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EVALUATION STUDY OF
SUMMER INSTITUTES IN RADIATION BIOLOGY

F. E. RUSHFORD

1965



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Abstract

From 1959 through 1964 six Summer Institutes in Radiation Biology were offered in Puerto Rico. A total of 115 teachers were enrolled. Since the number of applications for admissions dropped in 1964, no Institute was offered in 1965, and instead a study was made to determine the value of the Institutes to participants. Sixty participants were interviewed, and this report is a detailed account of the information obtained. The results indicate limited utilization of the training in most cases, due to the absence of radiation biology courses from the curriculum being taught, lack of basic teaching materials including textbooks, inadequate laboratory facilities, and lack of safe storage areas for equipment. The conclusion is that continuation of the Institutes under these conditions is not justified. It is recommended that the Department of Education be urged to recognize the importance of radiation biology in the science curriculum.

INTRODUCTION

The first Summer Institute in Radiation Biology conducted in Puerto Rico was offered at the College of Agriculture & Mechanic Arts of the University of Puerto Rico during the Summer of 1959. Table 1 lists pertinent data about the six Institutes offered from 1959 through 1964.

The objectives of the Summer Institute program in general are (a) to improve the subject matter competence of the participating teachers, (b) to strengthen their capacity to motivate able students toward careers in science, (c) to bring the teachers into personal contact with prominent scientists participating in the Institutes, and (d) to bring about greater mutual understanding and appreciation of their problems among people teaching science at various academic levels.

The specific objectives of the Radiation Biology Institute program are (a) to make teachers aware of the importance of radiation in the modern world, (b) to provide them with an adequate fundamental knowledge of radiation biology, and (c) to train them in the use of radiation detection equipment so that they are prepared to teach radiation biology within the framework of the present school curriculum.

In 1962, the Director of PRNC requested the cooperation of the Department of Education of the Commonwealth of Puerto Rico in offering the Institute. The Department of Education agreed (a) to help select teachers to attend the Institute, and (b) to provide funds for the participants' traveling expenses and lunches. At the request of the Science Curriculum Department of the Department of Education, the

Table 1

Summer Institutes in Radiation Biology Offered in Puerto Rico, 1959-1964

(Operating funds were provided by the US AEC. Participant support was provided by NSF, except in 1962, when it was provided by the P.R. Dept. of Education.)

Year	Sponsor	Director	Location	Enrollment (total, 115)
1959	CAMA, UPR	Dr. J. Ramos, Dr. H. Lugo	Mayaguez	22
1960	PRNC, UPR	Dr. J. Ferrer Monge	Mayaguez	21
1961	PRNC, UPR	Dr. J. Ferrer Monge	Mayaguez	20
1962	PRNC, UPR*	Mr. F. E. Rushford	Río Piedras	12
1963	PRNC, UPR*	Mr. F. E. Rushford	Río Piedras	20
1964	PRNC, UPR*	Mr. F. E. Rushford	Río Piedras	20

*With the cooperation of the P.R. Dept. of Education.

Table 2

Participation in Other Institutes by Radiobiology Institute
Participants Interviewed

No. of other Institutes attended	No. of persons	% of those interviewed
0	13	21.6
1	23	40.0
2	12	19.2
3	6	9.6
4	5	8.0
5	1	1.6
Total	60	100.0

American Institute of Biological Sciences BSCS* high school biology course materials were purchased for the participants, and a contemporary biology course was offered in addition to the radiation biology course as part of the Institute. Each course was assigned three semester hours of credit through the UPR Department of Biology in Río Piedras. The contemporary biology course was taught by Mrs. Graciela Candelas, Assistant Professor of Biology at UPR. The radiation biology course was taught by PRNC staff members. The Department of Education wanted the BSCS high school biology course taught because the decision had been made to offer this course in the public schools, and trained teachers were needed. The PRNC staff thought that this course would upgrade the background of the teachers and help them understand the more complex radiation biology course.

The cooperation of the Department of Education in selecting candidates for the Institute was continued in order to ensure that a maximum number of teachers participating would return to classroom teaching. In 1963, 86 applications were received and were reviewed by an ad hoc admissions committee composed of Mrs. María Antonia Ruiz, Director of Science Curriculum, P.R. Department of Education; Mrs. Graciela Candelas, Assistant Professor of Biology, UPR; and Mr. Frederick E. Rushford, Director, Summer Institute in Radiation Biology, PRNC. The Institute curriculum was similar to that in 1962, with Dr. Gustavo Candelas, Professor and Chairman of the UPR Department of Biology, teaching the contemporary biology course with emphasis on the Green

* Biological Sciences Curriculum Study

version of the BSCS high school biology course. Mrs. Ruiz had indicated that the teachers trained in this Institute would be provided with the BSCS materials needed for their students and would be assigned to teach this course during the next academic year.

