DOCUMENT RESUME

ED 024 615 24 SP 001 508

By- Caldwell, Harrie E.

Evaluation of an Inservice Science Methods Course by Systematic Observation of Classroom Activities. Final Report.

Syracuse Univ., N.Y.

Spons Agency- Office of Education (DHEW), Washington, D.C. Bureau of Research.

Bureau No- BR-6-8760

Pub Date Sep 67

Contract- OEC-1-7-068760-0344

Note- 64p.

EDRS Price MF-$0.50 HC-$3.30

Descriptors- Classroom Participation, Classroom Techniques, Course Content, *Course Evaluation, Elementary School Science, Evaluation Criteria, *Inservice Teacher Education, Measurement Instruments, *Methods Courses, *Observation, Research Methodology

A study was designed (1) to develop an instrument which measures activity ratios, the ratio of time a teacher spends teaching with indirect activities (those in which he acts as a co-ordinator of learning experiences) to time he spends teaching with direct activities (those in which he is imparting knowledge), (2) to devise an inservice science methods course which would encourage fifth grade teachers to use indirect activities when teaching science, and (3) to measure the effects of the methods course. Thirty volunteer fifth grade science teachers were randomly assigned to a control group or to an experimental group which was given the inservice methods course. All were observed by two of three observers four times before, twice during, and four times after the course. Activity ratios and laboratory and questioning ratios (the proportion of time the teacher spends with laboratory experiences and asking questions) were calculated, and differences in mean ratio changes were tested by applying the t-test and using a .05 level of significance. Results indicate that the inservice methods course caused change in teaching techniques: experimental teachers made greater use of indirect activities, especially laboratory experiences, after the course. (Included are an 18-item bibliography, a descriptive outline of the methods course, and a 16-page discussion of "Activity Categories," an instrument for quantitatively recording activities in a science class.) (JS)

BR-6-8760
PA-24

ED0 24615

FINAL REPORT
Project No. 6-8760
Contract No. OEC-1-7-068760-0344

EVALUATION OF AN IN-SERVICE METHODS COURSE BY SYSTEMATIC OBSERVATION OF CLASSROOM ACTIVITIES

September 1967

U. S. Department of
Health, Education, and Welfare

SP001508

EVALUATION OF AN INSERVICE SCIENCE METHODS COURSE BY SYSTEMATIC OBSERVATION OF CLASSROOM ACTIVITIES

PA

PROJECT NO. 6-8760
CONTRACT NO. OEC-1-7-068760-0344

Harrie E. Caldwell

September, 1967

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

SYRACUSE UNIVERSITY

SYRACUSE, NEW YORK

CONTENTS

TABLES

ILLUSTRATIONS

ACKNOWLEDGEMENTS

I would like to acknowledge the cooperation and assistance of several groups of individuals who contributed to this study. As a token of appreciation I offer my thanks.....

.....to the principals, secretaries and particularly the participating teachers in the Syracuse, New York, area school systems who took part in this study.

.....to the U. S. Office of Education, Department of Health, Education and Welfare.

.....to the professorial staff, secretarial staff and fellow graduate students at Syracuse University.

I am especially indebted to my friends and associates in the Division of Science Teaching at Syracuse University. Each individual was an invaluable source of assistance while planning and conducting this study. I particularly wish to thank Dr. Alfred T. Collette, Dr. William D. Romey, Dr. Marvin Druger, and Dr. Howard L. Jones for their guidance and assistance. Also, a special thanks goes to Harry Haakonsen and George Puerschner, my associate observers.

INTRODUCTION

Problem

Curriculum specialists have noted a need to increase student participation in elementary school science classes. Some of the recommendations are:

1. Students should be involved in processes of inquiry and investigation. They should be asked questions, learn to obtain and analyze knowledge and learn to present their interpretations.

2. Students should develop concepts and principles through physical manipulation of materials rather than through pure verbal experiences. Laboratory experiences should introduce new concepts and principles or extend old ones.

3. Students should use many sources for reference rather than just a textbook.

These recommendations are based on the fact that science is more than a body of knowledge; science is also a group of processes which involve inquiry and investigation. In general, curriculum specialists seem to advocate greater use of indirect activities and less use of direct activities. Indirect activities include laboratory experiences, group projects, student demonstrations, student reports and student talking. In these activities students are active participants; they are involved in obtaining or analyzing knowledge or presenting their interpretations. In direct activities, (lecture, teacher demonstrations, films and filmstrips), teachers impart information; students are told everything.

