Class size in grades 3 and 4
- Schools from government and church agencies

Unfortunately, problems of access prevented the Project from using a completely random sample of the schools in the province. Since the RSP office is in Port Moresby, the nation's capital, staff can only spend a small amount of time in East Sepik each year, making it important to have schools that are relatively accessible. It was determined, however, that the selected schools are relatively typical of the entire province.

B. Development of the Grade 4 Science Posttest

A pool of about 40 items for the test was written early in 1988. About 30 of these items were finally incorporated into the final version, with appropriate modifications in vocabulary and format. In addition to the type of multiple choice items present in the final version of the test (see Appendix II for a copy of the test), the preliminary version also contained a number of open-ended, short-answer items. When the pre- liminary version was field tested in schools in the Port Moresby-Central Province area, it became clear that the open-ended items were impossible to score. The combination of non-standard handwriting, creative spelling, and free use of miscellaneous symbolism defeated our attempts to set up scoring criteria for these items. Subsequently these items were either eliminated or redesigned in a multiple choice format. We also experimented with a few multiple choice items with more than one correct answer (e.g. Circle all the mammals...), but these also proved to be too difficult, and were revised so that they only had one correct answer. In general we found that, with a few minor modifications, children were able to follow the instructions and were not confused by the format of the test. The time allotted, about 40 minutes, also proved to be adequate. The final version of the test, as subsequently administered in East Sepik, is shown along with the written instructions in Appendix II. The test administrators were trained to work through the instructions along with the children in the classrooms.

Test items were designed to satisfy two main criteria. They are as follows:

A. The items on the test covered the entire Papua New Guinea official grade 4 science curriculum. The relative number of items on each topic reflects the amount of instruction time assigned to each topic during the year.

B. The difficulty of the items was controlled so that most of the items on the test were correctly answered by between 30 and 70 percent of the children. For this type of evaluation, in which we are trying to discover the difference (if any) between control and experimental groups, this is the range of item difficulty that provides maximum discriminatory power. A few items that were more difficult or easier were left in to provide a complete range of difficulty. In general, there was a problem in trying to cover the entire curriculum, as many of the items that naturally occurred to us proved to be too difficult.

Table 1 shows final scores in East Sepik for each item.

Table 1
Item Scores by Treatment

Item	Percentage Correct Control	Experimental
1. Which is a living thing?	69.1	81.9
2. Which needs electricity?	51.3	65.2
3. Which is a mammal?	17.4	24.7
4. Which can light travel through?	36.1	53.3
5. Which animal has feathers?	67.9	80.0
6. Which animal has scales?	32.5	33.3
7. Which can a magnet pick up?	51.1	68.8
8. Which is true about tadpoles?	27.4	26.7 (d)
9. Circle the seashore animal.	80.1	77.0 (d)
10. Which can electricity pass through?	18.5	33.3
11. Which is true about heating a wire?	33.4	23.6 (d)
12. Which is true about heating air?	24.7	34.5
13. Which allows the most light to pass through?	55.8	62.1
14. Which is true about how light travels?	53.1	61.7
15. Which is true about rainbows?	63.4	65.6
16. Which animals are most closely related?	39.3	40.7
17. Which is true about plants?	25.7	41.3
18. Which bulb will be brighter?	59.6	72.4
19. How do you make the shadow larger?	51.4	58.5
20. What does a string telephone tell us about sound?	17.6	14.1 (d)
21. What happens to the magnets?	24.7	16.1 (d)
22. Which is a human bone?	46.4	46.2 (d)
23. What do spiders eat?	41.5	45.4
24. Which is true about how sound travels?	18.5	13.8 (d)
25. Where does the bird of paradise live?	68.4	81.6
26. Which animal lives in the rain forest and seashore?	40.7	44.2
27. Which color do you get by mixing blue and yellow?	21.7	22.3
28. Why do we need joints?	69.1	73.8
29. What happens to water when it is heated?	38.9	34.3 (d)
30. What happens to light when it hits a mirror?	36.4	51.2

(d) indicates decline in score from control to experimental group.

C. Design of the Summative Evaluation

Because the three years of the Radio Science lessons are designed as a continuing course, with each year of instruction prerequisite to the following year, the evaluation is a longitudinal study of the cumulative effects of instruction. This means that Grades 5 and 6 are not evaluated independently but only in the context of a continuing series. There will be three evaluations conducted, but these will not be separate evaluations of the three grades. Instead the three evaluations will be of:

Grade 4
Grades 4 and 5
Grades 4, 5 and 6

There will be a comparison made with the children who take the Radio Science lessons with a group of children who are receiving the kind of science instruction that is now commonly given in Papua New Guinea schools ("conventional instruction").

In order to control teacher, school, and community variables the children in the two groups mentioned above are drawn from exactly the same schools. The plan is to select two cohorts of children from these schools. One of these cohorts consists of all of the children who start Grade 4 in 1988, and the second cohort are those children who start Grade 4 in 1989. The schedule for the involvement of each cohort is as follows:

	Cohort 1 (conventional)	**Cohort 2 (experimental)**
1988	Grade 4	
1989	Grade 5	Grade 4
1990	Grade 6	Grade 5
1991		Grade 6

As can be seen from the above schedule, this kind of "lapped" design with two cohorts each followed for three years requires a total of four years to complete.

Because these two cohorts are from the same schools, they are quite similar in many respects: the children, who are just one year apart in school, have very similar educational backgrounds, come from the same socioeconomic class, live in the same community, have similar language skills, and so on.

Ordinarily it would be expected that children one year apart in the same schools would have the same fourth-grade teachers, but teacher turnover in Papua New Guinea is so high that confounding teacher variables may not be well-controlled in this experiment.

A diagrammatic schedule of evaluation activities is shown in Figure 2.

	Cohort 1	Cohort 2
1988	Conventional Instruction for Grade 4	
	Posttest 4	
1989	Conventional Instruction for Grade 5	Radio Science Lessons for Grade 4
	Posttest 5	Posttest 4
1990	Conventional Instruction for Grade 6	Radio Science Lessons for Grade 5
	Posttest 6	Posttest 5
1991		Radio Science Lessons for Grade 6
		Posttest 6

Figure 2

Schedule of Evaluation Activities

D. School and Student Population Characteristics

Of the 27 schools in the sample, 23 are in the rural areas and four are in or near Wewak, the province's only urban area. Of the four in the Wewak area, two are classified as urban and two as semi-urban. Three of the 23 rural schools are classified by the Papua New Guinea government as remote rural. Most of the schools are relatively large by rural standards, as the national policy has been to build bigger schools further apart. None of the schools in the sample are multi-grade, as all of them have at least six teachers and classrooms. This is typical of Papua New Guinea as a whole, which has very few multi-grade schools. The sample includes government schools (9), Catholic mission schools (12), and Evangelical mission schools (6), which is also a typical mix for East Sepik Province. In general, the differences among these three types

of schools are not great; in all of them the teachers are paid by the Ministry of Education.

Since in Papua New Guinea there is equitable access for girls in the community schools, half of the students in both control and experimental groups are girls. The vast majority of students at the end of Grade 4 in this sample are 11 or 12 years old, with 12 being the modal age. Age data are not very reliable in Papua New Guinea; many children do not know their age, and we had to rely partly on teachers' records, which are probably not very accurate either.

See Table 2 for a summary of pertinent characteristics of the sample population.

Table 2
Treatment Population Characteristics

	Control	Experimental
Number of Schools	27	27
Number of Students	691	579
Percentage Female	49.8	49.6
Number of Students of Each Age		
9	6	9
10	64	89
11	198	148
12	228	204
13	71	58
14	17	23
15	5	8
16	0	1
17	0	1
Missing Data	102	38

E. Results

The basic test results are shown in Table 3. The mean score for the experimental group was 46.5 percent overall, compared to 41.5 percent for the control group. The effect size is .36, which is quite impressive for a low cost intervention, with only two 20-minute radio programs per week. Using analysis of variance, we get a value of $F = 24.45$, which makes the difference of the means significant at the $p < .001$ level.

In any field experiment of this kind, the observed difference between experimental and control group may be due to factors other than the treatment itself. For example, if older students ordinarily learn more and the sample is skewed so that there are a disproportionately large number of older students in the experimental group, then the better results for the experimental group might be entirely caused by the difference in age and not by the experimental treatment itself. To investigate this possibility, factors that were found to be correlated with scores were further investigated. These factors include: student's age, student's gender, and teacher's experience. Using a step-wise linear regression, the effect of each of these variables was taken into account before the treatment variable was entered. This analysis confirmed that there is a significant difference ($p < .01$) in favor of the experimental group, and that this difference is not attributable to extraneous factors.

The test can be broken up into two parts: 13 questions on biological science and 17 questions on physical science. For both subject areas, the radio programs produced positive results, with the achievement gain being slightly larger for the physical science part of the test. Many discussions with community school teachers have revealed the fact that most of them feel unsure of themselves in teaching physical science, and consequently, this is a neglected subject at the community school level. The teachers have been particularly appreciative of the Radio Science Project's efforts to introduce physical science activities into the classroom. The largest gains were registered in the areas of light and electricity-magnetism, which are given more time in the Papua New Guinea grade 4 science curriculum than heat and sound. Individual item results for every item on the test are shown in Table 1. (The items are only indicated in an abbreviated form in Table 1; the full test is shown in Appendix II.) Of the 30 items on the test, the experimental group performed better on 22, while the control group did better than the experimental group on the remaining eight items.

Table 3
Test Results by Treatment

	Control		Experimental	
	% Correct	SD	% Correct	SD
Total Test (30 items)	41.5*	14.0	46.5	15.1
Biology (13 items)	47.3	17.2	51.6	19.1
Physical Science (17 items)	37.0	15.4	42.5	15.5
Electricity-Magnetism (5 items)	39.5	21.7	50.1	21.5
Light (7 items)	45.2	22.6	52.3	22.9
Heat (3 items)	32.2	28.0	29.8	26.0
Sound (2 items)	18.0	27.8	13.8	23.9

* Effect size = .36
F = 24.45, difference of means between experimental and control group significant at $p < .001$

Table 4 shows how the different types of schools did on the test under both conditions - traditional science teaching and the new radio programs. In both years, the Evangelical schools scored the highest, followed by Catholic schools, with government schools having the lowest scores. The radio science programs consistently improve results in all three types of agency schools.

In regard to location of schools, it is more difficult to interpret the results, as the distribution of the schools is very uneven. There are only two or three schools in each of the remote rural, semi-urban, and urban categories, with only about 40-60 students in each category. This means that one particularly good or bad teacher can influence the result unduly. In general, the experimental group scores better than the control group in all locations except semi-urban. There is no obvious trend as we go from rural remote to urban.

Table 4
Test Results by Type/Location of School

School Type	Control % Correct	Control SD	Experimental % Correct	Experimental SD
Government (9 schools)	37.6	13.6	44.4	14.8
Catholic (12 schools)	41.7	13.7	46.6	16.0
Evangelical (6 schools)	46.3	13.5	49.2	13.3
Remote Rural (3 schools)	41.4	15.5	42.0	15.4
Rural (20 schools)	40.7	14.0	45.8	14.8
Semi-Urban (2 schools)	49.1	10.7	47.7	13.3
Urban (2 schools)	43.4	12.6	55.9	15.5

A complete list of results for every school in both control and experimental years is given in Appendix II. Science test scores improved during the experimental year in 21 of the 27 schools; in the remaining six schools, scores went down. The radio programs appear to be effective in the full range of schools; in both the best school (Wingei) as well as the worst school (Hiesi) scores improved during the experimental year. It should be noted that the radio programs were NOT used (due to the problem of radio reception) in Handara school, which is one of the six schools where results went down.

Table 5 shows the test results for students by age and sex in both control and experimental schools. In both the control and the experimental group, the boys scored significantly higher than the girls on the science test. It is interesting to note, however, that in the experimental group the gender gap has lessened somewhat. In the control group, the difference between boys and girls is 6.1 percentage points, whereas in the experimental group it is only 4.0 percentage points. In other words, although students of both sexes benefitted from the radio programs, the girls benefitted relatively more than the boys.

The trends for performance as a result of age were quite similar for both control and experimental groups. In both groups, the highest scores were obtained by the 12 year old students, which is the modal age for our populations. The experimental group's scores were higher than those of the control group at every age between 10 and 14, which were the only ages represented by more than ten students. Within this range, the

radio programs seemed to be most effective at the ages of 10, 11, and 14. There were only about twenty 14 year old students in each group, so the result for that group might not be significant. However, in both the 10 and 11 year old groups, there were relatively large numbers of students (see Table 2). Thus, it is clear that the programs are quite effective for younger students.

Table 5
Test Results by Student Age/Sex

	Control		Experimental	
	% Correct	SD	% Correct	SD
Sex				
Male	44.5	14.2	48.4	15.8
Female	38.4	13.1	44.4	14.2
Age				
10	37.8	12.1	45.1	15.2
11	39.6	13.3	46.4	14.6
12	45.7	13.9	47.5	15.9
13	44.8	13.3	45.1	13.6
14	41.9	11.9	47.1	13.5

Conclusions

1. The experimental group (science by radio) did better than the control group (traditional science teaching). Teaching science by radio is effective.

2. The gender gap was narrowed in the experimental group. The difference between boys and girls was higher in the control group than in the experimental group.

3. Programs were effective at all ranges of age. The highest scores were obtained by the 12 year old students. The experimental group's scores were higher than those of the control group at every age between 10 and 14.

4. Test instructions were understood by virtually all children. Both the experimental and control group had a small number of blank answers. Almost all children finished the test.

5. The radio programs were effective in both the biological and physical sciences, but slightly more effective in the physical sciences.

6. The experimental group scored better on 22 of 30 test items. These were spread across the whole curriculum.

7. The experimental group scored higher than the control group in all types of schools: government, Catholic, and Evangelical.

8. The radio programs were effective across a wide range of locales--remote rural, rural, and urban.

9. 21 of 27 schools in the experimental classes performed better than the control classes from the same school.