In 1964, 100 application forms and brochures were distributed, but only 44 applications were received. The Institute was held as in 1963. The sharp decline in the number of applications indicated that an evaluation of the impact of the Institutes should be made. The US AEC Division of Nuclear Education and Training granted permission to PRNC to utilize funds for making an evaluation study during the spring of 1965.

EVALUATION PROCEDURE

A personal interview with each former participant still teaching was considered to be the best way of obtaining pertinent information. A letter (see Appendix I) was sent to each of the 114 former participants requesting a personal interview and asking whether they were still teaching. In many cases a second letter had to be sent before an answer was received; in other cases information about former participants was obtained from Institute classmates or fellow teachers while visiting a school. If the participant was no longer teaching, a personal interview was considered unnecessary.

Sixty former Institute participants were visited. Each interview lasted about 30 minutes and was based on the AEC-NSF Institute Evaluation Guide (see Appendix II) used in a national survey of the AEC-NSF sponsored Summer Institutes in Radiation Biology covering the period from 1956 through 1961. (In this national survey 795 questionnaires were

returned out of approximately 1700 sent out (47% response). Of the 795, only 5 were from Puerto Rico. Since 63 persons had attended the three Institutes in Puerto Rico from 1959 to 1961, the 5 responses represented only an 8% response.) During the personal interview the questions were asked by the interviewer and the answers written down, with any additional comments or qualifications added. The interviews were conducted in Spanish.

ANALYSIS OF DATA

The enrollment recorded for the six Institutes was 115, but since one teacher attended twice, the total enrollment was considered to be 114. The number of persons interviewed was 60 (52.6% of the total). Of the 114 participants, 69 (60.5%) are still teaching; 29 (25.5%) are no longer teaching; and 16 (14%) did not respond. Since the interviews were based on the Institute Evaluation Guide, the data are presented according to its sections.

1. Identification Information. After giving his current home and school address, each person was asked to list all other Institutes, besides Radiobiology, in which he had participated. (See Table 2.) Of those interviewed, 47 (78.4%) had attended one or more other Institutes. Table 3 lists these by institution and type. Many of the Institutes attended were unrelated to actual teaching assignments. The data on educational backgrounds are given in Table 4. Of those interviewed, 33.2% had either graduate training or two undergraduate degrees. Of the undergraduate majors, 41.5% were in biology and 28.5% in education.

Table 5 lists subjects taught before attendance at the Institute and at present. Biology only was taught by 19 prior to attendance and is

Table 3

Institutions and Types of Institutes Attended by Persons Interviewed

Institution	Type of Institute	Date	No. of those interviewed attending
Catholic U. of P.R.	PSSC* Physics	Summer 1962	4
Cornell U.	Chemistry	Summer 1961	1
	Science Education	AYI 1962-63	1
Darwin Centennial Mtg.	Chemistry, Geology, Astronomy	Summer 1961	1
Florida U.	Aerospace	Summer 1963	1
Fordham U.	PSSC Physics	Summer 1961	1
Indiana U.	Biology	Summer 1957	1
Inter-American U.	Mathematics	Summer 1957	1
	Biology	Summer 1958	3
	Mathematics	Summer 1958	1
	General Science	Summer 1959	1
	Biology	Summer 1960	2
	Modern Biology	Summer 1962	2
	Modern Biology	Summer 1964	5
	Modern Biology	Summer 1965	2
Missouri State Teachers Coll.	Biology	Summer 1963	1
Montana U.	Science Teaching	Summer 1962	1
	Science Teaching	Summer 1963	1
	Science Teaching	Summer 1964	1
Ohio State U.	Biology	AYI 1958-59	1
U. of Pennsylvania	Biochemistry	AYI 1960-61	1

*Physical Sciences Study Committee.

Table 3 (continued)

Institution	Type of Institute	Date	No. of those interviewed attending	
UPR (Río Piedras)	Mathematics and Science	Summer 1958	5	
	Mathematics	In-service 1959-60	1	
	Mathematics and Physics	Summer 1960	1	
	Mathematics	Summer 1960	1	
	Teaching of Modern Biology	In-Service 1960-61	1	
	Astronomy and Meteorology	Summer 1961	1	
	Mathematics	Summer 1961	3	
	Chemistry	Summer 1961	1	
	Mathematics and Science	Summer 1961	2	
	Chemistry	Summer 1962	4	
	Geology and Meteorology	Summer 1962	3	
	PSSC Physics	Summer 1962	3	
	Chemistry	In-service 1962-63	1	
	Mathematics	AYL 1962-63	1	
	Ecology	In-service 1962-63	1	
	Mathematics	Summer 1963	2	
	Physics Seminars	In-service 1963-64	1	
	Mathematics	AYL 1963-64	1	
	Astronomy and Physics	Summer 1964	1	
	Chemistry Study	Summer 1964	1	
	BSCS Biology	In-service 1964-65	1	
	Chemistry Study	Summer 1965	1	
	Astronomy and Meteorology	Summer 1965	1	
	PSSC Physics and Geology	Summer 1965	1	
	UPR (CAMA)	Biology	In-service 1958-59	1
		Biology	Summer 1959	1
		Mathematics	Summer 1959	1
Biology		In-service 1959-60	1	
Biology		In-service 1961-62	3	
Chemistry		In-service 1962-63	3	
Marine Biology		Summer 1963	1	
Mathematics		In-service 1963-64	1	
Physics		In-service 1963-64	3	
Chemistry, Physics, Biology		Summer 1964	1	
Field Biology		Summer 1964	1	
Biology	In-service 1964-65	1		
		Total	90	