Many curriculum materials organized for the elementary school give greater emphasis to science processes. Materials are being organized by such new elementary science curriculum projects as: Science Curriculum Improvement Study (SCIS) at the University of California, Elementary Science Study (ESS) originated by Educational Services Incorporated, Elementary School Science Project (ESSP) at Utah State University and Science—A Process Approach sponsored by the American Association for the Advancement of Science. All forementioned projects emphasize involvement of students and use of indirect activities.

In-service methods courses are being developed to familiarize elementary school science teachers with the new science curricula and to encourage them to use indirect activities when teaching science. One major problem faced by instructors of these courses is training teachers to use indirect activities. Many experienced teachers are satisfied with direct activities. They have used direct activities for several years and are content with the security of structured and controlled classes. In some cases experienced teachers may fear the unstructured aspects of indirect activities. Beginning teachers have spent four or more college years learning from lectures. They were impressed by articulate instructors with a command of subject matter. In many instances beginning teachers and experienced teachers consider "lecturing" and "teaching" synonymous. What methods should instructors of methods courses use to effectively introduce new materials to elementary school teachers and at the same time encourage them to use indirect activities when teaching science?

Effective ways for instructors of methods courses to encourage elementary school teachers to use indirect activities when teaching science will be found by evaluating methods courses. Since methods courses are designed to change teachers' classroom behavior, the courses must be evaluated with respect to this variable. Instruments should be developed which will measure teachers' behavior in terms of goals set for the methods course.

Hence, the problem is two-fold; first, to measure effects of an in-service science methods course designed to encourage elementary school teachers to use indirect activities when teaching science; second, to develop an instrument which will measure teacher behavior in science classes in terms of goals set for the methods course.

Related Studies

Few studies have been made of the effectiveness of in-service training courses, institutes or programs for elementary school science teachers. Generally, investigators have measured effectiveness using:

1. checklists or questionnaires to elicit descriptive responses from participants or their supervisors (principals).

2. scores obtained by participating teachers on a paper and pencil test.

3. scores obtained by pupils of participating teachers on a paper and pencil test.

In some studies investigators used a combination of these approaches.

Early studies by Weber (10), Wood (11) and Wong (18) were attempts to evaluate the effectiveness of workshops using educators' ratings. Robinette (15) used structured interviews to determine types and extent of innovations in classroom practices of teachers who attended a summer workshop. He reported that participants gave the workshop credit for innovations they felt had been made in their science classes.

Before and after an in-service science course Brittain and Sparks (4) used a checklist of 88 items to investigate the seriousness of problems encountered in science teaching. Although the data appears conflicting, Brittain and Sparks stated;

> "Findings are consistent with the hypothesis that the course was effective in its contribution to the science teaching competence of the enrolled teachers."

Brandou (12) investigated factors related to 16 physical science background programs for in-service elementary school teachers. Data was gathered with standardized instruments, personal interviews, field surveys and prepared questionnaires. He concluded:

> "Elementary teachers who participated in the in-service programs reported significantly greater increases in the use of twelve of twenty-one classroom science teaching activities. The significant items were closely related to objectives established at the summer conference."

Test scores obtained by students were used by Mork (13) and Sims (8) to measure the effectiveness of in-service training. Both investigators found their in-service programs improve instruction. Selser (16) tested both students and their teachers to evaluate an in-service institute. Both experimental teachers and their pupils scored significantly higher (.05) than control teachers and their pupils, respectively.

Different forms of the Read General Science Test was used as pre-and post-tests by two investigators. Fowler (6) found a significant gain in general science achievement by participants in a summer science institute. Washton (9) found graduate students in his course made substantial gain in achievement in general science.

Effects of a lecture-demonstration method and effects of an individual laboratory method of teaching science to teachers were compared by Stefaniak (17). The students (650) taught by the teachers were tested before and after the courses with the Calvert "Science Information Test," attitude-inquiry forms constructed by the investigator and an interest test also constructed by the investigator. Fourth-grade pupils of teachers taught by the lecture-demonstration method made significantly greater gains in acquiring science information and acquired a greater interest in science. However, fifth-grade pupils and sixth-grade pupils of teachers taught by the individual laboratory method showed significantly greater gains in acquiring science information. Both fifth and sixth-grade groups showed a general loss of interest in science. No significant differences between groups were found for acquired scientific attitudes.