VII. INSTITUTIONALIZATION

The Project has been successful in developing support for its programs at a variety of levels. Evidence of this success at the grassroots level is that in 1990 the programs reached approximately 9,000 students. Further, participating teachers and headmasters have expressed a great deal of enthusiasm for the programs.

At the national level, final government approval for the optional use of the radio science lessons by teachers was obtained in May, 1990. The Board of Studies agreed to begin broadcast of Radio Science lessons for grade 6 in 1991, grade 5 in 1992 and grade 4 in 1993.

At the same meeting, it was also agreed that a national broadcasting committee would be reestablished to help assess programming priorities for the National Broadcasting Commission.

Important and as yet unresolved issues related to national implementation are who will provide the financial resources necessary for printing teachers guides and student worksheets, and who will provide inservice teacher training to instruct the teachers in the use of the lessons. It may be possible to provide the necessary training within the context of existing NDOE training programs and resources.

Education Development Center and the Government of Papua New Guinea signed the agreement for the Radio Learning Project. Because this agreement was not between the governments of PNG and the U.S., and because of the timing of this agreement, the Radio Learning Project was never listed as part of the PNG capital development budget. Consequently, recurrent expenses were not planned for. Both the former and current Project Directors have worked with the government officials to try to get the RSP listed as a capital development activity, but without success to date. Nevertheless, in early 1990 some key NDOE officials have been working to identify funds from other capital projects that could be reallocated to the RSP.

The following is a summary of Project activities that were carried out with the intention of developing support for official acceptance of the RSP lessons as an option for teachers.

Ministry of Education Briefings

The Project Director has met periodically with the Minister of Education to inform him of the progress of the RSP. As a result of these meetings, a former Project staff officer was appointed to the National Board of Education. This board has the task of studying and recommending all changes in education policy and program to the Minister of Education and the Prime Minister.

Secretary of Education Staff

Once a year the Director attended the Secretary of Education's staff meeting to inform him and his associate secretaries of the Project's activities. The Director also met with the Secretary of Education, the Deputy Secretary of Education, the First Associate Secretary for General Education, and the Associate Secretary of Curriculum on a regular basis to keep them informed of Project progress.

Advisory Committee

The Project's Advisory Committee is composed of representatives from the National Department of Education, Central Province and the National Capital District Education Department, U.S. Embassy, USAID Mission Office, Officers of the NDOE Curriculum Division, the University of Papua New Guinea, the Port Moresby In-Service College, the National Broadcast Commission and headmasters and teachers of the schools involved with the Project. The committee has met approximately three times a year to review Project activities. The committee was heavily involved in advising the Project in strategies that would insure future institutionalization of materials developed by the RSP.

Sub-Committees of the Advisory Committee

There are three sub-committees of the Advisory Committee that meet approximately once every three months to review Project activities and to approve Project direction. These committees are in the areas of science education, broadcasting and evaluation.

U.S. Embassy and USAID Briefings

The Director and Project consultants make regular visits and reports to the United States Ambassador, the USAID representative and their staffs.

Teacher Training

The teacher training efforts of the Project have increased the knowledge of community school headmasters and teachers about the value of the Project's materials. This has caused an increase in the demand for workshop sessions and copies of the materials.

An important part of the Project's programs is the involvement of teachers during and after the broadcasts. This involvement has convinced the teachers working with Project of the value of the materials, not only for the teaching of science to children, but for the teaching of science to the teachers. Project teachers have been "spreading the word."

Efforts to Integrate with the Curriculum Unit and Schools Broadcasting Unit

The RSP was established as an independent activity located in the complex with the Curriculum Unit and the Schools Broadcasting Unit. As part of an effort to become integrated into the NDOE, Project staff have actively sought collaboration with both units. Because the studio of the Schools Broadcasting Unit is utilized by the Project on a regular basis, good relations have been developed and maintained with broadcasting personnel. The Project has also played a key role in the maintenance and improvement of the broadcasting facilities.

Project staff relations with the Science Division of the Curriculum Unit have not been as strong, in part, because there has not been expertise in primary school science in that office. Virtually all of the curriculum development work has been done in the RSP office. Neverthe-less, the Project has sought the involvement of the science educators and they have periodically reviewed RSP plans for particular science topics, written comments on scripts and observed radio science classes.

During early 1990, in preparation for the closing of the Project at the end of the year, agreements were reached that would transfer many of the RSP staff to the Curriculum Unit and the Schools Broadcasting Unit. The NDOE has recognized that, as a consequence of the extensive training we have provided our staff, there are now many well qualified personnel that could contribute a great deal to curriculum and broadcasting activities. To date, two people from the RSP office have already been hired by the NDOE. Thus, even though the government is under great financial pressure, they have agreed to hire many of our personnel including the science educator, producer, radio engineer, artist, and scriptwriters. This action should do much to ensure a long-term benefit to PNG as a result of the Radio Science Project.

The NDOE has recently decided to proceed with the curriculum revision for Grades K-6. Radio Science Project staff will collaborate with the Science Division of the curriculum unit to assist in the revision process.

VIII. PLANS FOR 1990

The RSP has three major goals for the remaining months of 1990 -- to complete the development of the science programs for grade 6, to complete the summative evaluation of the grade 5 lessons, and to institutionalize the Project in the NDOE. A.I.D. activities will be completely phased out by the end of 1990. Obtaining these goals has been made more difficult because of a shortage of AID funds. Project funds have only covered about two-thirds of what the Project had budgeted. Consequently, the following measures are being taken to reduced the size and scope of the RSP:

- Eliminate the use of outside consultants;
- Cancel the planned extension of the radio producer advisor's contract;
- Reduce the number of national staff employees;
- Shorten the contract of the Project Director so that he returns to the U.S. at the end of August;
- Eliminate plans to further investigate the use of audio-cassette tapes to train teachers in science;
- Cancel plans for revision of Grade 4 lessons.

Despite the cutbacks, the RSP will complete all major Project objectives. A key activity will be to complete Grade 6 materials development and to test them in the schools. A test for the Grade 6 summative evaluation may also be pretested. The Project will also finish the Grade 5 summative evaluation as originally planned. The use of Grade 4 and 5 materials will also be expanded to meet the demands of school supervisors and teachers. Plans for the revisions of Grade 4 lessons will be completed; however, the actual rerecording of the lessons will not take place.

The following activities will be accomplished by the end of the Project in December, 1990:

- Adaptation of the IRI methodology to science teaching and documentation regarding how IRI can best be used to teach a discipline that is inquiry based and includes the use of hands-on materials;
- Development and evaluation of full science curriculum for grades 4-6;
- Completion of summative evaluation for Grades 4 and 5 materials;
- Agreement with the NDOE for national implementation;

- Development of a highly trained staff with skills in curriculum development, scriptwriting, radio production, evaluation, and project management.

- Arrangements for Project staff's further employment.

APPENDIX I

Radio Science Pilot Project Evaluation

PAPUA NEW GUINEA

RADIO SCIENCE PILOT PROJECT EVALUATION

MICAEL OLSSON
EXTERNAL EVALUATOR

OFFICE OF EDUCATION
BUREAU FOR SCIENCE AND TECHNOLOGY
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

JUNE 1989

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SUMMARY

SPONSORING OFFICE:

Office of Education
Bureau for Science and Technology
United States Agency for International Development
Washington, D.C., USA

PURPOSE OF ACTIVITY EVALUATED:

Research required for developing a radio-based instructional system for science at the primary school level in Papua New Guinea which, once developed, would be usable by other countries wishing to use radio to teach primary school science.

PURPOSE OF EVALUATION AND METHODOLOGY USED:

The purpose of the evaluation is to get an overview of progress towards institutionalisation and the achievement of learning gains among radio science pupils over pupils using the standard curriculum, keeping recurrent costs low and administration manageable for less developed countries like Papua New Guinea.

The methodology used included classroom and training observations, interviews and the examination of reports, materials, agreements, administrative forms and related documents. The interview technique avoided direct questions as much as possible, given the cultural demand to fulfill the expectation of guest inquirers. Rather, respondents were invited to discuss the strengths and weaknesses of prescribed topic areas.

FINDINGS AND CONCLUSIONS:

Neither the National Department of Education (NDOE) or the Radio Science Pilot Project (RSPP) staff feel that the radio science broadcasts could or should carry the burden of curriculum. Conversely both agree that the radio broadcasts are providing the kind of assistance, without which, the teacher cannot carry the burden of the curriculum either. The conclusion is that the RSPP has introduced a potentially effective co-teacher in the classroom and that learning gains are already beginning to emerge among science students in Papua New Guinea's community schools.

The project will need to facilitate the recruitment of a science educator sympathetic to the radio science approach within the NDOE if the RSPP is to be effectively institutionalised. And while the NDOE is interested in adopting the approach nationwide, there are still unanswered questions regarding add-on costs, the reach of radio and the need for more teacher-directed support materials.

RECOMMENDATIONS:

The RSPP should be extended by six months to June 1991 with the agreement that NDOE join the programme in 1991 to continue supporting the revision of materials, their implementation and the summative evaluation. Add-on costs should be calculated as soon as possible using the model as currently adapted

with revised kit materials and flip charts in lieu of worksheets in order to show that the two proposed Public Investment Programmes will cover the bulk of the add-on costs.

The RSPP should also develop a research model and initiate a survey to determine what percentage of rural community schools are likely to benefit from radio broadcasts. The study should aim to determine which areas get an adequate daytime signal, which areas get only a nighttime signal, which schools have radios, which schools require radio antennas and which areas have difficulty obtaining batteries.

Finally, along with workshop materials, more teacher-directed content should be camoflouged in the classroom broadcast tape, leaving one easy-to-read teacher-preparation guide and a one broadcast tape.

LESSONS LEARNED:

That science is different from maths and language instruction in that it does not easily lend itself to teacher-independent radio broadcast instruction. Broadcasts should be listen/interact events only, followed by hands on pupil activities that are teacher directed.

That the materials and distribution costs for RSPP materials currently being produced are high for less-developed countries like Papua New Guinea.

That more time is needed to design effective lessons that relate in practical ways to the life situation of the majority of the pupils and yet rely mostly on locally available materials.

PROJECT DETAILS

COUNTRY: Papua New Guinea

PROJECT TITLE: Radio Science Project

PROJECT NUMBER: #DPE-5818-C-00-4087-00

PROJECT DATES:

a. First Project Agreement: PNG-NDOE and EDC 1986
b. Final Obligation Date: December 1990
c. Incremental Funding for FY 89: US $600,000

PROJECT FUNDING: A.I.D. Funding US $5,319,000

MODE OF IMPLEMENTATION:

Education Development Center (direct contractor)
55 Chapel Street
Newton, MA 02160, USA

PROJECT DESIGNERS:

U.S.AID Bureau for Science and Technology, Office of Education
Education Development Center, Inc.
Friend Dialogues

RESPONSIBLE MISSION OFFICIALS:

Louis Kuhn	Frank Watson
Mission Director	Project Director, 6/87 - present

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BACKGROUND

Innovations within the NDOE are necessary to improving the overall standard of education in the country. However, innovations have followed one after another year after year, creating frustration among the teachers and strain on the system as it struggles to adapt materials and training programmes with very limited resources. This being the case, it is important that the RSPP be sympathetic with the NDOE's perspective of longterm goals and its preference for gradual, systematic adjustment of its programmes.

The NDOE is more modest in its projection of what is possible to glean from RSPP than were the project planners. NDOE tends to look 10-15 years down the line while the RSPP project planners were looking to effect changes within a 4-year period. The project was slow in getting off the ground, leaving a tight production schedule during the later stages. The implication, then, is that NDOE may now be happy to narrow the scope of this project and to complete its ultimate goals through subsequent proposals that may well be funded through other agencies and carry on for some time to come.

Radio broadcasts coupled with hands-on work for the students are seen to cause an attention problem, hence the current shift to hands-on work following the broadcast and to more work using the teacher to demonstrate in front of the class. The *Notes to the Teacher*, then, and in-service workshops take on a much more important role.

There are now positive indications that NDOE is interested in adopting a radio based approach to science at the Grade 4-6 level. This has not always been the case. In fact, the Curriculum Development Division resisted the project in the beginning as being too inflexible regarding its mode of delivery. The current director is largely responsible for opening channels of genuine communication on the strengths and weaknesses of the project and how best to improve it.

There is fear within NDOE that if Grade 6 broadcast materials are not completed now, those brought in to do them later will revamp the whole of Grade 4, 5 and 6 and the value of this project will be lost altogether. On the other hand, if the remaining project time is spent on the Grade 6 materials, there is the danger that the Grade 4 and 5 materials never will be revised.

At its most recent meeting, the national Community Schools Board of Management discussed the institutionalisation of the Radio Science Project and expressed the following:

a. reservations regarding the costs associated with producing and replacing workbooks for every pair of Grade 4, 5, and 6 science students.

b. reservations regarding centrally purchasing and distributing additional science kit material

c. satisfaction with the recent decision to shift toward producing more teacher-directed support material

1.0 INSTITUTIONALISATION

1.1 STRONG ADVOCATE

With competing, justifiable demands all vying for limited funds in a cumbersome bureaucratic system, it is often the case that no rational process of prioritising needs finally governs the allocation of resources.

That being the case, an important longterm factor in the success of integrating RSPP into the NDOE curriculum on a permanent basis is the presence of an influential advocate within the NDOE over the next few years.

NDOE has intimated that it is not beyond its resources to deploy its own officers to assist the project from 1991 and beyond. It is possible then that a position for a science educator (contract officer or volunteer) could be made available although there may still need to be some provision for a salary differential in order to recruit the kind of officer needed to complete the development and revision of the RSPP materials.

This officer should be vigorously pursued jointly by both the NDOE and the RSPP in order to provide as much overlap as possible with the incoming interim director. He should liaise on a regular basis with the various divisions of th NDOE to ensure the full integration of radio science within the curriculum.