Table 4

University or College Training of Participants Interviewed

<u>Undergraduate degrees</u>			<u>Undergraduate majors</u>			<u>Undergraduate minors</u>		
Type	No.	%	Type	No.	%	Type	No.	%
None	1	1.6	Biology	27	41.5	None	16	24.0
B.A.	24	40.0	Education	19	28.5	Chemistry	17	26.5
B.S.	28	46.6	Science	6	9.0	Science	9	13.5
B.A. & B.S.	7	11.8	Mathematics	4	6.0	Education	7	10.5
Total	60	100.0	Home Economics	1	6.0	Mathematics	5	7.5
			Pharmacy	1	1.5	Biology	3	4.5
			Chemistry	1	1.5	Physics	3	4.5
			Social Sciences	1	1.5	Social Sciences	3	4.5
			Nutrition	1	1.5	Agriculture	1	1.5
			Agronomy	1	1.5	Psychology	1	1.5
			French	1	1.5	Spanish	1	1.5
			Total	66	100.0	Total	66	100.0

<u>Professional Diploma</u>			<u>Graduate Majors</u>		
Type	No.	%	Type	No.	%
Supervision	4	6.6	Professional Diploma		
			Supervision	4	30.7
			M.A. Degree		
			Biology	1	7.7
			Science Education	2	15.4
			Public Administration	1	7.7
			M.S. Degree		
			Science Education	1	7.7
			Biochemistry	1	7.7
			Biology	1	7.7
			Mathematics	1	7.7
			M.P.H. Degree		
			Public Health	1	7.7
			Total	13	100.0

<u>Graduate Degrees</u>		
Type	No.	%
M.A.	4	6.6
M.S.	4	6.6
M.P.H.	1	1.6
Total	9	14.8
Grand Total*	13	21.4

*Either Professional Diploma or Masters Degree

Table 5

Teaching assignment before Radiation Biology Institute participation		Present assignment	
Biology only	19	Biology only	24
Biology & Chemistry	4	Biology Demonstration Classes	1
Biology & General Science	1	Biology & Chemistry	4
Biology & Mathematics	2	Biology & General Science	3
Biology & Physical Sciences	2	Biology & Physical Science	1
Biology, Chemistry, & Mathematics	3	Biology, Chemistry, General Sciences, & Physics	1
Biology, Chemistry, & Physical Sciences	6	Chemistry only	2
Biology, General Science, & Mathematics	3	General Science only	8
Chemistry only	1	Mathematics only	3
General Science only	7	Mathematics & Science	1
Mathematics only	2	Physics & Physical Science	2
Mathematics & Science	5	Chemistry, Physics, & Mathematics	1
Physics & Physical Sciences	2	Mathematics, General Science, & Religion	1
Chemistry, Physics, & Physical Science	1	Science Teaching Methodology	1
Mathematics, Physics, English, & Religion	1	Science Coordinator, Physics & Health	1
Science Coordinator	1	Pathology Teaching Assistant	1
		Curriculum Technician	2
		Principal	3
Total	60	Total	60

Table 6

Numbers of Sections, Students, and Textbooks for Each of 16 Teachers

Subject	No. of sections	No. of students	No. of textbooks
BSCS Biology	3	84	84
Biology	4	147	30
Biology	4	158	no texts
Biology	4	160	no texts
Biology	2	65	no texts
BSCS Biology	3	125	60
BSCS Biology	3	140	no texts
Biology	3	102	60
BSCS Biology	3	120	26
Biology	3	104	28
Biology	4	160	160
BSCS Biology	1	36	28
General Science	8	320	160
BSCS Biology	3	130	no texts
BSCS Biology	3	121	29
Biology	1	44	no texts
Total		2016	665

being taught by 24 now. For biology either alone or with other subjects, the corresponding numbers are 40 (66.7%) and 34 (56.7%). Three persons were promoted to principal and two were named curriculum technicians after participation. The numbers of sections taught, pupils, and textbooks for each of 16 teachers are listed in Table 6. Note that only about one textbook was available for every three students on the average. Of the 7 teachers teaching BSCS biology, only one had enough texts. All the teachers interviewed indicated a shortage of texts, laboratory manuals, laboratory equipment, or a combination of these.