These studies which used comments by teachers or their supervisors were concerned with changes in behavior of teachers or techniques used by teachers that could be attributed to participation in an in-service training program. Studies which tested teachers with paper and pencil tests were trying to measure changes in the teachers' subject-matter background which resulted from participation in the in-service training program. Investigators who measured pupils of participating teachers assumed a correlation between pupil achievement and participation by the teacher in in-service training program. Most of the studies reported above have merit. However, one goal of an in-service training program is to change the behavior of teachers when teaching science. Little attempt has been made to objectively evaluate the effectiveness of in-service programs as they relate to classroom teaching behavior.

Direct observation of teachers in classrooms has been a part of much research in education during this century. Medley and Mitzel (Gage, 1963), discuss several instruments and methods for observing classes. The major use of these instruments has been to measure effective teacher behavior or classroom climate. The most sophisticated instrument reported was developed by Flanders (1).

Flanders' system of verbal interaction analysis categories consists of ten categories; i.e., teacher accepts student feelings, teacher praises student, teacher accepts student ideas, teacher asks questions, teacher lectures, teacher gives direction, teacher criticizes student, student answers with a fact, student answers with an opinion or concept, and silence or confusion. Using these categories in a classroom or while listening to a tape, an observer makes one observation every three seconds. When the verbal behavior shifts, the observer records both categories. Several derived measures may be calculated with these data. Classroom verbal interaction is then described in terms of these derived measures.

In one study reported by Fischler and Anastasiow (5), the behavior of participating teachers was recorded before and after a special summer training program. In the spring audio tapes were made of each teacher during two science lessons. The summer program was called "School Within a School" because participating teachers were those teaching summer school and the training program was integrated with their teaching responsibilities. In the mornings supervisors observed teachers, did classroom demonstrations, and carried out analysis sessions with teachers after class. In the afternoon teachers attended classes to acquire additional background and to work on various methods for teaching science. Prior to summer school four workshops were conducted to introduce Science Curriculum and Improvement Study (SCIS) materials to teachers. Teachers were encouraged to ask fewer questions and to encourage pupils to observe and express their views. In the fall two audio tapes were made of each teacher during science lessons. Complete data was obtained for ten teachers. The tapes were analyzed with Flander's verbal interaction analysis category system and the Science Teaching Observational Instrument. The latter instrument analyzed questions posed by teachers. Each question is classified by what students are asked to do; i.e., recall facts, see relationships, make observations, hypothesize, or test a hypothesis. After the summer program teachers demonstrated a reduction in lecturing and questioning. They did ask more indirect questions and allowed students to answer at greater length. Answers by students were less of a factual nature and more opinion or concept in nature. This was a unique study because investigators did not evaluate the course with statements by the teacher or his principal. Instead, they used actual changes in teachers' verbal behavior to measure the course effectiveness.

Methods courses are designed to develop the teacher's ability to teach. While it is true that a major portion of the teacher's behavior has been and is verbal, one present trend in science classrooms is to use indirect activities. These activities require less talking by the teacher and more involvement of students. If this is the case, science methods courses must be designed to encourage greater use of activities involving student participation. Evaluation of these courses should be made in terms of changes in participating teachers' behavior.

Objectives

The trend in science education, as seen in recently prepared curricula, is for increased student involvement. Many experiences and all prospective science teachers will need to be trained to use activities which encourage student participation. These activities termed "indirect" included laboratory experiences, group projects, student demonstrations or reports, and student talking. Hence, the first objective of this study is:

> To devise an in-service science methods course which will encourage fifth-grade teachers to use indirect activities when teaching science.

The basic assumption for the design of the course is: Teachers learn to use indirect activities most effectively if in the course they are required to prepare and teach using these activities. The instructor of the methods course should minimize lectures and increase involvement of participating teachers. The second objective is:

> To measure the effect of the in-service science methods course on the teaching techniques of participating teachers.

Since the course is designed to cause a change in activities used by the teachers, evaluation is based on this variable. The third objective is:

> To develop an instrument which will measure the ratio of time spent teaching with indirect activities to time spent teaching with direct activities.