There is consensus that the remaining materials must be planned and underway before the new director arrives. The current director could then be invited to retain a role in guiding the project through to its completion even though it may need to be done via computer communications and short-term visits. The new director, then, would serve more in a cooperative relationship than in an independent role, controlling design on his own.

The viability of such computer communications has already been demonstrated within the project through the current director's computer links with the other U.S. based consultants.

It is expected that the two officers would work side by side through the first 6 months of 1991.

FINDING 1: That the RSPP will fail to be institutionalised without recruiting a strong science educator committed to the radio science approach into the NDOE system.

1.2 PROJECT GOALS

In order for the RSPP materials to be a successful means of science instruction, the teacher's role in reviewing previous material and in carrying out the post-broadcast activities is crucial. The observation reports and the director's *Notes On Work Plan Shift* make it clear that the broadcast itself cannot carry the burden of a science curriculum.

This is further supported by the minute from the Superintendent of the Curriculum Development Division to Tom Tilson and Frank Watson (28/3/89) outlining the Curriculum Development Division's scepticism about stand-alone RSPP instruction. There is consensus in the Curriculum Development Division and on the RSPP Advisory Board that more teacher-directed support materials are needed.

The stand-alone strategy developed in the Dominican Republic and elsewhere has not been well accepted here in Papua New Guinea.

Two strong themes that keep recurring in responses from various NDOE staff are:

1. That the RSPP should assist with the revision of the existing Grade 6 science broadcast materials.

2. That the RSPP should give greater priority to assisting teachers to improve their science lessons.

FINDING 2: That science education is fundamentally different from language education and mathmatics, that radio broadcasts cannot carry the burden of the science curriculum alone and that science education requires an active role on the part of the teacher in the classroom.

FINDING 3: That NDOE would like more teacher-directed Grade 6 science support materials that can be used as a model for developing similar teacher-directed materials for later revisions of the Grade 4 and 5 radio science materials.

1.3 ACCOMPANYING BENEFITS

Innovative projects like the RSPP are more likely to be institutionalised in a complex system like the education bureaucracy here if the project is seen by departmental decision-makers to have spin-off benefits other than the stated objectives of the project.

Benefits that NDOE happily expects to take away from the project include:

1. a revived, fully functional schools broadcast studio

2. trained scriptwriters that can be absorbed into the system; some to school broadcasts and some to curriculum writing.

The Materials Superintendent refers enthusiastically to the submission jointly prepared for rewriting the scripts for all radio broadcast materials currently being aired and for a more functional broadcast studio.

Thanks to the script-writing training currently going on in the project, the Curriculum Development Division is now enthusiastic about incorporating scriptwriters trained during the project into their unit. RSPP is also producing growing experience in curriculum development, administration and teacher training.

NDOE hopes to find ways to incorporate the skills being developed during the RSPP into providing radio assisted in-service training for teachers in science and other core subjects as well.

At the same time, the original project proposal (Galda/Chaytor 1985:3) calls for limited use of the project for nonformal adult education broadcasting at later hours. With the promotion of adult literacy now part of the agenda of the Curriculum Development Division, the use of some of the scientific material related to practical agriculture, health, nutrition and community life for adult learning could increase the worth of the project to the NDOE.

FINDING 4: That the RSPP is generating spin-off benefits that are valued by NDOE.

1.4 CAPACITY BUILDING

The ability of the RSPP staff to carry on and complete the project depends a lot on holding existing staff together.

It is obvious to all that not all staff will be absorbed by the Curriculum Development Division. Less than half of the current 17 Papua New Guineans on the staff list are likely to be absorbed into the Curriculum Development Division. With this insecurity, trained staff can easily be tempted to accept other positions outside the project simply because they are permanent.

RSPP is sometimes criticised for being overstaffed for the level of production involved. The higher staff/production ratio is necessary, however, in a project whose limited duration necessarily combines training and intense production with job insecurity and inevitable turnovers. The recent aquisition of two former inspectors has given the project new credibility in terms of staff quality.

The contract agreement's call for the training of a counterpart primary school science education specialist is still a problem. Although the new science education associate is very capable and quickly learning the art of breaking science units into appropriate segments, he has been outside the profession living in the village for the last ten years and may well find it difficult to complete the Grade 6 production schedule without the support of a good science educator.

The identification of segments suitable for covering unit topics of the syllabus depends on analytic skills and considerable science background, particularly where physical science is involved. The scriptwriters rely heavily on the backup support of a science educator as well.

FINDING 5: That the RSPP does not yet have a trained primary school science education specialist to leave behind as called for in the contract agreement.

FINDING 6: That turnover of staff may continue to be a problem with so few permanent positions becoming available within the Curriculum Development Division once the project folds.

1.5 COMMITMENT OF RESOURCES

There are several key factors that point to a growing commitment on the part of NDOE to incorporating the RSPP into the Curriculum Development Division. These include:

1. The inclusion of K75,000 for materials in the Public Investment Programme approved for Curriculum Development and Distribution 1989-1994.

2. Plans by the Field Service Unit of the NDOE to cooperate with RSPP in developing an in-service training programme that concentrates on science during 1991 (following a focus on English in 1989 and maths in 1990).

3. A willingness on the part of NDOE to hire a science educator to follow up and complete the development and revision of RSPP from 1991.

4. The joint preparation of a new Public Investment Programme submission which funds scriptwriters along with staffing and maintaining a more efficient school broadcast studio.

FINDING 7: That NDOE is interested in adopting the RSPP approach nationwide but will remain uncertain until questions regarding costs, the reach of radio and teacher-directed support materials are resolved as per additional findings below.

1.6 ADD-ON COSTS

The project description calls for a detailed implementation plan on how this programme can be used on a nationwide basis in both the formal and nonformal education sectors, minimizing future recurrent costs for the Papua New Guinea government.

As yet, no serious projection of the add-on costs required for assimilating the RSPP has been attempted. This is due, in part, to the evolving design of the project, an evolution which is justifiable and, in fact, necessary if the project is to be made compatible with the national system.

So while the *Sub-Projects for Curriculum Development and Distribution* in the Community School Public Investment Programme for 1989-1993 has been approved, it was basically approved 'in principle', not on the basis of projected add-on costs.

The figure of K75,000, then, is an indication of NDOE's support for the direction that the RSPP is heading rather than a firm commitment to assume responsibility for the total costs of running the programme under its original design on a national scale.

On the whole, NDOE officials are not optimistic about centrally distributing student workbooks and/or inexpensive science kits on a 1:2 basis for all Grade 4, 5 and 6 science students nationwide.

Experience with reusing broadcast workbooks over several years has been problematic, some books disappearing and others being marked and torn. Current practice in trying to provide workbooks in support of other school broadcasts is to provide one sample book for each class. It is then up to the local board of management to find a way to duplicate or photocopy the material for other students to share. This, unfortunately, disadvantages students from the less developed areas, the polar opposite of the project's objective on equity.

Books for individual students have been centrally distributed through the recent World Bank programmes, but the aid donor took responsibility for the initial distribution, with NDOE accepting responsibility for replacement costs. While this has been agreed to, the programmes are new and have not yet affected recurrent budget funds for the NDOE.

The science kit material presents a similar problem. While there was one central distribution of science kits back in the early seventies, there has been considerable reluctance over the years since then to fund such kits centrally. Currently, each school must pay for their own science kit. While several hundred such kits have been sold in recent years at a cost of about K210, a large percentage of the more rural schools have been denied access to science literacy through lack of resources.

There is some support at the moment for providing a simple science kit of largely replaceable materials on the grounds that science is a core subject prescribed at the national level which the national government is then obliged to look after. However, it is not likely that the national government will assume responsibility for centrally funding science kits of the kind currently available.

NDOE's Overseas Aid Section is confident that, if given the opportunity, they can reduce the price of any science kit agreed upon, through special tenders.

Studies projecting low recurrent costs per student-year like that described by Jean Meadowcraft for Nicaragua and Dominican Republic are unlikely in the Papua New Guinea context. Both distribution and production costs here are high.

Costs for broadcast time may add yet another expense. As the National Broadcasting Commission is in serious financial difficulty, a ministerial review committee has been established to make recommendation on its future. The committee is looking at a variety of ways to assist the National Broadcasting Comission to generate revenue. One such measure has been the call on the NDOE to prepare a budget to pay for the air time currently used by school broadcasts on the National Broadcasting Commission.

Should this recommendation be adopted, six science broadcasts a week plus any teacher-directed broadcasts that may result must be taken into consideration when calculating the add-on costs of implementing the RSPP on a national level.

This initiative by the National Broadcasting Commission has been opposed before and will be vigorously opposed again this time, but the National Broadcasting Commission's financial difficulties are now so serious that some strong remedial action is almost certain to be adopted.

There has been no suggestion that batteries for radios would be provided centrally.

Currently, a series of cassette tapes provided for other programmes by the schools broadcast unit costs K50 for 24 cassettes and postage. If cassettes are used in lieu of broadcasting over the Karai services in areas where there are difficulties in receiving those services, the corresponding increase in add-on costs will be significant.

FINDING 8: That it is not yet clear that the materials now being developed for RSPP instruction are cost efficient and applicable to other less developed countries as required by the DOE-EDC contract.

2.0 PRODUCTION

2.1 STUDIO PRODUCTION

The early history of the project was marked by a variety of technical difficulties related to the repair of equipment, maintenance service and engineer training. There are still some technical difficulties hampering the efficiency of the system such as the hiss in the cartridge machine, the 12-slave copier operating below capacity, the lack of adequate sound-proofing, the overheating console and the needed power supply. Maintenance and critical spare parts are the most critical. But recording is possible and the general situation has greatly improved.

Two important steps in that improvement process were the hiring of a RSPP engineer who now concentrates entirely on RSPP broadcast productions and the complete overhauling of the broadcast studio by the National Broadcasting Commission at the end of last year.

The schools broadcast studio came into being as a result of the failure of National Broadcasting Commission to meet the expectations of the Curriculum Development Division. With no means of improving on the capability of that agency to perform, NDOE chose to take on the function themselves and, in so doing, soon discovered the difficulties involved in producing quality school broadcasts on a regular basis.

Last year, an agreement reached with the National Broadcasting Commission to revamp the schools broadcast studio resulted in marked improvement to the schools broadcast studio. More recently, the new Public Investment Programme submission has been prepared to build and maintain the capacity of the school broadcast studio to regularly produce good broadcasts.

In addition, the ministerial review committee is currently reviewing broadcast policy in Papua New Guinea with a view to consolidating services and bringing government-sponsored video, radio, and print productions under the umbrella of one national agency. Attention is being given to the growing number of aid-sponsored audio/video studios that have been set up but little used because of a lack of maintenance and technical skills in Papua New Guinea to keep them operating.

Considering the current momentum for consolidating such production facilities, it is not unlikely that the Government will opt to maintain scriptwriters and content-control for media productions within specific departments but to consolidate the audio/visual production studios into one central facility that is properly staffed and maintained.

The Public Investment Programme submission for *Support of Curriculum Materials Using Radio and Television 1990-1994* would then need to be modified accordingly.

2.2 PRODUCTION SCHEDULE

The current project director has expressed his concern that it has been not been possible to revise the Grade 4 materials in a quality form at the same time that Grade 5 lessons are being produced, given the limited time available.

Timing in the production schedule has been a problem right along. All staff work to a tight schedule in order to keep the broadcast schedule from falling behind. This means that everyone works under considerable pressure and that any unexpected delay in the production process threatens to upset the classroom broadcast schedule.

The teacher support broadcasts are weak to date simply because of the time that has gone into producing and revising the other materials. The current production schedule for Grade 5 is also tight although the the schedule is currently 10 lesson plans ahead, partly because of good help coming from one of the staff now drafting segments. This could free the director to spend to turn more attention to the preparation of teacher training materials.

Some classroom teachers have asked for more lead time between the point when the materials are delivered and the date of the broadcast. The tight schedule makes it difficult for them to adequately prepare when the materials arrive so late.

FINDING 9: The RSPP production schedule is too tight to allow for adequate researching of unit topics, creative use of the actors in relating the syllabus to practical community life, proper attention to the production of teacher-directed support materials and proper incorporation of the results of the formative evaluations.

2.3 SCRIPTWRITING

The scriptwriters are widely applauded within NDOE as a welcome and needed addition to the Curriculum Development Division.

The writer's workshops that have been going on since September have been designed to prevent scripts coming out with too much focus on content and not enough on the interactive reinforcement.

One staff evaluator, however, suspects that the writers, left on their own, will fall back into mechanically transposing the segment outline into the script format without creatively scripting the message into the interactive mode. This leads to scripts that lack the imagination and creativity the interactive method tries to establish in order to captivate the students attention. Part of this is undoubtedly due to the tight production schedule.

Early indications from the summative evaluation are that the scriptwriters sometimes assume science background that would better be repeated than assumed. This may be due, in part, to the higher standard of teachers in the area of the formative schools as opposed to the more rural summative schools of the East Sepik.

When the science terminology is adequately broken down for the scriptwriters, the standard of the script is also much better. The staff evaluators agree that more than one-page of background on the segments of a unit is needed in order for the scriptwriters to produce an effective script.

Care must be taken to ensure that the scriptwriters and actors are given as much background information as possible. Current project design does this by providing short, clear science notes for the writers, lesson planning meetings with the science educator and then writer planning meetings. Writer background is further strengthened by actually doing themselves all the science activities they write about.

This has not always been the case however. It was not until late 1987/early 1988 that full time writers and actors were employed and the key science education, producing and scriptwriting functions distinguished. From that point, the major task for the associate science educator has been science education, the major task for the associate producer has been producing and the major task of the chief scriptwriter/producer has been scriptwriting.

FINDING 10: That some cyclic reinforcement of scriptwriting principles will be needed for some time before the scriptwriters are fully independent.

2.4 LANGUAGE

Both classroom teachers and staff evaluators confirm that the standard of English in the RSPP materials is too difficult for the average Grade 4 or 5 student in the nonurban areas of Papua New Guinea.