2. Institute Carry-Over. A numerical tabulation of the answers to the questions in this section appears in Table 7. Note that 63.0% of the people interviewed stated that their participation in the Radiation Biology Institute was highly useful, yet only 16.7% stated that they could use the training received a great deal in their teaching. This is a reflection of the fact that radiation biology has not been incorporated into the school curriculum and that any teaching of this material comes from the individual teacher's effort alone without official support. Of those interviewed, 54 (90%) stated that the school administration was generally sympathetic toward their efforts to incorporate radiation biology into their regular courses. It appears that the local school administrations are in favor of introducing radiation biology into the curriculum, but that this is not supported by the Department of Education.

Of those interviewed, 51 (85%) indicated they had maintained contact with their Radiation Biology Institute Director; 36 (60%) of the 60 persons interviewed indicated they had not used their training in nonteaching activities; 45 (75%) indicated that their training had been helpful in

Table 7

Tabulation of Answers to Institute Carry-Over Questions

1. Do you consider your participation in a Radiation Biology Institute to have been: slightly useful 4, useful 20, highly useful 36, not answered 0. Total 60.
 - 1a. Has your school administration been generally sympathetic toward incorporating radiation biology into your course work? yes 54, no 3, uncertain 1, not answered 2. Total 60.
 2. To what extent have you been able to incorporate the training received into your teaching? none 2, very little 9, some 39, a great deal 10. Total 60.
 3. Have you continued liaison with your Institute director? yes 51, no 8, not answered 1. Total 60.
 - 3a. How? correspondence 4, repair equipment 2, arrange student visits 18, science fair consultation 3, not specified 24. Total 51.
 4. To what extent have you used your training in nonteaching activities, i.e., lectures to community groups? none 36, civil defense 8, lecture to civic groups 12, not specified 4. Total 60.
 5. Has your training been of use with respect to science fairs, science clubs, etc.? yes 45, no 14, not answered 1. Total 60.
 6. Would you enroll in a Summer Institute in Advanced Radiation Biology? yes 57, no 1, not answered 2. Total 60.
 - 6a. Why? teacher supervision 1, improve teaching 24, personal interest 17, no reason given 15. Total 57.
 7. Do you receive the Radiation Biology Newsletter regularly? yes 44, no 16. Total 60.
 - 7a. Do you find it: of little use 1, of moderate use 27, of much use 15, did not specify 1. Total 44.
-

guiding students for science fairs and science clubs.

Fifty-seven (95%) of those interviewed indicated they would enroll in an Advanced Institute in Radiation Biology if it were offered, in order to improve teaching (42.1%) and for personal interest (30%). Again it should be stressed that the participants appear to recognize the value of radiation biology and indicate a desire to learn more, but there is no official provision within the existing science curriculum of the public schools of Puerto Rico for them to use the training properly.

The Radiation Biology Newsletter is received regularly by 44 (73.3%) of those interviewed, and 42 find it useful. Suggestions for improving the Newsletter included describing experiments in more detail, adding a Spanish section or translation, publishing more information on new equipment, adding topics related to a tropical environment, adding a section from Puerto Rico (possibly contributed through PRNC), and publishing descriptions of student projects. Note that language was mentioned here as a prime factor in communication of ideas. Teachers requesting a Spanish edition feel that their students' knowledge of English is too poor for them to use the present English version. It should be emphasized that more than 90% of the teachers interviewed indicated that their students have difficulty reading English, so that the teachers spend much of their classroom time translating into Spanish. This is an additional obstacle to the introduction of radiation biology into the curriculum, since most of the reference materials originate in the United States and are in English.

3. Equipment Kit. Each participant in a Radiation Biology Institute is provided with an equipment kit, which he learns to use during the Institute and which is then assigned to his school. The kit remains the

property of the U.S. Government, but the teacher uses it as desired and takes it with him when transferred to another school. The return of some scaler ratemeters was requested because of a manufacturing defect, and some participants did not take a kit because of uncertainty regarding their next teaching assignment.

A typical kit contains the following:

- 1 Scaler ratemeter
- 1 Beta-gamma detector, side window
- 2 Beta detectors, mica end window
- 1 Probe and cable
- 1 30-in. cable
- 1 Tube mount and sample holder with clamp
- 1 Absorber set, 8 aluminum, 4 lead
- 1 Radium D and E source
- 1 Cobalt-60 source
- 100 Planchets and rings
- 1 3-Wire and ground adapter
- 1 Electroscope
- 1 Spinhariscope
- 1 Cloud chamber kit
- 1 Stop watch
- 4 Film holders for autoradiography experiments
- 1 Package X-ray film
- 1 Package developer
- 1 Package fixer
- 2 1-cc syringes

- 2 2-cc syringes
- 2 5-cc syringes
- 12 Hypodermic needles
- 1 Package assorted micropipettes
- 1 Rubber-bulb pipettor
- 1 Pair rubber gloves
- 1 Pair plastic gloves
- 2 Radioactivity warning placards
- 1 Roll radioactivity warning tape

Each equipment kit costs about \$700, and about 100 kits were issued to participants in Puerto Rico, so that about \$70,000 worth of science equipment was given to the schools. Note that part of this equipment is useful for conventional science experiments.