This ratio of indirect activities to direct activities is termed "activity ratio." Direct activities are those in which the teacher is imparting information to students. The activity ratio represents a measure of the teacher's use of indirect activities. A subjective is:

> To formulate directions which would enable future workers to use the instrument effectively.

METHOD

The principal goals in this study were (1) to devise an in-service science methods course which would encourage fifth-grade teachers to use indirect activities when teaching science and (2) to measure the effectiveness of the course. An experimental group of teachers was compared with a control group of teachers. Experimental teachers were given the in-service science methods course during the study; the control teachers were not given the course.

Subjects

A sample population of 32 teachers was selected from the fifth-grade teachers in Syracuse, New York, area school systems. Fifth grade was chosen arbitrarily. Included in the sample were 19 public school teachers (7 men, 12 women), and 13 parochial school teachers, (10 nuns, 3 female lay teachers). All taught science and volunteered to participate in the study. Each expected to be observed while teaching science and possibly take an in-service science methods course. Sixteen teachers were randomly chosen for the experimental group and 16 for a control group.

Instrument

(A brief description is included here; a thorough discussion of the instrument is given in Appendix B.)

A set of 11 categories was developed by the investigator (Table I) for observers to use when visiting teachers. These categories describe general types of activities used in science classes. The first six categories--laboratory experiences (openended and structured), group projects, student demonstrations, student reports and student talking are classified indirect activities. During these activities a teacher acts as a coordinator of learning experiences. Emphasis is on student participation. The direct categories--workbook work, lecture and teacher demonstration --describe activities during which a teacher imparts knowledge verbally or with some device. Two categories are not classified direct or indirect; i.e., teacher questioning and general havoc.

Classroom activity during a science lesson is classified by writing the number of the category which describes the activity. The recorder writes the number at definite intervals during the period. In this study five-second intervals were used to acquire adequate precision. Several ground rules (Table II) were developed to clarify use of the instrument.

INDIRECT ACTIVITIES	1.	LABORATORY EXPERIENCES: OPENENDED	Students are presented a problem to be solved by experimentation. The procedure may or may not be given. They are required to make observations and analyze or interpret their findings.
INDIRECT ACTIVITIES	2.	LABORATORY EXPERIENCES: STRUCTURED	Students are presented a laboratory experiment with a structured procedure. They are not required to analyze or interpret their data. They are asked to make observations.
INDIRECT ACTIVITIES	3.	GROUP PROJECTS	One or more groups of students are working on a science project during the class period. Some may work individually. (not written projects)
INDIRECT ACTIVITIES	4.	STUDENT DEMONSTRATIONS	A student or group of students demonstrate a science experiment or project which they have prepared. (Oral report on science project would be included).
INDIRECT ACTIVITIES	5.	STUDENT LIBRARY RESEARCH, REPORTING, ETC.	(a) A student or group of students give an oral report they have prepared based on reference material. (b) The class works with reference materials for purposes of writing or making reports.
INDIRECT ACTIVITIES	6.	STUDENT SPEAKING	The student contributes verbally by asking a question, answering a question or simply volunteering information.
	7.	TEACHER QUESTIONING	Students are asked a question by the teacher.
DIRECT ACTIVITIES	8.	WORKBOOK WORK	Students work in class on workbooks, homework, questions from text, art-type work, etc.
DIRECT ACTIVITIES	9.	TEACHER DEMONSTRATIONS	The teacher presents material by film, filmstrip, record, TV, radio, demonstration, etc.
DIRECT ACTIVITIES	10.	LECTURE	The teacher reads aloud, expresses his views, gives directions, makes an assignment or asks rhetorical questions. Students are expected to listen. They may interrupt only when they do not understand. Student reading in the text is also included.
	11.	GENERAL HAVOC	The class may be cleaning up, settling down or doing nothing. In general, this category should be used sparingly.

Table I Activity Categories. Eleven categories which describe general types of activities used in science classes.

GROUND RULES

1. When two activities occur simultaneously in a five-second interval, observers choose the category with the smallest number. For example, a teacher may be talking while showing a filmstrip (No. 9). If the teacher is telling the students (No. 10), observers record a 9. If the teacher is asking a question (No. 7), observers record a 7.