One Port Moresby area teacher reported that her class was evenly divided between a faster and a slower group and that the language standard was appropriate for the faster group only. Standards for English in the rural areas can be expected to be even lower.

The staff evaluators agree that it would be better to restrict the standard of English to:

a. basic active sentences
b. trimming the metalanguage to basic equivalents, and
c. repeating definitions of terms even if prior explanations have been given.

New terms sometimes need repeated explanations. Violet and indigo, for example, are generally unfamiliar to speakers of English as a second language. Boxes vs. squares and generic terms like 'objects' and 'image' are other expressions that frequently cause difficulties in many parts of Papua New Guinea.

The use of directional terms presents a particular problem. To give instructions on how to place an object on the worksheet, for example, is difficult for the radio teacher who has no points of reference within the classroom itself.

For example, in Grade 4, Unit 5, Lesson 46, the radio teacher's instruction is to look at the first colour of the rainbow in the box, but it is not clear from a crosscultural point of view what is meant by the 'first' colour. Is it the one at the bottom or the one at the top?

In the same lesson, the radio teacher asks the class to use the mirror to complete the pictures in boxes 5 to 10. In 6, for example, the instruction is to use the mirror to make a comb that has no broken teeth. But without clear directionals, it is difficult to know how to place the mirror near the image in such a way as to create the desired affect.

Partly because of such problems, the Grade 5 materials have shifted away from hands-on activities during the radio lessons, leaving them to the teacher to do as dry lab experiences during the post-broadcast portion of the lesson.

Some teachers have asked for a glossary to be developed for the *Notes for the Teacher* to help build familiarity with unfamiliar scientific terms.

FINDING 11: The standard of English required for RSPP materials is too high at times.

2.5 ACTING

The use of actors/actresses is a powerful learning device that is one of the strengths of the interactive radio approach to science learning. While the actors do refer back to community life and culturally familiar items and events from time to time, a more relaxed production time-line would make it possible to exploit their potential more fully.

3.0 BROADCASTING

Radio has not been a priority with NDOE in recent years. The last significant funding for radio was during the series of World Bank sponsored education projects. However, with

the sudden departure of the school broadcasts' coordinator at the end of 1984, support for school broadcasting has been poor.

Some radio scripts are now 25 years old and much of that material is now completely unrelated to the current curriculum. The English language broadcasts developed during the sixties, for example, are still in use despite the fact that the approach to language learning used there has since been abandoned as ineffectual.

However, the RSPP and its success with scriptwriting and material production has demonstrated the power of radio as a medium for learning in the Papua New Guinea context. This has generated new enthusiasm in the NDOE such as that expressed by the Superintendent of the Materials Unit through his Public Investment Programme proposal to rewrite all school broadcast scripts and improve broadcast production.

FINDING 12: That the RSPP has been influential in generating new support for the role of school broadcasts in primary education in Papua New Guinea.

3.1 LIMITATIONS OF BROADCAST HOURS

Audience research for radio has been poor in Papua New Guinea. There is no research that has sampled conditions in various parts of the country over the seasons of the year. It is well-known, however, that radio services are erratic with isolated pockets where reception is always difficult and others where reception is good only at certain times and under certain conditions.

The Director for Engineering Technical Services for the National Broadcasting Commission advises that provincial services are not capable of broadcasting during daylight hours. It is hoped that the current restructuring may lead to improvements that could result in daylight broadcasting from provincial stations. But the review is still in progress and the outcome is uncertain.

School broadcasts take up much of the morning scheduling for the Karai services at the moment. Currently, two of thirty one broadcasts slots are reserved for science broadcasts. Two broadcasts per week for each of Grade 4, 5 and 6 would require an additional four broadcast slots. Slots that are still open are the less attractive ones, either because they are late morning when reception is difficult or on Fridays, a day that tends to attract a lot of interruptions to class schedules. One weakness in the original project proposal was its reliance on the use of afternoon hours in the broadcast schedule.

FINDING 13: That the scheduling of the full range of radio science programmes will require further negotiations with the National Broadcasting Commission.

3.2 RANGE OF RECEPTION

Among the findings of the 1987 *Board of Inquiry Into Broadcasting (Including Television)* is the conclusion that radio coverage in Papua New Guinea is grossly inadequate and, in much of the country, nonexistent altogether. Radio coverage and transmitter failure were the most common problems identified by the public during the hearings. Given the lack of any carefully sampled survey data, this record of the hearings during the inquiry is an important indicator of the current limitations to radio coverage in Papua New Guinea.

The study expresses concern over specific examples where even the Karai Services with its seven relay centres cannot be received, including Alotau (the provincial centre for the Milne Bay Province), various points in the Western Province, East and West Sepik, Manus, North Solomons, Enga and others.

Provincial stations are even more limited with their 2 to 5 kw transmitters covering roughly a 50-80 km radius, depending on a range of technical factors including the conductivity of the soil and the conditions of the ionosphere.

One longshot projection is that Papua New Guinea will gain a huge 50 kw transmitter through overseas assistance that would be set up near Lae and enable complete coverage nationwide. No such package has been negotiated as yet, however.

A survey on school broadcasts was attempted in 1983. The data is of limited value, however, because it relies on return mail in a situation where the remote areas with reception difficulties have distribution difficulties as well and may not have received or may not have been interested in the questionaire in the first place. Nonetheless, the survey results have value simply because so little data on radio reception of any kind exists.

Most provincial stations cannot broadcast during the late morning and early afternoon hours when children are normally in classes. This is true in spite of the Japanese funded boosters now being put in place to improve the reach of some of the provincial stations. For this reason, broadcasting in Central Province has not been possible. Instead, cassette tapes have been used.

Although the original proposal states that the project would explore, during the life of the project, other sources of funding for the strengthening of transmission lines, no progress has been made as yet.

FINDING 14: That too little is known about the range of radio reception in Papua New Guinea to assess whether or not the RSPP will be able to provide inexpensive, effective primary radio science instruction to the targeted rural areas of the country.

3.3 DISTRIBUTION OF CASSETTE TAPES

Any use of cassettes depends on effective distribution which is often difficult under conditions in Papua New Guinea.

To ensure delivery in the Wewak summative evaluation scheme, all cassettes were hand-delivered to workshop participants who had gathered in Wewak prior to the launching of the programme. Each participant then carried the cassettes back to their commmunity school location. This is obviously an artificial solution.

Education materials have traditionally been delivered to the schools through the provincial offices of education. The method of distribution varies from area to area but it is not uncommon for a pigeon-hole mail slot to be kept in the provincial office for each school.

It is normally the responsibility of the Provincial Materials Supply Officer (PMSO) to coordinate the distribution of materials. He must record the supply given to each school and follow-up with an assessment of what is currently available at each school. The effectiveness of his coordination often depends on informal communication at the marketplace, church, pubs, etc. regarding who happens to be going to particular rural areas.

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Such informal coordination works reasonably well for schools along well-travelled routes with good roads or frequent air/shipping links. However, the system breaks down for the more remote schools. Some schools get their supplies only once or twice a year when the teacher/headmaster himself manages to get to the provincial centre.

In addition to the necessary dependence on informal coordination, regular school material supply is sometimes processed at two or three sub-centres before reaching the target school. After delivery to the central provincial office, the materials may go to a district office, then perhaps to an area centre which finally distributes to a cluster of schools. Time lags through such a series of steps are inevitable, although the materials can still move rather quickly where transport is more efficient.

The conclusion here is that the distribution of cassettes (and other material) via the traditional means of distributing school materials is slow for the rural schools.

The obvious alternative, of course, is to use the Post and Telecommunications Services. Efficiency in the postal service in Papua New Guinea has increased significantly in recent years. The number of remote outstations receiving regular mail bags in care of local businesses, schools or churches has risen sharply. There are still some locations, however, such as coastal villages in the Western Province where there are no fortnitely or even monthly transport services.

Currently, a significant percentage of paycheques are being sent through the post. Cost may be prohibitive, however, if the mailing of cassette tapes becomes large-scale.

A possible solution currently being debated here is government subsidy of postal rates on educational material. Other government agencies are also asking for subsidised rates for the distribution of educational and awareness materials in an effort to promote national unity, law and order and rural development.

The RSPP proposal ruled out the distribution of cassettes but, at the same time, failed to identify any effective means of broadcasting in areas where radio reception is poor.

FINDING 15: That distribution costs cannot be calculated until some estimate is made on what percentage of community schools can receive the Karai services and then, conversely, what percentage will require cassette tapes.

3.4 AVAILABILITY OF BATTERIES

Questions still remain regarding the availability, shelf life and cost of batteries necessary to maintain the broadcasts. There has been no suggestion that batteries will be centrally provided.

One experiment is currently being conducted in the East Sepik summative evaluation in which half of the schools have been provided with fresh torch batteries while the other half have been given vouchers for purchasing their batteries through the local trade store where shelf life could turn out to be a problem.

There are frequently times when the boards of management are out of funds or refuse to purchase yet another set of batteries. In dealing with the battery problem, some teachers report having used their own money to purchase the batteries. One teacher charged each student in the class 5 toea to recover the cost of the batteries.

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It is the remote schools that the project is designed to reach and yet it is the remote schools that have the greatest difficulties in obtaining batteries.

FINDING 16: That it is still an untested assumption that rural community school boards of management will be willing and able to provide the batteries necessary for maintaining the RSPP broadcasts on a regular basis.

3.5 AVAILABILITY AND USE OF RADIOS

The school broadcasts unit has already circulated a bulletin on broadcast capabilities, duty free prices and related procedures for obtaining preferred radios through a recommended supplier.

There is some concern that the project has fostered a new dependency by providing radios to the schools involved in the pilot project when most schools already have at least one radio purchased by their board of management.

The radios provided by the RSPP project have been critisised in both the Central and East Sepik provinces as being less powerful than the school radios purchased by the Boards of Management.

The question now is whether to recall the radios already distributed or simply leave them for whatever use the schools may choose to make of them. Considering the ill-feeling that would result from recalling the radios at this point, it is probably best to simply leave them with the schools.

3.6 AVAILABILITY AND HANGING OF ANTENNAS

Experience in the East Sepik has shown that schools without antennas or with antennas that are not positioned properly have difficulty in picking up the fairly weak provincial station. Schools need assistance in order to properly hang their antennas. Staff who travelled to the East Sepik schools early in the year did not take enough time to complete the job for the pilot schools with the result that some schools do not receive a strong enough signal to make sense of the broadcasts.

The National Broadcasting Commission's Karai service is stronger, however, and will enable a wider reach if the science broadcasts are institutionalised and broadcast over the Karai service.

There will still be areas that require antennas, but fewer of them. It is expected that this cost will continue to be born by the local community school boards of management.

FINDING 17: That antennas and instructions on how to install them will be needed by many rural community schools.

4.0 CURRICULUM DEVELOPMENT

4.1 CURRICULUM CONTENT

Classroom teachers are enthusiastic about the radio science materials and consider them an improvement over the current science teachers' guides. Teachers feel the new material is much clearer and easier for them to follow. Many teachers confessed to simply skipping much of the older material because it was too difficult to follow.

Science as with other areas of the primary school curriculum has been questioned regarding the relevance of its curriculum for rural community life to which most school leavers must return. Accordingly, the education development plan calls for matching exposure to the international science world with the practical aspects of agriculture, communications, health, transport and community life in Papua New Guinea.

The curriculum is further constrained by the requirement that it follow the current curriculum outlined in the *Science Syllabus for Community Schools.*

Even given these constraints, however, there is widespread acceptance of the content and value of the RSPP curriculum. It is the pedagogy that has attracted attention rather than the curriculum content.

FINDING 18: That there is general acceptance of the content and value of the RSPP materials being produced over the science materials currently being used in the system.

4.2 RSPP PEDAGOGY

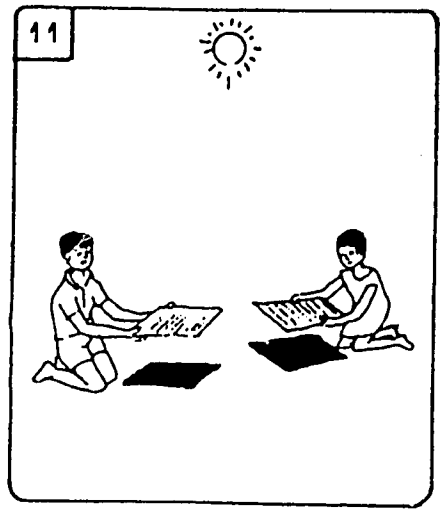
There is good support for the RSPP strategies of providing support systems for teachers, of developing instructional materials that reflect the pupil's daily experiences, of outlining post-broadcast activities for applying their new knowledge and of developing the model through rigorous formative and summative evaluation.

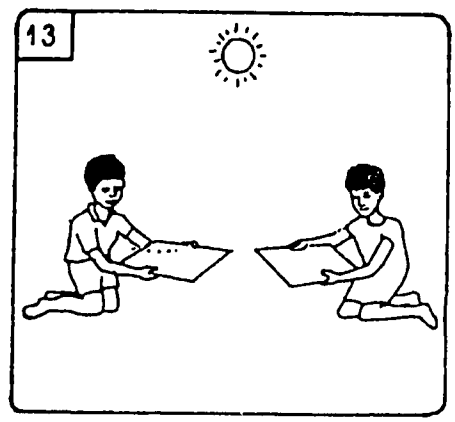
The areas of concern relate to the more controversial 'stand alone' and 'hands on' strategies discussed above under 1.2 PROJECT GOALS and below under 5.2 INTERACTIVE RADIO SCIENCE LESSONS.

4.3 SELECTION OF GRAPHICS

There is considerable variation in the quality of the graphics used in the worksheets, although they have improved considerably since the project acquired its own full-time artist who has been able to give his full attention to the needs of the project.