Table 8 summarizes the information obtained on equipment kits from the persons interviewed. The average dimensions of 39 classroom-laboratories indicated adequate size and ventilation. The utilities were inadequate in many cases (e.g., defective electrical installations, no water, no gas). The result is that many teachers conduct a very limited laboratory program as part of courses such as biology, which require laboratory exercises. With utilities defective or missing, it is impossible to do experiments in radiation biology. Autoradiography experiments require dark room facilities, and the fact that 78% of the teachers had none indicates that they were not able to do autoradiography experiments even though all the equipment was provided.

The equipment kit was used, on the average, 23 days or 12.8% of the academic year. This does not mean that all the equipment was being used

Table 8

Laboratory Facilities Available to Teachers Having Radiation Biology Kits, and Information on Kit Utilization

1. Estimated size of average science classroom-laboratory (based on approximate floor area dimensions of 39 classroom-laboratories visited): approximately 40 ft. x 25 ft., approximately 1075 sq. ft.
2. Utilities available to the teacher (based on 41 classroom-laboratories visited): Electricity: yes 35, defective 6. Water: yes 30, no 11. Gas: yes 21, no 20.
3. Darkroom facilities available in school or nearby: yes 9, no 32.
4. Estimated average use of equipment kit during an approximately 180-day school year (based on 43 replies): 23 days.
5. Ten (16.7%) of the persons interviewed indicated they did not have an equipment kit for the following reasons: left at another school 5, returned to Director 2, equipment not issued 1, equipment in storage 2.
6. Utilization of equipment in courses other than biology (based on 46 replies): physics 20, chemistry 17, general science 13, physical science 4, mathematics 1, none 7.
7. Utilization of equipment for research: yes 14, no 36, total 50. Type of research: student project for science fair 12, not specified 2. Total 14.
8. Does scaler ratemeter function properly at this time? yes 30, no 18. Total 48.
9. Has maintenance and repair of equipment been a minor problem? 33, a serious problem? 11. Total 44.
10. Evaluation of five instruments from the equipment kits in order of their value to the participants (based on 43 replies):

	<u>1st</u>	<u>2nd</u>	<u>3rd</u>	<u>4th</u>	<u>5th</u>
Scaler ratemeter	39	2	1	0	0
Electroscope	0	16	13	7	2
Autoradiography kit	1	16	6	11	9
Cloud chamber	2	9	16	11	3
Spinthariscopes	0	2	7	10	14
11. Would you prefer the scaler ratemeter available as a separate unit? yes 37, no 8. Total 45.
12. If the ratemeter were portable, as a separate unit, would it be preferred over the present combined unit? yes 36, no 7. Total 43.
13. Estimate how much use you could make of the ratemeter: none 1, little 0, some 7, considerable 32. Total 40.

at the same time, but only that some part of the equipment, in most cases the scaler ratemeter, was used in a demonstration or an experiment. The equipment kit had been used for research in less than one-third of the cases, mostly in projects being done by students for a science fair.

Almost two-thirds of the scaler ratemeters were not functioning properly. Since the scaler ratemeter is a basic radiation detection unit needed for the majority of radiation biology experiments, it may be assumed that teachers with defective ones were doing little or no radiation biology laboratory work. One-fourth of the teachers stated that maintenance and repair of equipment had been a serious problem. The main difficulty is that the equipment must be brought to the Nuclear Center for repair, and, since it does not belong to the school, the teachers have difficulty in obtaining transportation and in some cases have made little or no effort.

4. Radioisotopes. Radioisotopes are needed for most experiments in radiation biology. Each participant is entitled to order a free package of radioisotopes once during each of the three years following an Institute. Subsequently he must either purchase them or find another source of supply. The utilization of radioisotopes is a direct reflection of the extent that a participant has been able to incorporate the training received into his teaching.

Table 9 summarizes the information obtained. Only 20 (33.3%) of the 60 persons interviewed indicated that they had ever ordered radioisotopes. Not one of the 16 participants from the 1964 Institute had ordered any. Some of the reasons for failure to order free radioisotopes were as follows. After the 1959 and 1960 Institutes the free packages were sent without being ordered. Some teachers had no equipment and therefore could not use the radioisotopes. Three teachers had no safe place to store the

Table 9

Information on Radioisotope Procurement and on Availability of
a Source of Ionizing Radiation