2. When two or more activities occur sequentially with a five-second interval, observers choose the activity which occupied the major portion. If this is not possible, observers choose the category with the lowest number.

3. Lulls during a lecture for purposes of notetaking (No. 10). If the lull occurs following a teacher's question, it is recorded as a question (No. 7).

4. If an interval cannot be assigned a number, it is left blank. The situation should be explained in the margin as soon as possible.

6. A test is coded as "T".

7. Laboratory experiments: If a distinction between categories 1 and 2 cannot be made because the directions are nonverbal, then an "L" will be used until the directions can be examined. While students are predominantly reading directions, consider this as Category 10, directions.

8. When Category No. 8 is applicable, the observer should check the materials. If the materials are thought-provoking rather than "look-up-the answer" type, the observer will note this on the reverse side of the sheet.

9. Guest speakers are not recorded. "Guest speaker" is written across the blank intervals.

Table II Ground Rules. Rules to clarify use of the activity categories.

The data may be used to calculate three ratios. The activity ratio is a measure of time spent teaching with indirect activities. It indicates the degree to which a teacher acts as a coordinator of learning experiences. The laboratory ratio measures the percent of time spent with laboratory experiences. The questioning ratio measures the amount of time a teacher spends asking questions with respect to the total amount of recorded teacher talk.

General Design

The study was divided into three phases. Prior to Phase I two associate observers were trained to use the activity categories. (A discussion of the activity categories and training of two associate observers is found in Appendix B.) During the study the investigator and associate observers made independent observations of teachers. A high reliability between observers was desirable since all data were to be combined. Reliability estimates between each pair of observers were calculated before Phase I. All observers visited the same two classes and independently used the activity categories. Scott's method (described in Appendix B) was applied to data obtained by each pair of observers. All reliability estimates were greater than 0.880.

Each of the three observers visited 20 teachers during their science lessons (Table III). Observer A saw nine experimental teachers and eleven control teachers. Observer B saw eleven experimental teachers and nine control teachers; Observer C saw ten teachers from each group.* When observing classes, observers used the activity categories discussed in Appendix B.

Phase I, (October 7, 1966 to December 31, 1966), was the period before experimental teachers were given the methods course. During this phase both experimental teachers and control teachers were observed while teaching science. Each teacher was observed four times, twice by two of the three observers. Data were used to calculate three measures of each teacher's behavior before the methods course was given. These measures were activity ratio, laboratory ratio, and questioning ratio. All data on a teacher were combined when calculating these ratios.

---

*In the original design each observer was to have seen ten experimental teachers and ten control teachers. Teachers No. 31 and No. 32 were serving as extras. Two teachers were forced to discontinue because of illness. Unfortunately, the extra experimental teacher was seen by different observers than the experimental teachers who dropped and the extra control teacher was seen by different observers than the control teacher who dropped.

	EXPERIMENTAL			CONTROL		
Observer A	4, 7 11, 21	10, 17 18, 26 30		2, 22 23, 28 29, 31	3, 8 12, 13 19	
Observer B		10, 17 18, 26 30	5, 9 15, 20 25, 32		3, 8 12, 13 19	1, 6 14, 16
Observer C	4, 7 11, 21		5, 9 15, 20 25, 32	2, 22 23, 28 29, 31		1, 6 14, 16

Table III Assignment of Teachers to Observers. The numbers designate teachers. Each teacher was observed by two observers. Teachers No. 24 and 27 dropped due to illness and are not included in this chart.

After a round of observations, during which every teacher was observed once, data on members of the experimental group were combined and data on members of the control group were combined. Three measures were calculated for both groups for each round of observations. Four group activity ratios, four group laboratory ratios, and four group questioning ratios were calculated for the experimental group of teachers and for the control group of teachers.

Phase II extended from January 1, 1967 to March 31, 1967. During this phase experimental teachers and control teachers were observed twice, once by each of the two assigned observers. Data were used to calculate group measures for both the experimental group of teachers and the control group of teachers. Two group activity ratios, two group laboratory ratios, and two group questioning ratios were calculated for each group of teachers.

A reliability check on each associate observer was made during this phase. The investigator accompanied each associate observer to two classes. Both used the activity categories and independently recorded data. Reliability estimates between the investigator and each associate observer were greater than 0.91.