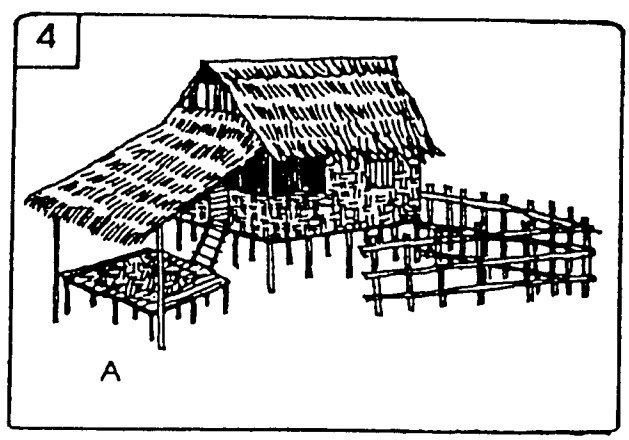
Line drawings such as the one below, for example, are frequently misinterpreted in many parts of Papua New Guinea. Testing has shown that, unless clothes on line figures are shaded, these figures are thought to be wearing ornaments only, the lines meant to mark sleeves, neckline, waist, etc. being interpreted as armbands, waist bands, etc.





Similarly, line drawings like the above on their own, given the lack of any graphic distinction between the surface of the ground and open space, leaves the line figures to be interpreted as suspended in open space.

Later work has given more detail to the graphics as in the house of #4 below.



Even with the minimal line drawings, the context of the presentation normally fills in what is not represented in the graphic.

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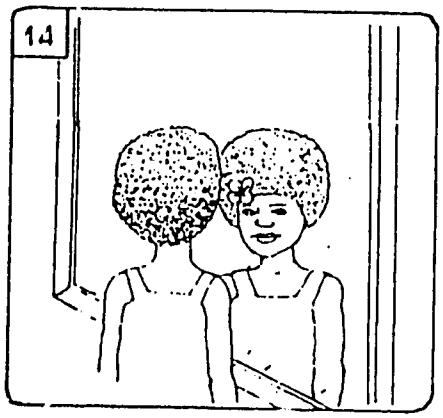
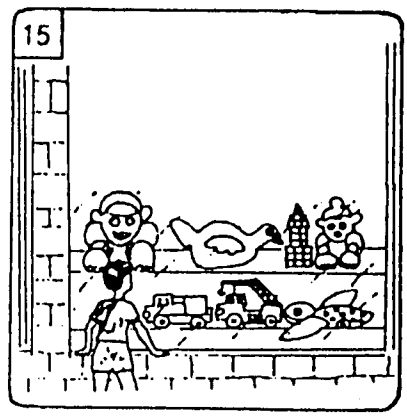
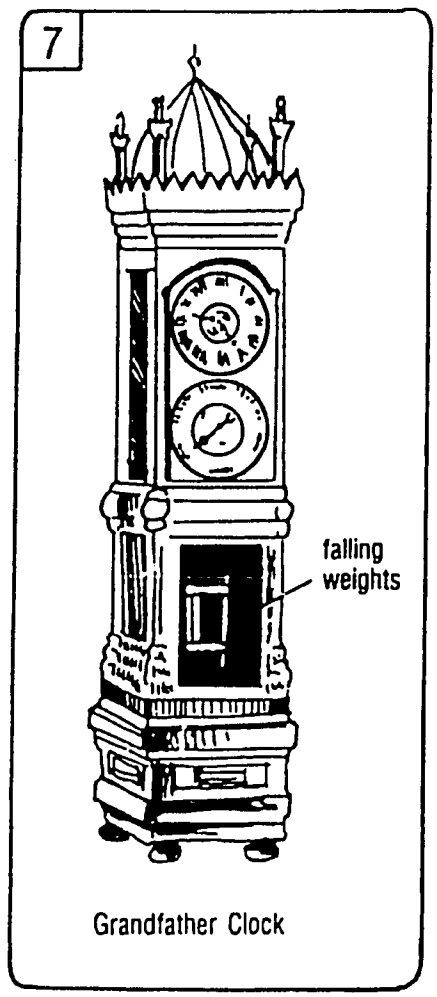
It is difficult to ensure the relevance of all graphics to the everyday experience of the students, given the wide range of variation in exposure to Western lifestyles. Students living along roads that access the national capitol are not typical of the majority who would not be familiar with large mirrors (14), grandfather clocks (7) or store windows filled with toys (15).







The questionable images are few, however. They are not essential to the basic principle of the unit and can easily be changed in later revisions.

FINDING 19: That some graphics which are easily interpreted by most people in the Central Province, where the formative evaluations take place, are likely to be much more difficult to interpret for people in the more remote areas of the country.

4.4 NONFORMAL EDUCATION

The RSPP proposal originally submitted to the NDOE (Galda/Chaytor 1985:3) provided for a link between the formal and nonformal education sectors:

> THE PROJECT WOULD STRIVE TO MAKE SOME OF ITS BROADCASTS SUITABLE FOR OUT-OF-SCHOOL AUDIENCES. THESE BROADCASTS, HEAVILY EMPHASIZING PRACTICAL APPLICATIONS, COULD BE USED WITHOUT A CLASSROOM TEACHER OR OTHER FACILITIES. THE BROADCASTS COULD BE RE-TRANSMITTED AT A CONVENIENT HOUR AND, IF NECESSARY, TRANSLATED INTO OTHER LANGUAGES. THEY WOULD BE SUITABLE FOR DISCUSSION GROUPS IN THE COMMUNITY RESOURCE CENTRES BEING ESTABLISHED BY THE NONFORMAL EDUCATION SECTION. THE PROGRAM CAN SERVE AS A LINK BETWEEN THE FORMAL AND NONFORMAL EDUCATION SECTORS.

Radio, using the interactive approach with radio actors, should be a powerful tool for nonformal learning as well. Its under-utilisation in Papua New Guinea is due in part to the lack of a viable strategy for exploiting its potential as a good learning tool. As the RSPP is bringing such a tool to the country, it presents an opportunity to trial the approach for transferring important knowledge to out-of-school youths and adults at the same time.

Cash-cropping is an important area where adult farmers are anxious to gain scientific agro-chemical knowledge about how to improve their production. This knowledge needs to be balanced with food production (nutrition) and safety precautions (health), all areas outlined in the proposal for applying scientific knowledge to everyday community life.

With newly approved initiatives within the Curriculum Development Division for improving literacy skills among out-of-school youths and adults, this is an opportunity to trial transferring practical scientific knowledge and building reading skills using radio actors, the radio teacher concept and community discussion groups.

FINDING 20: That time constraints have prevented the project from testing the radio science instruction for out-of-school youths and adults as outlined in the project proposal.

5.0 SCHOOL USE OF MATERIALS

5.1 NOTES FOR THE TEACHER

Teachers have repeatedly expressed satisfaction with the RSPP *Notes for The Teacher* as compared with the standard science teacher's guide.

Considering the reading background of many of the teachers in the rural areas of the country, greater attention needs to be given to the presentation of this material, varying type styles, print styles, creating attention-getting black patches, blocks with sub-headings, themes boxes and graphics. Consultant staff are currently working on these aspects of the teacher-directed materials, creating greatly impoved layouts.

Even if further teacher-support materials are prepared, there is the additional problem of ensuring that they are used. Experience in Papua New Guinea bears testimony to the fact that teachers fail to make use of much of the teacher-aid material.

Cassette tape learning for teachers has some of the same problems. Such learning is individual-oriented, isolating the teachers from one another in a cultural context where shared learning experiences are valued. Distribution of the cassettes to the rural areas is another factor, of course, but even apart from that, most teachers will take only limited time to read or listen to new information apart from the minimal class preparation time.

A newly approved Public Investment Programme covering in-service training has given much needed support to a long neglected area of teacher training. Plans call for 2-3 day workshops for 30 or 40 participants (the school inspector plus one selected teacher for each inspectorate). It is up to these two, then, to run their own in-service courses for the classroom teachers back in their inspectorate. It is important that the teacher workshops and teacher-support broadcasts associated with the RSPP should be made consistent with the new staff development policy and in-service training programmes developing out of it.

Some concern has been expressed that innovations like the RSPP require closer collaboration between curriculum designers and in-service trainers than was practised in the early stages of the project if such programmes are to be institutionalised on a national level. Such collaboration has now been established and is developing well.

This could be the means whereby new models for in-service training can evolve that combine the strengths of experience in the Papua New Guinea context with the strengths of the RSPP approach to teacher-training activities.

FINDING 21: That, until recently, RSPP teacher training and NDOE in-service training were heading in different directions.

5.2 INTERACTIVE RADIO SCIENCE LESSONS

The broadcast tapes are widely accepted and appreciated in spite of the fact that they clearly do not carry the burden of the curriculum as originally hoped. In some places, science is being taught for the first time as a result of the response to these materials.

In the earlier materials, observations showed there was a problem in controlling the attention of the pupils who were having difficulty deciding whether to focus on the worksheets, the teacher or the radio.

That problem has now been largely eliminated by the current practice of trying to limit student activities during the broadcast, leaving any hands on activities to the teacher-directed post-broadcast period.

Teachers report that occasionally a tape will revert to a slower speed for a short period and then pick up again, indicating some technical problem during recording. Instances of this are infrequent and not a serious problem.

Some teachers complained that the voices of the child actors/actresses 'blare', that the pitch is too high and too strong compared to the other actors'/actresses' voices. This was not a consistent complaint, however, and may be attributed to the quality of the radio receiver being used in particular schools rather than to the production quality of the tape as there

was noticeable variation in the voice qualities of the child actors/actresses even with the same broadcast in different classrooms.

There is also some concern that the post-broadcast activities are sometimes too time-consuming and take away from other important school activities. This can be curbed if necessary.

5.3 RADIO SCIENCE LESSON WORKSHEETS

In what is intended to be a cost-saving measure, folders of worksheets are distributed one to every two students. These are then collected and stored following each science class. Students are requested not to mark on the worksheets. In practice, however, the worksheets frequently wind up crumpled or dirty. Some are lost or taken away. Only a percentage of the materials remain reuseable.

RSPP staff overextended themselves in trying to revise the Grade 4 materials and get them to the summative schools in the East Sepik by early February with the result that the worksheets still have a lot of errors. This concern was part of the motivation behind the proposal to cut back on the production of new material in favor of revising some of the earlier work during the last 20 months of the project.

The worksheets are vital to the radio science approach. It is possible, however, that they will be treated the same as other school broadcast workbook material, one copy being supplied to each school, leaving it up to the school's board of management to find a way to duplicate or photocopy the material to be shared amongst the students.

FINDING 22: That NDOE is concerned that the cost of producing and maintaining work-folders or workbooks for every two science students in all 2300 community schools in Papua New Guinea is likely to be prohibitive.

5.4 SCIENCE KITS FOR LESSONS

The pilot project may have set a difficult precedent by supplying additional science kit material free of charge. The science kits currently being distributed must be purchased by the local school.

Pilot project teachers, according to the staff evaluators, are delighted that they are finally being provided with appropriate materials. It is not likely, however, that the national government will provide science kits of the type now available to all community schools.

The project as it now stands calls for a limited number of additions to the science kit which sells for about K210. There is a certain degree of tension here between past project experience and the clause in the project description that states: "in no case would we require purchase of additional equipment beyond the science kits already distributed by the Department" (Galda/Chaytor 1985:11).

Teachers report that even very simple items thought to be available in the local community are often difficult if not impossible to get. For example, simple plastic cups often used for ice-blocks, are sometimes available and sometimes not. The local stores near Avababina Community School were out of stock at the time of the lesson that called for them so the experiment was skipped. But many rural areas would have no refrigeration in any case and, therefore, no ice blocks at any time.

The science kits are meant to be reusable, but like the worksheets tend to get abused and pieces lost. They should be limited primarily to items that can be easily replaced.

Because of the cost involved in supplying hands on science kits in all 2300 community schools in Papua New Guinea, the project is now turning to experimentation with dry labs wherever possible. The teacher carries out the experiment during the post broadcast activities while the students watch. It is difficult to eliminate kit materials altogether, however, especially for the physical science portions of the syllabus.

In order to be equitable and ensure that the science programme reaches the more rural schools, a minimal science kit largely of locally replaceable materials purchased collectively through tender and centrally distributed to all schools may be the only solution.

FINDING 23: That NDOE is concerned that it will be too expensive to provide each pair of Grade 4, 5 and 6 students in all 2300 community schools with science kit materials like those used for Grade 4 science.

5.5 DISTRIBUTION OF LESSONS AND KITS

The distribution of lessons and kits faces the same problems as those discussed under 3.3 on the distribution of cassette tapes.

The problem of distributing materials in the rugged hinterlands of Papua New Guinea escalated during the recent World Bank funded Education II and III projects. There is still no way of knowing which schools actually receive materials leaving Waigani, especially in remote areas where distribution patterns involve third and fourth agents such as local businesses, mission aviation aircraft or church education personnel.

Nor is there adequate information on how long it takes such materials to reach their final destination when they do arrive. Details of provincial distribution plans are sketchy or unknown at Waigani.

FINDING 24: That there is no guarantee of learning gains in the targeted rural schools until there is reasonable assurance that the workbooks, Notes to the Teacher, kit materials, antennas and possibly cassettes actually reach these schools.

5.6 TEACHER SUPPORT BROADCASTS

The director's recent *Notes on Work Plan Shift* suggests a variety of teacher directed support materials including:

a. revised *Notes For The Teacher* including additional follow-up activities.

b. a new set of special *Notes For The Teacher* that give in-service support and help with post broadcast activities.

c. a set of in-service cassette tapes expanding the *Notes For The Teacher*.

d. two 10-15 minute teacher broadcasts per week with

help on the radio lessons

At the same time, however, the inspectors are sceptical about the value of additional teacher support materials in the long run, at least those that the teacher is expected to use on his own. From their experience, they feel the teachers will not listen to an additional tape or find time to take advantage of additional written materials. They feel the most the project can hope for from the teachers is the time they will need to invest in reading one well-prepared set of teacher notes and preparing for any post-broadcast activities suggested there.