	1959	1960	1961	1962	1963	1964	Total	%
1. Did you order radioisotopes?								
yes	4	5	4	3	4	0	20	33.3
no	9	4	0	3	8	16	40	66.7
						Total	60	100.0
2. If NO, why not?								
a) free package sent without ordering	7	3	0	0	0	0	10	25.0
b) no equipment	2	1	0	0	1	1	5	12.5
c) not teaching	0	0	0	2	1	0	3	7.5
d) inadequate facilities	0	0	0	1	1	1	3	7.5
e) no specific reason	0	0	0	0	5	14	19	47.5
						Total	40	100.0
3. If YES, how many times did you order the free packages?								
a) one time	2	1	2	1	2	0	8	40.0
b) two times	0	1	0	0	2	0	3	15.0
c) three times	2	3	2	2	0	0	9	45.0
						Total	20	100.0
4. Did you ever purchase radioisotopes?								
yes	0	0	0	0	0	0	0	00.0
no	13	0	4	6	12	16	60	100.0
						Total	60	100.0
5. If NO, did you obtain additional free radioisotopes?								
yes	1	1	1	1	0	0	4	6.7
no	12	8	3	5	12	16	56	93.3
						Total	60	100.0
6. If YES, where did you obtain them?								
PRNC	1	1	1	1	0	0	4	100.0
7. Do you have access to a source of ionizing radiation?								
yes	12	8	4	6	12	16	58	96.7
no	1	1	0	0	0	0	2	3.3
						Total	60	100.0

radioisotopes. Three did not return to the classroom. Nineteen gave no specific reason, but the factors prompting them not to order radioisotopes included inadequate utilities, lack of safe storage area, no official place in the curriculum for radiation biology experiments, not teaching biology or other courses including laboratory work, schedule too full to allow time for preparation of experiments, and equipment not functioning - or a combination of these. Not one of the 60 persons interviewed had purchased radioisotopes. All of this indicates that the application of the training received at a Radiation Biology Institute is limited largely to mention of theoretical concepts in class while the more valuable laboratory training of the students is generally not done.

Almost all the teachers had access to a source of ionizing radiation where they could send seeds or other materials to be irradiated, namely, the Puerto Rico Nuclear Center irradiation sources in Río Piedras and Mayaguez. The main difficulty is transportation of samples from small towns that are not near either San Juan or Mayaguez.

5. Supplementary Information. To obtain additional information helpful to PRNC in determining its role in training and support of teachers in Puerto Rico, a series of questions was added to the AEC-NSF Institute Evaluation Guide Questionnaire. The results are tabulated in Tables 10 and 11.

The most frequently mentioned applications of the training received were curriculum enrichment (32.6%) and classroom demonstrations (22.2%). In general, the ideas and concepts on radiation biology are mentioned to the students when appropriate during regular science classes. Demonstrations are usually limited to showing the scaler ratemeter functioning

Table 10

Supplementary Information on Utilization of Training,
Training Program, and Equipment

A. UTILIZATION OF TRAINING

1. How has the teacher been able to use the training received?

	<u>No.</u>	<u>%</u>
Curriculum enrichment	29	32.6
Classroom demonstrations	20	22.2
Not specified	14	15.5
Science fair projects	8	8.8
Special science lectures	7	7.7
Science club	6	6.6
Civil defense teaching	3	3.3
Teacher supervision	3	3.3
Total (based on 60 interviews)	90	100.0

2. Does the Department of Education allow you to add radiation biology to biology or other science courses you teach? yes 48, no 1, not sure 3, no answer 8. Total 60.

B. TRAINING PROGRAM (60 interviews)

	<u>Yes</u>	<u>No</u>	<u>No answer</u>
1. Was it adequate?	57	1	2
2. Were you able to retain enough to feel confident in this area?	57	1	2
3. Was the laboratory training enough for you to learn how to use the equipment?	57	1	2
4. Did you receive enough reference material for your own use?	56	2	2
5. Did you receive enough reference material for your student's use?	29	29	2
5a. If NO, why not?	<u>No.</u>	<u>%</u>	
English too difficult	8	27.5	
Contents too difficult	6	20.6	
Quantity not sufficient	15	51.9	
Total	29		100.0

C. EQUIPMENT KIT (60 interviews)

	<u>Yes</u>	<u>No</u>	<u>No answer</u>
1. Was it adequate for teaching radiobiology?	53	0	7
2. Is it now adequate?	42	5	13
3. Is the equipment now working?	30	17	13
4. Do you have radioactive sources?	33	4	23
5. Would you like to receive additional free radioisotope packages?	29	1	30
6. Would you like PRNC to service your equipment?	30	0	30

Table 11

Possible Future Contributions of the Puerto Rico Nuclear Center
(60 interviews)