Experimental teachers participated in the in-service science methods course designed to encourage fifth-grade teachers to use indirect activities when teaching science. This course is described in Appendix A.

Phase III, the final phase of the study, began April 1, 1967 and ended in the middle of June, 1967. Experimental teachers and control teachers were observed four times, twice by each assigned observer. Data on each teacher were combined to calculate three measures of the teacher's behavior after the methods course had been given. These measures were the activity ratio, laboratory ratio and the questioning ratio. After each round of observations, data obtained during the round for experimental teachers were combined and data obtained during the round for control teachers were combined. Four group activity ratios, four group laboratory ratios and four group questioning ratios were calculated for the experimental group of teachers and for the control group of teachers during Phase III.

Near the end of this phase a second reliability check on each associate observer was made. The investigator accompanied each associate observer to two classes. Both used the activity categories and independently recorded data. Relability estimates between the investigator and each associate observer were greater than 0.93.

Analysis of Data

Three measures of each teacher's behavior were calculated from data obtained before the methods course. These were the activity ratio, laboratory ratio and questioning ratio. The same three measures of each teacher's behavior were calculated from data obtained after the methods course. Changes in each ratio were calculated for all teachers. Ratio changes were determined by subtracting ratios calculated with data obtained before the course from corresponding ratios calculated with data obtained after the course. Ratio changes reflect how the teacher taught, in terms of each measure, after the course with respect to how he taught before the course.

Data obtained before the course were analyzed statistically to determine if significant differences existed between the control group of teachers and the experimental group of teachers before experimental teachers were given the methods course. A two-tailed, t-test as described by Hays (.3) was applied to differences between the means of corresponding ratios for experimental teachers and control teachers.

The effect of the methods course on the teaching techniques of participating teachers (experimental teachers) was determined by comparing the experimental group of teachers with the control group of teachers. The groups, experimental and control, were compared on the change scores for each measure. A two-tailed t-test as described by Hays was applied to differences in means for the two groups. Three null hypotheses were used to give direction to the analysis. A five percent level of significance was chosen for rejection of the following null hypotheses:

1. The mean of the changes in activity ratio for the experimental group is equal to the mean activity ratio change for the control group; i.e., $u_e = u_c$.

2. The mean of the changes in laboratory ratio for the experimental group is equal to the mean laboratory ratio change for the control group; i.e., $u_e = u_c$.

3. The mean of the changes in questioning ratio for the experimental group is equal to the mean questioning ratio change for the control group; i.e., $u_e = u_c$.

Ten rounds of observations were made during the study. After each round of observations, the data obtained on experimental teachers were combined and the data obtained on control teachers were combined. The combined data on experimental teachers were used to calculate a group activity ratio, group laboratory ratio and group questioning ratio for the experimental group of teachers. The combined data on control teachers was used to calculate similar ratios for the control group of teachers.

Ten group activity ratios for experimental teachers and ten group activity ratios for the control group were graphed. Similar graphs were also constructed for group laboratory ratios and for group questioning ratios. These graphs illustrate changes in the experimental group of teachers, changes in the control group of teachers, and differences between the two groups over the course of the study.

A subjective analsysis of various factors was also made. The factors which were discussed included observer effects, effects arising from differences in the subject matter taught before the course and subject matter taught after the course, and effects resulting from informing teachers before observations were made.

Many calculations were performed with a systems/360 Fortran III Computer. The program for the computer was written by the investigator. First, an activity ratio, laboratory ratio and questioning ratio are calculated for:

a. each observation of a teacher.

b. both the experimental group of teachers and the control group of teachers from data collected during each round of observations (group ratios).

c. each teacher with data obtained before the course.

d. each teacher with data obtained after the course.

The activity ratio change, laboratory ratio change and questioning ratio change are also determined with the computer.

Then, an analysis is made of differences between experimental teachers and control teachers on six measures; i.e., the activity ratios, laboratory ratios and questioning ratios obtained before the methods course and the three ratio changes. A separate analysis is made of each measure. In each analysis a mean and variance was calculated for scores obtained by the experimental group of teachers and for scores obtained by the control group of teachers. The t-test is applied to the null hypothesis that the mean score for experimental teachers is equal to the mean score for control teachers. The final step in the analysis is acceptance or rejection of the three null hypotheses written to give direction to the study.