Part of the reason for this is that science does not have the same status as other core subjects such as English and maths. Expectations for progress with English and maths are high both within the education system and without. As a result, teachers will spend more time preparing for English and maths than they will for science.

Results of the 1983 School Broadcasts Survey show that *Education News* is the most popular and regularly followed of all school broadcasts. This being the case, *Education News* can become a good medium for making spot announcements to the teachers about the current radio science schedule or even a quick reference to a good post-broadcast activity for that week's science unit. Additional teacher-directed broadcasts are not apt to get as big a following.

Cost factors would training workshops exclusively for radio science apart from other in-service training. In-service training, as mentioned, has recently been given a boost in budget support and the RSPP staff have begun dialogue with Staff Development Unit and the In-Service College to find ways to incorporate the needed radio science teacher training within the currently expanding teacher in-service training programme.

While workshops have the advantage of face-to-face dialogue and group interaction, they must be given first at the inspectorate level and then at the community level, the problem being that some inspectors fail to do their local-level, in-service training.

Nonetheless, RSPP staff have begun preparing materials for these workshops. The trial materials use graphics with limited text in an attempt to produce materials that teachers are more likely to use. It has been proposed that two of the existing scriptwriters be diverted to this new task which will mean extra time and energy going into training for such scripting. Once done, however, this approach could prove to be valuable to in-service teacher training generally, both in the Papua New Guinea and elsewhere.

While the feeling in Waigani is that more teacher-directed training materials are urgently needed, the feeling in the community schools is that many teachers are already getting better science training than they have ever had before even with the RSPP model as it is now. In fact, the project proposal stresses that the classroom broadcast itself can become an effective, indirect medium of teacher training.

Apart from the workshop materials, it may be necessary to compromise then and provide but one simply written and well-illustrated set of teacher-directed support materials that both build-up the teacher's background knowledge and assist him/her in preparing the post-broadcast activities lesson by lesson.

FINDING 25: That the proposed shift in focus toward teacher-directed materials may easily result in the preparation of more teacher aids than the teacher will find time to use.

6.0 EVALUATION

6.1 CLASSROOM OBSERVATIONS

Evaluation is tightening up as the project progresses. Evaluation staff are now capable of running workshops on critical observation. The reports and their summaries are well organised so that segments that need special attention are easily pinpointed. The observation recording devise itself has been revised following gaps picked up in the formative records.

All staff participate in the classroom observation exercises which provide an opportunity for all involved to evaluate their work. Early observations found pausing and timing constraints that were too complicated. These have been improved as a consequence of the formative evaluations.

Too often, however, the observations have indicated that the pupils do not know what is going on. A lot of the revision that needs to be done is being held up by time contraints. The sound component of the Grade 4 materials, for example, has been rewritten but still has not been recorded.

6.2 PRE-TESTING

The head evaluator conducted the pre-test and analysed the data yielding levels of pre-knowledge that should have been helpful, but, by that time, production was already too far ahead for the new information to be useful.

Staff carrying out the pre-testing were not experienced in how to approach a class with such a test. As a result, students were confused about the meaning of the test and later complained about being examined on material thay had not been taught.

6.3 POST-TESTING

The test instrument itself needs refining. Either the test questions are too difficult or science is not being taught as well as projected.

The post-test was trialed in East New Britain and the Eastern Highlands but the pace of production precluded taking time for a good analysis and any incorporation of the findings before the Grade 4 summative testing began.

The test questions, themselves should be somewhat less difficult, given the 42% general mean average in the Grade 4 post-test.

FINDING 26: That further work is needed on the testing tool itself to determine why the post-test scores were not above the 50% mark.

FINDING 27: That test questions should be designed initially in the host country and then sent to Friend Dialogue in South Carolina, USA for adjusting, with follow-up once again back in the host country.

6.4 SPREAD OF PILOT PROJECT SCHOOLS

Concern has been expressed that Central Province conditions are not typical of the country's community schools and that it would have been better to maintain the project in the Eastern Highlands, where for a variety of reasons, the project was eventually withdrawn.

The influence of English and the exposure to Western influences is far greater in Central Province than in any other part of the country. Since the key lingua franca for the Momase, Highlands and Islands region is Tok Pisin, students hear little use of English in their day to day routine outside of school. In the Central Province, however, there is broad exposure to English through easily accessible radio, TV and newspapers, all in an area where English is a competing lingua franca as well.

Further, teachers generally prefer postings in or near the bigger cities with the result that better teachers, with better language skills and more science background are apt to be located in and around Port Moresby.

FINDING 28: That the standard of English and exposure to Western influences is much greater in the Central Province than in any other part of the country.

6.5 LEARNING GAINS

A key indicator of the projects success will be statistically established gains in learning among students involved in the RSPP project classes as against those in the control groups. However, due to the early setbacks in the projects time schedule, the first summative classes have only just begun this year in the East Sepik Province. It will be some time, then, before good comparative data is available.

Early indications from the formative evaluations and from the conclusions of both the Project Director and the Superintendent of the Curriculum Development Division are that statistically significant gains in learning will not be registered until further teacher-directed assistance is incorporated into the programme.

While there is considerable confidence in the educational quality of the radio lessons, there is still general scepticism regarding the learning gains actually achieved so far.

In spite of this, learning gains were reported among students in schools like Porebada where the parents have relatively strong educational backgrounds. The headmaster at Porebada (which had two Grade 4 classes participating in the RSPP last year and two Grade 5 classes participating again this year) reports that, in both cases, students being taught the RSPP lesson are getting the better results.

FINDING 29: That the RSPP must incorporate more teacher-directed support materials before the majority of students receiving the radio science education show significant gains in learning compared to students receiving the Department's standard science education.

7.0 SUMMARY OF FINDINGS

FINDING 1: That the RSPP will fail to be institutionalised without recruiting a strong science educator committed to the radio science approach into the NDOE system.

FINDING 2: That science education is fundamentally different from language education and mathmatics, that radio broadcasts cannot carry the burden of the science curriculum alone and that science education requires an active role on the part of the teacher in the classroom.

FINDING 3: That NDOE would like more teacher-directed Grade 6 science support materials that can be used as a model for developing similar teacher-directed materials for later revisions of the Grade 4 and 5 radio science materials.

FINDING 4: That the RSPP is generating spin-off benefits that are valued by NDOE.

FINDING 5: That the RSPP does not yet have a trained primary school science education specialist to leave behind as called for in the contract agreement.

FINDING 6: That turnover of staff may continue to be a problem with so few permanent positions becoming available within the Curriculum Development Division once the project folds.

FINDING 7: That NDOE is interested in adopting the RSPP approach nationwide but will remain uncertain until questions regarding costs, the reach of radio and teacher-directed support material are finally settled.

FINDING 8: That it is not yet clear whether the materials now being developed for RSPP instruction are cost efficient and therefore applicable to other countries as required by the DOE-EDC contract.

FINDING 9: That the RSPP production schedule is too tight to allow for adequate researching of unit topics, creative use of the actors in relating the syllabus to practical community life, giving proper attention to the production of teacher-directed support materials and for incorporating the results of the formative evaluations.

FINDING 10: That some cyclic reinforcement of scriptwriting principles will be needed for some time before the scriptwriters are fully independent.

FINDING 11: That the standard of English required for RSPP materials is too high at times.

FINDING 12: That the RSPP has been influential in generating new support for the role of school broadcasts in primary education in Papua New Guinea.

FINDING 13: That the scheduling for the full range of radio science programmes will require further negotiations with the National Broadcasting Commission.

FINDING 14: That too little is known about the range of radio reception in Papua New Guinea to assess whether or not the RSPP will be able to provide inexpensive, effective primary radio science instruction to the targeted rural areas of the country.

FINDING 15: That distribution costs cannot be calculated until some estimate is made on what percentage of community schools can receive the Karai services and then, conversely, what percentage will require cassette tapes.

FINDING 16: That it is still an untested assumption that rural community school boards of management will be willing and able to provide the batteries necessary for maintaining the RSPP broadcasts on a regular basis.

FINDING 17: That antennas and instructions on how to install them will be needed by many rural community schools.

FINDING 18: That there is widespread acceptance of the content and value of the RSPP materials being produced over the science materials currently being used in the system.

FINDING 19: That some of the illustrations which are easily interpreted by most people in the Central Province where the formative evaluations take place, are likely to be much more difficult to interpret for people in the more remote areas of the country.

FINDING 20: That time constraints have prevented the project from testing the radio science instruction for out-of-school youths and adults as outlined in the project proposal.

FINDING 21: That, until recently, RSPP teacher training and NDOE In-Service training were heading in different directions.

FINDING 22: That NDOE is worried that the cost of producing and maintaining work-folders or workbooks for every two science students in all 2300 community schools in Papua New Guinea is likely to be prohibitive.

FINDING 23: That NDOE is worried that it will be too expensive to provide each pair of Grade 4, 5 and 6 students in all 2300 community schools with science kit materials like those used for Grade 4 science.

FINDING 24: That there is no guarantee of learning gains in the targeted rural schools until there is reasonable assurance that the workbooks, Notes to the Teacher, kit materials, antennas and possibly cassettes actually reach these schools.

FINDING 25: That the proposed shift in focus toward teacher-directed materials may easily result in the preparation of more teacher aids than the teacher will find time to use.

FINDING 26: That further work is needed on the testing tool itself to determine why the post-test scores were not above the 50% mark.

FINDING 27: That test questions should be designed initially in the host country and then sent to Friend Dialogue in South Carolina, USA for adjusting, with follow-up fine tuning once again back in the host country.

FINDING 28: That the standard of English and exposure to Western influences is much greater in the Central Province than in any other part of the country.

FINDING 29: That the RSPP must incorporate more teacher-directed support materials before the majority of students receiving the radio science education show significant gains in learning compared to students receiving the NDOE's standard science education.

RECOMMENDATIONS

I. That the RSPP be extended by six months to June 1991 with an agreement that NDOE join the programme in 1991 to continue supporting the revision of materials, implementation and evaluation.

II. That the current director retain a key role in guiding the project through to its completion via computer communications and short-term visits.

III. That the NDOE and RSPP begin talks immediately to identify a contract officer who is a science educator with the skills required to complete the more difficult Grade 6 broadcast materials in order for him to take up duty alongside the new interim director in late 1990 or early 1991.

IV. That RSPP provide a salary differential for the NDOE position for one contract period to ensure the completion of production, revision and summative evaluation of all the Grade 4, 5 and 6 materials.

V. That the new interim director be appointed with responsibilities focusing on supervising the implementation of the model as adapted by the current director and on orienting the new NDOE contract officer to the model for carrying out the completion of the production, revision and summative evaluation of all the Grade 4, 5, and 6 materials.

VI. That add-on costs be calculated as soon as possible using the model as currently adapted with revised kit materials and flip charts in lieu of worksheets.

VII. That RSPP scriptwriters be included in interagency workshops to update their skills from time to time following the departure of the writing consultant.

VII. That a glossary be maintained in the Grades 4, 5 and 6 *Notes for the Teacher.*

VIII. That negotiations for solving the programme scheduling difficulties that will eventually arise on the Karai services are best left until material preparations for the national broadcasts are complete, since the rewriting and other adjustments made to school broadcasts is expected to result in a pattern of flux for broadcast scheduling.

IX. That the RSPP develop a research model and intiate a survey to determine what percentage of rural community schools are likely to benefit from the RSPP broadcasts. The study should aim to determine which areas get an adequate daytime signal, which areas get only a nighttime signal, which schools have radios, which schools require radio antennas and which areas have difficulty obtaining batteries. (The same study may also be able to determine which schools have difficulties receiving materials. See recommendation XVI.)

X. That technical input should be included in the regional In-Service Training Workshops planned for school broadcasts in order to provide basic information on positioning antennas in specific regions.

XI. That in order to maximise the benefit to the students in the rural areas, provision in future planning should include further testing of the interpretation of the illustrations specifically in remote areas without road access to the towns.

XII. That the RSPP sponsor a trial radio science programme for adults and out-of-school youths combining the infrastructure already developed for coffee rehabilitation in Papua New Guinea with the new adult literacy initiative in the Curriculum Development Division in one of the Highlands provinces.

Appendix II

Grade 4 Summative Evaluation Test

RADIO SCIENCE PILOT PROJECT

GRADE 4 POSTTEST

****

NAME:_____ BOY_____ GIRL_____

SCHOOL:_____ DATE:_____

****

WHAT YOU MUST DO IN THIS TEST

(1) In this test you put a circle around ONLY the letters A,B,C, OR D.

(2) You must put a circle around ONLY ONE LETTER. This is because there is ONLY ONE CORRECT ANSWER for each of the questions. Let us do EXAMPLE I:

EXAMPLE I

A closed electric circuit in order to work must have which of the following?

A. rope, battery and electricity.

B. a battery, light bulb (globe) and a piece of wire.

C. a light bulb, battery and a piece of wood.

D. a radio, battery and a tin.

(3) What if you have already put a circle around a letter but later realize that it is the wrong answer? You want to change it and put a circle around another letter. In cases like this YOU MUST PUT A CROSS (X) IN YOUR FIRST ANSWER. THEN YOU CAN PUT A CIRCLE AROUND THE SECOND ANSWER. EXAMPLE II shows you how to do this.

EXAMPLE II

Which sentence below is true about a thermometer?

A. We use it to measure people

B. We use it to find out how bright the sun is.

C. We use it only to check how hot a person is when he or she is sick.

D. We use it to find out how hot or cold something is.

In Example II we first put a circle around letter C. But this is wrong because measuring the heat or the temperature of a person when he or she is sick is NOT the ONLY way we use a thermometer. We also use a thermometer to measure how hot the air is. Because C is wrong, we put a cross over our circled C. We then circle the correct answer D.