	Yes	No	No answer
1. Would you like a film library available?	56	1	3
2. Does your school have a projector?	45	12	3
3. Would you like PRNC to prepare detailed radiation biology laboratory exercises?	55	2	3
4. Would you like a bibliography of reference material on radiation biology?	57	0	3
5. Would you like PRNC to make available expert lecturers or consultants on radiation biology to visit your school and speak to the students?	57	0	3
6. Do you think PRNC should keep the Department of Education informed about new developments in the teaching of radiation biology?	57	0	3
7. Do you think PRNC should organize a seminar for all former Radiation Biology Institute participants?	57	0	3
8. Would you like descriptive brochures on the Puerto Rico Nuclear Center for your students?	57	0	3

by using the radioactive sources provided with the kit. It has been clearly established that the participants have made very limited use of the free radioisotope packages (see above). Of the 60 persons interviewed, 48 (80%) stated that the Department of Education allowed them to add radiation biology to biology or other science courses; only one person said he was not allowed to teach radiation biology, and this could be a misunderstanding. The important point here is that radiation biology is not in the curriculum, and the individual teacher is completely on his own when he adds it to his regular course. It has been shown above that the majority of teachers are working under far from ideal conditions (textbook shortages, inadequate laboratory facilities), which makes them hesitant to undertake any task without receiving official support. Almost all of the 60 teachers interviewed said that the training they had received was adequate, that they still felt confident in this area, and that the laboratory training was sufficient for them to use their equipment. About half said that they did not receive adequate reference materials for their students. The reasons given were insufficient quantity (51.9%), contents too difficult (20.6%), and English too difficult (27.5%). This is the second time the language problem was mentioned specifically.

Most of the teachers agreed that the equipment provided is adequate for teaching radiation biology. Of the 47 answering the question, 42 (89.1%) stated that their equipment is still adequate. On the other hand, 17 (36.1%) said that their equipment (scaler ratemeter) was not functioning; in some cases it had not been functioning for several years. Five people mentioned theft as one of the reasons why their equipment was no longer adequate. The lack of safe storage areas in the schools seems to be a

serious problem throughout Puerto Rico. Many teachers do not keep the equipment in the school. When they want to use it they transport it from home. Obviously, this contributes to the over-all lack of use, as it is a major task to move this equipment each time it is needed.

In regard to possible future contributions of the Puerto Rico Nuclear Center, it is apparent that the teachers are overwhelmingly in favor of any additional help that could be provided. In regard to film library services, 12 teachers (20%) stated that their school does not have a projector, which precludes the showing of movies.

IMPLICATIONS OF THE INFORMATION REVEALED

The training in radiation biology has been utilized only to a limited extent by most of the Institute participants. This is primarily because radiation biology has not been incorporated into the school curriculum, and therefore any effort in this direction is made by the individual teacher without official support. Additional factors are overcrowded schools and shortened school days, lack of basic materials such as textbooks, inadequate facilities for laboratory work, and a lack of safe storage areas for the equipment.

It appears that the Summer Institutes in Radiation Biology were started in Puerto Rico prematurely. That is, the more basic problems of the Department of Education have not been resolved, and no real effort to incorporate radiation biology into the school curriculum has been made during the past 6 years. This is true in spite of the fact that the Department of Education was cooperating with the Puerto Rico Nuclear Center in offering the last three Institutes, in which 52 teachers were trained. At the request of the Department of Education the participants in the last

three Institutes were also trained to teach the Green version of the BSCS high school biology course. However, most of those interviewed from this group stated that their training was not recognized by the science supervisor or that they were not provided with adequate textbooks and materials, as they had been promised.

In summary, after the training of 114 teachers during the past 6 years in the basic fundamentals of radiation biology, it is clear that the application of this training to the actual teaching of students in the classroom has been very limited. To continue the program under these conditions does not appear to be justified.

RECOMMENDATIONS

1. The Department of Education of the Commonwealth of Puerto Rico should recognize officially the importance of radiation biology in the science curriculum.

2. The Department of Education should take full advantage of the training and equipment received by the participants in the Radiation Biology Institutes.

3. Closer cooperation should be established between the Puerto Rico Nuclear Center and the Department of Education to explore ways in which PRNC can continue its efforts toward training teachers and introducing radiation biology into the schools.

4. Summer Institute Directors should make a greater effort to select participants who have not had previous opportunities and who can give

reasonable assurance that they will return to classroom teaching after the Institute.

5. Teachers who accept appointments to an Institute should recognize and accept the moral responsibility for returning to classroom teaching immediately afterward.

APPENDIX I
LETTER SENT TO PARTICIPANTS BEFORE INTERVIEW

PUERTO RICO NUCLEAR CENTER
Operated by
UNIVERSITY OF PUERTO RICO
for
U. S. ATOMIC ENERGY COMMISSION

Cable Address:

Nuclear. Río Piedras

Address reply to:
Bio-Medical Building
Caparra Heights Station
San Juan, Puerto Rico
00935

In reviewing our records I noted that you participated in a Summer Institute in Radiation Biology in For the past three years I have directed these Institutes offered by the Puerto Rico Nuclear Center.

During the current academic year I am interested in visiting former participants at the school where they are teaching in order to evaluate the effectiveness of this program. I would sincerely appreciate your filling in the attached paper and returning it to me in the addressed envelope as soon as possible.