RESULTS

Statistical Analysis of Ratios Calculated with Data Obtained Before the Course

Activity ratios, laboratory ratios and questioning ratios were calculated for all teachers with data obtained before the methods course. The mean and variance was calculated for each set of ratios obtained for the control group and for each set of ratios obtained for the experimental group. The difference in means of corresponding sets of ratios for the two groups of teachers were analyzed statistically. The t-test was applied to differences in corresponding means. At the .05 level of significance none of the differences were significant. The difference in means for corresponding sets of questioning ratios were not significant at the 0.10 ($t_{.10} = 1.313$) level. The difference in means for corresponding sets of laboratory ratios was not even significant at the 40 percent level ($t_{.40} = .256$).

Class Size: Parochial School Teachers and Public School Teachers

In Table IV the experimental group of teachers and the control group of teachers are compared on several factors; i.e., number of parochial school teachers (column 2), number of public school teachers (column 3), sizes of classes (column 4), number of years of experience teaching science in the elementary grades (column 5), and number of courses taken in science (column 6).

The experimental group of teachers included 6 parochial school teachers and 9 public school teachers. The control group of teachers included 7 parochial and 8 public school teachers. The average class size for experimental teachers was 35.1 and for control teachers 35.8. The overall average class size was 35.5. An asterisk marks those teachers with more than 35.5 students. It is interesting to note that with two exceptions* column No. 2 and column No. 4 show one-to-one correspondence between parochial school teachers and classes larger than the mean size. The number of students in parochial school classes is almost consistently higher than the number of students in public school classes.

*Teacher No. 26, a public school teacher, had 36 students while teacher No. 3, a parochial school teacher, has 34 students.

Tchr. No.	Parochial School Teachers	Public School Teachers	No. of Students	No. of years Teaching Science	No. of Science Courses
4	*		46*	3	3*
5	*		50*	11*	2
7	*		50*	1	1
9	*		42*	23*	3*
10	*		41*	15*	2
30	*		45*	9*	4*
11		*	27	6	2
15		*	22	2	1
17		*	24	13*	3*
18		*	30	13*	3*
20		*	32	13*	2
21		*	24	25*	5*
25		*	27	5	1
26		*	36*	5	0
32		*	31	11*	2
Mean for experimental Teachers	---	---	35.1	10.3	2.3
1	*		47*	3	1
2	*		46*	15*	1
3	*		55*	8	0
6	*		43*	7	5*
8	*		34	2	3*
16	*		45*	4	3*
28	*		47*	8	6*
12		*	31	2	4*
13		*	23	32*	3*
14		*	31	5	1
19		*	33	4	4*
22		*	20	2	6*
23		*	29	3	3*
29		*	25	1	3*
31		*	28	8	2
Mean for control teachers	---	---	35.8	7.0	3.0

Table IV: A comparison of the experimental group of teachers and the control group of teachers on number of parochial school teachers, number of public school teachers, number of students in classes, number or years teaching experience and number of science courses.

*The teacher's score is greater than the overall mean for all teachers.

Teaching Experience

The mean number of years teaching experience was 10.3 for experimental teachers and 7.0 for control teachers. The overall mean number of years teaching experience was 8.6 years. Nine experimental teachers had more than 8.6 years while only 2 control teachers had more than 8.6 years.

Science Background

The number of science courses (including science methods courses) each teacher had taken prior to this study is given in Table IV, column 6. The average number of science courses was 2.3 for experimental teachers and 3.0 for control teachers. The overall mean number of courses was 2.36. Six experimental teachers had more than 2.36 science courses while 11 control teachers had more than 2.36 science courses. Evidently control teachers had stronger science backgrounds than experimental teachers.

Analysis of Ratio Changes

Three ratios were calculated with data obtained before the methods course as pre-measures of the teachers' behavior. Three ratios were calculated with data obtained after the methods course as post-measures. The ratios were the activity ratio (a measure of the use of indirect activities), the laboratory ratio (a measure of the percent of time spent with laboratory experiences) and the questioning ratio (a measure of time spent asking questions). The differences between pre-measures and post-measures was termed ratio change. The activity ratio change was found by subtracting the activity ratio calculated with data obtained before the methods course from the activity ratio calculated with data obtained after the methods course. The laboratory ratio change and questioning ratio change were determined by subtracting ratios calculated with data obtained before the methods course from corresponding ratios calculated with data obtained after the methods course.