IMPORTANT THINGS TO REMEMBER

1. DO NOT PUT A CIRCLE AROUND THE ANSWER. YOU ONLY PUT A CIRCLE AROUND THE LETTER IN FRONT OF THE ANSWER.

2. READ EACH QUESTION AND ANSWERS FOR THAT QUESTION VERY CAREFULLY.

3. IF YOU HAVE FINISHED EARLY CHECK YOUR ANSWERS AGAIN TO MAKE SURE THEY ARE CORRECT.

==========

NOW YOU ARE READY TO DO THE TEST. PLEASE TURN TO THE NEXT PAGE AND BEGIN.

* GOOD LUCK *

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1. Which of these is a living thing?

   A. car

   B. stone

   C. house

   D. crab

2. Which needs electricity to work?

   A. hammer

   B. radio

   C. bicycle

   D. screwdriver

3. Which of these is a mammal?

   A. bird

   B. frog

   C. rat

   D. worm

4. Light can travel through which of these things?

   A. a stone

   B. the moon

   C. empty space

   D. a piece of wood

5. Which animal has feathers?

   A. parrot

   B. pig

   C. goat

   D. butterfly

6. Which animal has scales?

A. crab

B. snake

C. spider

D. snail

7. Which thing can a magnet pick up?

A. needle

B. piece of paper

C. bottle

D. plastic bag

8. Which sentence is true?

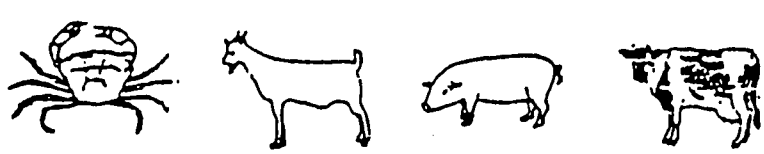
A. A tadpole is the grown up form of a frog.

B. A frog is the grown up form of a tadpole.

C. A tadpole never has legs.

D. A tadpole has many tails.

9. Circle the seashore animal.



A B C D

10. Which thing can electricity pass through?

A. wood

B. glass

C. tin

D. plastic

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11. Which sentence is true about what happens to wire when it is hot or cold?

A. When wire is heated it gets shorter.

B. When wire contracts it gets larger.

C. When wire gets cold it gets shorter.

D. When wire is cooled, it gets longer.

12. Which sentence is true about what happens to air when we make it hot?

A. Air will get bigger.

B. Air will both get bigger and get smaller.

C. Air will get smaller.

D. Air will not change.

13. Which thing would allow the most light to pass through it?

A. a piece of paper

B. a piece of wood

C. a tin

D. clear glass

14. Which sentence is true about how light travels?

A. Light can travel through all objects.

B. Light can travel only in a straight line.

C. Light can travel in circles.

D. Light can travel through tin.

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15. Which of these sentences is true when we see a rainbow in the sky?

A. It is dark outside.

B. It is late at night.

C. It is cloudy and dry.

D. It is raining lightly.

16. Which two animals are most closely related?

A. horse and wallaby

B. butterfly and caterpillar

C. bird and bee

D. cat and mouse

17. Which sentence is true about plants?

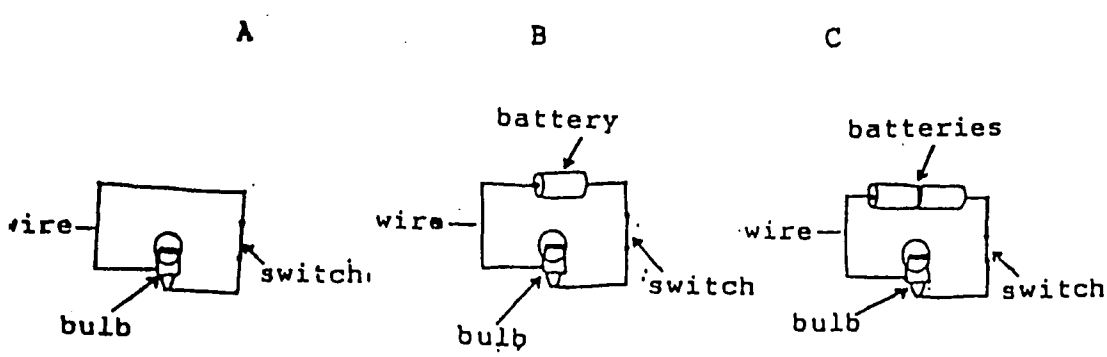
A. Trees are too big to be called plants.

B. Grasses are plants.

C. Sweet potatoes are not plants because the part we eat grows in the ground.

D. Mammals are plants.

18. Look at the three circuits. Which bulb will be brighter?



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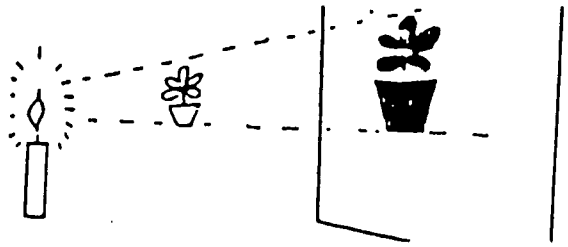
19. Below is a picture which will help you answer the question about the shadow?



To make the shadow of the flower in the pot larger, what should you do?

A. Move the flower away from the light.

B. Make the candle light brighter.

C. Put out the light.

D. Move the flower closer to the light.

20. What does a string telephone tell us about sound?

A. Sound travels through air.

B. Sound travels through liquids.

C. Sound travels through solids.

D. Sound travels through air and liquids.

21. Below are the pictures of two bar magnets with different ends close together. What will happen to these magnets?

A. They will attract or pull towards each other.

B. They will repel or push each other apart.

C. Nothing will happen to them.

D. They will become hot and heat up.

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22. Which of these is a bone in the human body?

A. stomach

B. heart

C. muscle

D. skull

23. What do spiders eat most often?

A. leaves

B. grass

C. pigs

D. flies

24. Which of these sentences is true about sound?

A. Sound cannot travel through empty space.

B. Sound cannot travel through wood.

C. Sound cannot travel through air.

D. Sound cannot travel through water.

25. Where does a bird of paradise usually live?

A. grassland

B. seashore

C. village

D. rainforest

26. Which of these animals live in the rainforest and seashore?

A. clam

B. cuscus

C. crocodile

D. wallaby

27. Wich colour do you get when you mix blue and yellow?

A. green

B. orange

C. red

D. white

28. Why do we need joints in the human body?

A. Joints protect the skin.

B. Joints help the body parts to move.

C. Joints store blood.

D. Joints let us hear

29. What happens to water when it is heated?

A. It contracts.

B. It expands.

C. It freezes.

D. It turns red.

30. What happens to light when it hits a mirror or looking glass?

A. It goes through.

B. It stops.

C. It reflects or comes back.

D. It changes colour.

Appendix III

Samples of Radio Science Materials

Radio Science Project Curriculum Topics
Grade 6

UNIT I

Process Science and Air Pressure

1 Introduction
2 Observing
3 Classifying
4 Measuring
5 Air Pressure
6 Air
7 Air
8 Inferring

UNIT II

Chemical Change

9 Burning
10 Burning
11 Burning
12 Mixtures & Solutions
13 Solutions
14 Solutions
15 Evaporation & Condensation

UNIT III

Simple Machines

16 Simple machines
17 Doing work
18 Inclined plane
19 Lever
20 Wheel and axle
21 Pulley
22 Pulleys
23 Applications

UNIT IV

Light

24 Travels in straight lines
25 The eye
26 Color
27 Reflection
28 Magnification
29 Images
30 Electricity I
31 Electricity II

UNIT V

Plants

32 Classification
33 Variety
34 Makes food
35 Uses
36 Gardens
37 Life Cycles
38 History of use

UNIT VI

Animals

39 Classification
40 Variety
41 For food
42 Domestic Animals
43 Life Cycles
44 Populations

UNIT VII

Ecology

45 Dependence
46 Food webs
47 Balance
48 Populations
49 Extinction
50 Predicting

NOTES FOR THE TEACHER

RADIO SCIENCE PROJECT

GRADE 6
UNIT 1 PROCESS SCIENCE
LESSON 8 INFERENCES
TIME FOR THE BROADCAST: 20 MINUTES
POST-BROADCAST TIME: 10 MINUTES

SPECIAL THINGS IN THIS LESSON:

During this broadcast the children will be making **inferences**. The definition and use of inferences is very important so you need to read the Science Notes carefully.

In the post-broadcast lesson please have a container with an object in it. Pass it around the class and have children make observations. After they have made lots of observations have them make some inferences. Then open the container to show them the object.

THINGS THAT YOU WILL NEED:

- Radio Science Book (page 8) for each pair of children.
- A pencil and an exercise book for each child.
- Fresh batteries for your radio.
- Have the children sit in pairs so that two children can share materials.
- Tell the children **not** to write in the Radio Science Book.

FINISH THE BROADCAST LESSON BY:

Revising the definition of the words observation and inference. Pass around your container with the object inside (suggestions are given below). List the **observations** on the chalkboard. Have them make **inferences**. List these. Now open the container. Did the children guess correctly? Did they make good inferences? Remember: the inference is good if it fits the observations.

Suggestions: containers: matchbox, Milo tin, Sunshine tin, small box.
object: a coin, a shell, some rice, a piece of chalk, a biro.

SCIENCE NOTES FOR THE TEACHER:

We all make guesses. Inferences are just special guesses. The guesses are special because we make as many observations as we can and then make a gues that fits the observation. Science people are looking for good answers to difficult questions so they make inferences. Then they test their inferences with experiments. It is sometimes difficult to tell the difference between an observation and an inference.

Observations state facts: It is green. It is hot. It is big. It is 100 years old. It is soft. It tastes sweet. It smells like a pineapple. It sounds like a kundu It feels smooth (these are things you know).

Inferences are guesses: I think it is a mango. It might be a stone. It may be good to eat. Maybe it's a small worm (these are things that you don't know exactly).

Doctors make observations: He has mosquito bites, he has a temperature, he feels awful, he has aches in his joints.

Doctors make inferences: I think he has malaria.

Then they experiment to be sure: take a drop of his blood and look at it under a microscope. If there are parasites then he has marlaria, if not then he has the flu.

AN ADDITIONAL LESSON ON THIS TOPIC:

Take several small containers and repeat the activity you did for the post-broadcast lesson. Children like these and you can do some easy ones and some hard ones. You can even trick the children like our teachers did with the tissue.

Children also like to put objects in containers for their classmates. It is like a game to make observations and inferences to guess what is in the container.

8
INFERRING

1

	Looking	Feeling	Hearing	Smelling	Tasting
Inferences	small oblong	heavy	rattles		

2

A.	Maybe it is made of wood
B.	It feels like a rubber ball
C.	I think it's an orange
D.	It is round like a ball
E.	It maybe a ball

3

sunshine milk

A

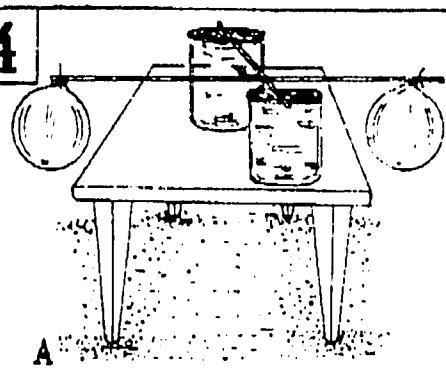
sunshine milk

B

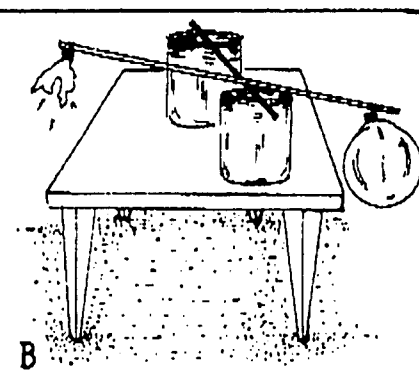
paper tissue

C

4



A



B

RADIO SCIENCE PROJECT

Grade 4 Lesson 54

Version: 4

Unit: Electricity and Magnetism

Lesson: What Is Electricity?

Materials: Radio Science Book Page Fifty Four.

Segment	Content	Page
1	Intro	1
2	What Is Electricity	2
3	Being Careful With Electricity	7
4	Revising A Simple Circuit	11
5	Revise Making A Torch Bulb Light	14
6	Using Electricity	17
7	Where Does Electricity Come From	19
8	Outro	25

Date Recorded: 15 December 1988

Music:

Science Song (Intro and Outro)

Music Bridges (Eight)

Playing Time: 19:14

Cast:

Mr Tore:	Timothy Gaemate
Mrs Poro:	Gwen Moide
Mary:	Lydia Elliot
Peter:	Isabel Aihi
Announcer:	Paul Mungul

Sound Effects:

Children Singing Softly
Batteries Being Removed From A Radio
Putting Batteries In A Torch
Radio Button Pressed
Taking Batteries Out Of A Torch
Mary and Peter running
Door Opening and Closing
Teacher Cue

INTRO

ANNOUNCER: This is Radio Science for grade four, lesson number fifty four. For this lesson, you will need your Radio Science Book page fifty four.

SCIENCE SONG INTRO (:10)

MRS PORO: Hello Mr Tore. I think Peter and Mary enjoyed our last lesson on electricity.

MR TORE: Yes, they did. Now the children know how to use a torch battery, a torch bulb and a wire to make a simple circuit.

MRS PORO: I heard Peter and Mary asking each other what electricity is and what makes it work.

MR TORE: Mary and Peter are asking important questions about electricity. We cannot see electricity unless we see lightning or an electric spark. But we can see how electricity makes many things work. We'll find this out in today's lesson.

MUSIC BRIDGE (:05)

WHAT IS ELECTRICITY

FX: RADIO MUSIC (:06)

MARY: I like singing and listening to music.

PETER: Me too. Let's sing.

FX: CHILDREN SINGING SOFTLY WITH RADIO (:04)

MR TORE: Sorry to stop your fun children. Look! I bought a new torch today. But I forgot to buy batteries. Peter, may I try my torch with the batteries from your radio?