Sincerely yours,



Frederick E. Rushford
Director, Summer Institute
in Radiation Biology

sfc

Enclosures: As stated above

Name: _____

Home address: _____
Street

_____ City Telephone _____

Name of school where you
are now teaching: _____

School address: _____
Street

_____ City Telephone _____

Hours during which you would be available for a personal interview at your
school:

From _____

Until _____

NOTE: If you are not teaching, please let me know as I am interested in
determining if the equipment you received is being utilized in a school.
I would like to know the type of work you are now doing if you are no
longer teaching.

APPENDIX II
QUESTIONS ASKED DURING INTERVIEW

USAEC - RBI
6/62

AEC-NSF INSTITUTE EVALUATION GUIDE

I. IDENTIFICATION INFORMATION

1. Name (No initials, please) _____
2. Home address _____
3. High School or University address _____

4. Radiation Biology Institute attended _____ Date _____
5. Other institutes attended, dates _____

6. University or college training: Major, minor, degrees, dates

7. What did you teach before participating in the Radiation Biology
Institute? _____
8. What do you teach now? _____

II. INSTITUTE CARRY-OVER

1. Do you consider your participation in a Radiation Biology Institute
to have been slightly useful _____, useful _____, highly
useful _____ (Consider factors such as new subject matter,
new teaching techniques, career benefit.)
 - a) Has your school administration been generally sympathetic toward
incorporating radiation biology into your course work? _____

2. To what extent have you been able to incorporate the training received in a Radiation Biology Institute into your teaching:
None _____, very little _____, some _____, a great deal _____.
3. Have you continued liaison with your institute director? _____
To what extent? _____

4. To what extent have you used your training in radiation biology in non-teaching activities, i.e., lectures to community groups, etc.? _____

5. Has your training been of use with respect to science fairs, science clubs, etc.? _____
6. Would you enroll in a summer institute in advanced radiation biology? _____
Why? _____
7. With respect to the Radiation Biology Newsletter, do you receive it regularly? _____. Do you find it of little use _____, of moderate use _____, of much use _____? How might it be improved? _____

III. EQUIPMENT KIT

1. Estimate how much space (in square feet) you have and describe briefly present facilities for using your kit. Is it adequate?

2. How frequently is the kit used? _____
 Hours per week;

 Days per month; _____
 Days per school year.
3. Has the kit been used in course other than biology, i.e., physics
 _____, chemistry _____, others _____.
 (be specific, please).
4. Has the kit been used in research? _____
 Whose? _____
5. Is your scaler rate meter functioning at present? _____
6. Have maintenance and repair of the equipment been a minor problem?
 _____, a serious problem? _____.
7. Please rate these five instruments from the equipment kit in the
 order of their value to you. (Use scale of 1 to 5 with 1 as
 highest rating). Scaler rate meter _____, electroscope
 _____, cloud chamber _____,
 spinthariscopes _____, autoradiography kit _____
 Do you recommend additional items? _____ Which? _____
 _____.
8. Would you prefer the scaler rate meter available as separate units?
 _____. If the rate meter were portable, as separate units,
 would it be preferred over the presently combined unit? _____.
 Estimate how much use you make of the rate meter (none-little-
 some-considerable). _____

IV. RADIOISOTOPES

1. Did you order radioisotopes? _____
2. If no, why not? _____

3. If yes, how many times did you order the free packages? _____
4. Did you ever purchase radioisotopes? _____
5. If no, did you obtain additional free radioisotopes? _____
6. If yes, where did you obtain them? _____
7. Do you have access to a source of ionizing radiation? _____

V. SUPPLEMENTARY INFORMATION

A. Utilization of training

1. How has the teacher been able to use the training received? _____

2. Does the Department of Education allow you to add Radiation Biology to Biology or other science courses you teach? _____

B. Training Program

1. Was it adequate? _____
2. Were you able to retain enough to feel confident in this area? _____
3. Was the laboratory training enough for you to learn how to use the equipment? _____
4. Did you receive enough reference material for your own use? _____
5. Did you receive enough reference material for your student's use?

- 5a. If no, why not? _____

C. Equipment Kit

1. Was it adequate for teaching Radiobiology? _____
2. Is it now adequate? _____
3. Is the equipment now working? _____
4. Do you have radioactive sources? _____
5. Would you like to receive additional free radioisotope packages? _____
6. Would you like PRNC to service your equipment? _____

VI. POSSIBLE FUTURE CONTRIBUTIONS OF THE PUERTO RICO NUCLEAR CENTER

1. Would you like a film library available? _____
2. Does your school have a projector? _____
3. Would you like PRNC to prepare detailed Radiation Biology Laboratory exercises? _____
4. Would you like a bibliography of reference material on Radiation Biology? _____
5. Would you like PRNC to make available expert lecturers or consultants on Radiation Biology to visit your school and speak to the students?

6. Do you think PRNC should keep the Department of Education informed about new developments in the teaching of Radiation Biology? _____
7. Do you think PRNC should organize a Seminar for all former Radiobiology Institute participants? _____
8. Would you like descriptive brochures of the Puerto Rico Nuclear Center for your students? _____