PETER: Okay. Let me take them out for you.

FX: BATTERIES BEING REMOVED FROM RADIO (:03)

MR TORE: Thank you. Let me put them in. I only need two.

FX: PUTTING BATTERIES IN A TORCH

MR TORE: Look what happens when I turn the switch on.

PETER: (excited) It works Mr Tore, it works! The torch lights.

MARY: (annoyed) Peter turn on the radio. I want to finish singing with the radio.

PETER: Okay. I'll turn it on.

FX: RADIO BUTTON PRESSED

PETER: Umm, why is my radio not working?

MR TORE: Children, what does Peter's radio need to work?

PAUSE (:02)

MR TORE: Batteries. Peter's radio needs batteries to work just like my torch needs batteries to light. Peter your radio will work when you put the batteries back in the radio.

1 PETER: Good! But Mr Tore I don't understand
2 how a battery helps the radio work.

3 MR TORE: Well Peter, in order for the radio and
4 the torch to work, they need something
5 called electricity.

6 MARY: Elec...lec

7 MR TORE: Electricity. Children, say: Electricity.

8 PAUSE (:04)

9 MR TORE: That's right. Electricity.

10 PETER: What has a battery got to do with
11 electricity, Mr Tore?

12 MR TORE: Peter, you ask good questions. A
13 battery is one of the things that helps
14 make electricity.

15 MARY: But Mr Tore, when the battery sits on
16 the table, nothing happens. Where is
17 the electricity?

1 MR TORE: Good question, Mary. Electricity is
2 stored inside the battery. The battery
3 cannot do anything by itself. When you
4 connected the wire to the bulb and the
5 battery, you made a simple circuit. The
6 electricity inside the battery traveled
7 through the wire, to the bulb, and back
8 into the battery.

9 MARY: I understand. The circuit is like a
10 path for the electricity to travel.

11 MR TORE: That's a good way to describe it Mary.

12 PETER: Mr Tore, what does electricity do?

13 MR TORE: Well for one thing, electricity makes
14 the radio work. Electricity also

15 MARY: Makes the torch light up!

16 MR TORE: Yes Mary. Electricity makes things
17 happen. The wire is very thin, like the
18 one in a bulb, it gets so hot that it
19 gives off light. Electricity heats the
20 wire. That is how the bulb works!

PETER: That's interesting. Mr Tore, don't forget that my batteries are in your torch. May I have them back so that I can make my radio work?

FX: TAKING BATTERIES OUT OF TORCH (:)

MR TORE: Here they are Peter and thank you for letting me use them. Now I know my torch works. All I need are batteries. Children, can a battery work by itself?

PAUSE (:02)

MR TORE: No. A battery can not work by itself. We cannot see electricity inside a battery, but we can hear, see and feel what it does.

MUSIC BRIDGE (:05)

BEING CAREFUL WITH ELECTRICITY

1 MR TORE: Peter, you seem to be very busy. What
2 are you doing?
3
4 PETER: I'm making a kite to fly this afternoon.

5 MR TORE: Peter, it is not safe to fly a kite in
6 our school yard.

7 PETER: Why not Mr Tore?

8 MR TORE: Look at those power lines up there. It
9 is not safe flying your kite near those
10 lines. So never ever go near those
11 lines.

12 PETER: Okay. I won't.

13 MUSIC BRIDGE (:05)
14
15 MRS PORO: Children, you heard Mr Tore telling
16 Peter about being careful when playing
17 near Power lines.

18 MR TORE: Power lines carry electricity.
19 Electricity can be dangerous if you are
20 not careful with it.

1 MRS PORO: Yes. It can harm you if you are not
2 careful. Here are some of the things
3 you should remember when using
4 electricity.

5 MR TORE: Children, look at Box One... That's a
6 power point. When you switch on a power
7 point, always make sure you switch it
8 off when you have finished.

9 MRS PORO: You can switch these power points on and
10 off but never play with them.

11 MR TORE: Do not put a knife or other metals into
12 power points. Use only a safe cord.
13 Make sure the cord is not broken or that
14 it does not have loose wires.

15 MRS PORO: If you are flying kites, you should fly
16 them in clear places where there are no
17 power lines.

18 MR TORE: Never handle electric appliances like
19 radios if you are touching water. You
20 must be careful not to spill water on
21 electric appliances.

1 MRS PORO: Children, you may see power posts and
2 lines along the roads. Should you climb
3 these power posts or touch these power
4 lines?

5 PAUSE (:02)

6 MRS PORO: No. Never climb these power posts or
7 touch these power lines.

8 MR TORE: Now look at Box Two... This shows wires
9 from the power post that have fallen to
10 the ground. You can see the electric
11 sparks. Is it safe to touch these
12 wires?

13 PAUSE (:02)

14 MR TORE: No. It is not safe to touch wires from
15 a power post. Wires may have
16 electricity flowing through them and the
17 electric current is very powerful.

18 MRS PORO: Electricity can be very dangerous to you
19 if you touch wires when electricity is
20 flowing through them.

MR TORE: Children, we have learnt some ways that we should be careful when using electricity. You can make safety posters with your teacher after the broadcast.

MUSIC BRIDGE (:05)

REVISING A SIMPLE CIRCUIT

MR TORE: Children, look at Box Three... Point to Letter A... Is the wire wrapped around the metal part of the bulb?

PAUSE (:02)

MR TORE: Yes. The wire is wrapped around the metal part of the bulb.

MRS PORO: Point to Letter B... Is the bottom of the bulb touching the top of the battery?

PAUSE (:02)

MRS PORO: Yes. The bottom of the bulb must touch the top of the battery.

MR TORE: Point to Letter C... Is one end of the wire touching the bottom of the battery?

PAUSE (:02)

MR TORE: Yes. One end of the wire must touch the bottom of the battery.

1 MRS PORO: Box Three shows one way we can light the
2 bulb. Electricity will flow from the
3 battery into the bulb, through the wire
4 and back into the battery at C. This is
5 a complete circuit.

6 MR TORE: Tell me children, if I turned the
7 battery upside down, would the bulb
8 still light?

9 PAUSE (:02)

10 MR TORE: Yes. The bulb would still light because
11 electricity is still flowing through.

12 MRS PORO: If the wires in the bulb broke, would
13 the bulb light?

14 PAUSE (:02)

15 MRS PORO: No. If the wires in the bulb broke,
16 electricity could not flow through.

17 MR TORE: Children, if you did not have a wire
18 connected to the bulb and battery, would
19 the bulb light?

PAUSE (:02)

MR TORE: No. The bulb would not light. There must be a wire connecting the bulb and battery to make the bulb light.

MRS PORO: A complete circuit has electricity going from one end of the battery through the wire, through the bulb and then back into the battery. The bulb lights.

MR TORE: When a bulb lights, we know the circuit is complete. If the bulb does not light up, we know the circuit is not complete.

MRS PORO: We know the simplest circuit is made up of a battery, a wire, and a bulb.

MUSIC BRIDGE (:05)

REVISE MAKING A TORCH BULB LIGHT

MRS PORO: Children, look at Box Four... The pictures in Box Four show some of the ways to light the bulb. Some of them work and some do not. Look at them carefully.

PAUSE (:02)

MRS PORO: Now we'll ask you some questions about the circuits.

MR TORE: Look at Picture A... Will the bulb light?

PAUSE (:02)

MR TORE: No. The bulb will not light.

MRS PORO: Children, what is missing in Picture A to make the bulb light?

PAUSE (:02)

MRS PORO: The wire. The wire is missing. You need a wire, a bulb and battery for a simple circuit.

1 MR TORE: Look at Picture B... Will the bulb
2 light?

3 PAUSE (:02)

4 MR TORE: Yes. The bulb will light. The wire is
5 connected to the metal part of the bulb.
6 The electricity can get from one end of
7 the battery to the other. Picture B is
8 a complete circuit.

9 MRS PORO: Look at Picture C... Will the bulb
10 light?

11 PAUSE (:02)

12 MRS PORO: No. The bulb will not light. If the
13 wire could touch the metal part of the
14 bulb, would the bulb light?

15 PAUSE (:02)

16 MRS PORO: Yes. We must have a wire, a bulb and a
17 battery touching correctly to make the
18 bulb light.

MR TORE: Children, look at Box Three again... Now look at Box Four... Which picture in Box Four is the same as the picture in Box Three?

PAUSE (:02)

MR TORE: Picture B. Picture B is the same as Box Three. They are both pictures of a complete circuit.

MRS PORO: When the wire, bulb and battery are touching correctly, we have a complete circuit. The bulb will light.

MUSIC BRIDGE (:05)

USING ELECTRICITY

PETER: Mary, we must tell Mrs Poro and Mr Tore about our visit to the power station.

MARY: That's a good idea. It was very exciting to see all the machines the men were working on. I had never seen such big machines.

PETER: Come on, let's go.

FX: MARY AND PETER RUNNING (:)

FX: DOOR OPENING AND CLOSING (:0)

PETER: Mrs Poro, Mr Tore we're back from our trip.

MARY: Peter and I have so much to tell you.

PETER: Yes. Mary and I visited the power station and we saw lots of machines. Big one! Very big ones!!

MARY: Mr Tore, these machines help to make electricity.

1 MR TORE: Yes Mary, the power station has machines
2 that make electricity. Let's look at
3 some of the things that use electricity.

4 MRS PORO: Children look at Box Five... These
5 pictures show different kinds of things
6 which use electricity. Look at A...
7 That's an electric stove. Look at B...
8 That's an electric jug.

9 MR TORE: Look at C... What is it?

10 PAUSE (:02)

11 MR TORE: A light bulb. Look at D... What is it?

12 PAUSE (:02)

13 MR TORE: A television. All of these things use
14 electricity, but they need electricity
15 from power lines. They need powerful
16 electricity.

17 MUSIC BRIDGE (:05)

WHERE DOES ELECTRICITY COME FROM

MR TORE: We've learnt what electricity can do.

MRS PORO: Children, do torch batteries make your radio work?

PAUSE (:02)

MRS PORO: Yes. Torch batteries make your radio work.

MR TORE: We have used a battery and a wire to light a bulb. The battery made electricity.

MRS PORO: Children, did your battery make a large amount or a small amount of electricity?

PAUSE (:02)

MRS PORO: Small. Your battery could make only a small amount of electricity.

MR TORE: Children, towns and cities use a lot of electricity. Your small batteries

1 TEACHER CUE (:01)

2 MRS PORO: Teacher. Call on one child to tell
3 where electricity comes from?

4 PAUSE (:04)

5 MRS PORO: Another child.

6 PAUSE (:04)

7 MRS PORO: You may have said electricity comes from
8 batteries, or may be someone said
9 electricity comes from lightning. We
10 can see electricity during a lightning
11 storm.

12 MR TORE: Look at Box Six... The picture you see
13 shows one way of making electricity.
14 This way of making electricity is called
15 Hydro Electric Power. Children, Say:
16 Hydro.

17 PAUSE (:02)

18 MR TORE: Say: Electric

PAUSE (:02)

MR TORE: Say: Power

PAUSE (:02)

MR TORE: Let's say it all together. Say after me: Hydro Electric Power

PAUSE (:05)

MRS PORO: The word hydro means water. Look at Letter A... Letter A shows the water that has collected behind a dam. Children, what does the word hydro mean?

PAUSE (:02)

MRS PORO: Water. The word hydro means water. Look at B... Letter B shows a big wall built across a river. It is called a dam. The dam holds the water.

MR TORE: Look at C... That is a turbine. Say: Turbine.

PAUSE (:02)

1 MR TORE: When the water falls from the dam, it
2 turns the turbine. Look at Letter D...
3 That is a generator. Say: Generator.

4 PAUSE (:03)

5 MR TORE: The turbine spins the generator very
6 fast. The generator produces
7 electricity.

8 MRS PORO: Now look at Letter E... That is a power
9 line. Electricity flows from the
10 generator to the power lines. The power
11 lines carry electricity to the buildings
12 and houses in towns and cities.

13 MR TORE: Children, most of our power supply in
14 Papua New Guinea comes from water.
15 Papua New Guinea has many rivers. Dams
16 can be built across these rivers. The
17 water can be piped into the turbines and
18 large generators.

19 MRS PORO: Children. Does most of our power supply
20 in Papua New Guinea come from water?
21
22

PAUSE (:02)

MRS PORO: Yes. In Papua New Guinea we use water for our power supply.

PETER: Mrs Poro, sometimes my friends and I pile stones and sticks across a stream to make a little pond. Would that be a dam?

MRS PORO: Yes Peter, you made a small dam. You were holding back the water just like the picture in Box Six.

PETER: Could I make electricity with my small dam?

MRS PORO: (laughing) No! Peter. It takes very big machinery and a large dam to make electricity. You could make a wheel that would turn in the water like a turbine.

PETER: How would I do that.

MRS PORO: You would have to find a place where the river runs fast. You could make a wheel out of bamboo or palm leaves and make it turn on a stick. It wouldn't be easy, but you could do it.

PETER: I think I'll try it. I like building dams. I'll see if I can make a wheel with a bamboo stick and palm leaves. I'll tell you how it comes out.

MUSIC BRIDGE (:05)

OUTRO

PETER: Mr Tore, I didn't know electricity could do so many things. Electricity is very important to us.

MR TORE: You are right, Peter. We know there are many ways to make electricity. And many ways to use it.

MRS PORO: Peter. I want you to remember that electricity can be very dangerous to us if we are not careful.

PETER: Yes. Mary made a safety poster. I will make one too.

MRS PORO: Good Peter. Children, after the broadcast, you should make some safety posters about electricity for your classroom too. This will remind you to use electricity safely.

MR TORE: Have fun making your safety posters. Goodbye now.

125

ANNOUNCER: Teacher, you will continue the lesson by revising what is electricity. Please read the Notes For The Teacher for details. This was Radio Science for grade four, lesson number fifty-four.