A negative activity ratio change was obtained by two experimental teachers and six control teachers. Teachers obtained a negative activity ratio if they used indirect activities proportionately less after the methods course. The mean activity ratio change for the experimental group of teachers was larger than the mean activity ratio change for the control group. The activity ratio change for most teachers was below average; only four experimental teachers had an activity ratio greater than the mean value.

Thirteen experimental teachers had a positive laboratory ratio change. Five control teachers had a positive laboratory ratio change, but two were negligible; i.e., .007 and 0.022. Parochial teachers in the control group had laboratory ratios equal to 0.0 before and after the course. The mean laboratory ratio change was higher for the experimental group of teachers.

There was no appreciable differences between experimental teachers and control teachers in questioning ratio changes. Both had positive and negative scores. The mean questioning ratio change for experimental teachers was negative but small.

Analysis of Activity Ratio Changes

An analysis of ac vity ratio changes obtained for teachers in the experimental group and the control group is shown in Table V. Differences in mean activity ratio changes were tested by applying the t-test to the null hypothesis:

> The mean activity ratio change for experimental teachers is equal to the mean activity ratio change for control teachers; i.e., $u_e = u_c$.

This null hypothesis was rejected at the .05 level of significance. The mean activity ratio change (.995) for experimental teachers was significantly greater than the mean activity ratio change (.181) for control teachers. After the methods course experimental teachers spent a greater proportion of science class time with indirect activities than they did before the methods course when compared with a control group of teachers.

Analysis of Laboratory Ratio Changes

An analysis of laboratory ratio changes obtained for teachers in the experimental and control groups is given in Table VI. Differences in mean laboratory ratio changes were tested by applying the t-test to the null hypothesis:

> The mean laboratory ratio change for experimental teachers is equal to the mean laboratory ratio change for control teachers; i.e., $u_e = u_c$.

The null hypothesis was rejected at the .05 level of significance. The mean laboratory ratio change for experimental teachers (.232) was significantly greater than the mean laboratory ratio change for control teachers (.016). The difference was also significant at the .01 level ($t_{.01} = 2.977$). After the methods course experimental teachers spent a greater percent of class time with

Table V: Analysis of Activity Ratio Changes

Experimental	Control
$\bar{X}_e = .995$	$\bar{X}_c = .181$
$s_e^2 = 1.686$	$s_c^2 = .370$
$N_e = 15$	$N_c = 15$
$s_{(\bar{X}_e - \bar{X}_c)} = .370$	

Ho: $\bar{X}_e = \bar{X}_c$

$$t = \frac{\bar{X}_e - \bar{X}_c}{s_{(\bar{X}e - \bar{X}c)}} = 2.199$$

$t_{critical}$ (= .05) = 2.145

$\therefore$ reject H_o

Table VI: Analysis of Laboratory Ratio Changes

Experimental	Control
$\bar{X}_e = .232$	$\bar{X}_c = .016$
$s_e^2 = .052$	$s_c^2 = .007$
$N_e = 15$	$N_c = 15$
$s_{(\bar{X}_e - \bar{X}_c)} = .063$	

Ho: $\bar{X}_e = \bar{X}_c$

$$t = \frac{\bar{X}_e - \bar{X}_c}{s_{(\bar{X}e - \bar{X}c)}} = 3.453$$

$t_{critical}$ ($= .05$) = 2.145

$\therefore$ reject H_o

laboratory activities than they did before when compared with a control group of teachers.

Analysis of Questioning Ratio Changes

An analysis of questioning ratio changes obtained for teachers in the experimental and control groups is given in Table VII. Differences in mean questioning ratio changes were tested by applying the t-test to the null hypothesis:

> The mean questioning ratio change for experimental teachers is equal to the mean questioning ratio change for control teachers; i.e., $u_e = u_c$.

The null hypothesis was not rejected at the .05 level of significance. The mean questioning ratio change for experimental teachers (-0.028) was not significantly greater (or less) than the mean questioning ratio change for control teachers (-.001). After the methods course both groups spent a smaller proportion of talking time on asking questions than they did before. However, the change was negligible.

Group Activity Ratios, Group Laboratory Ratios and Group Questioning Ratios

Ten group activity ratios were calculated for the experimental group of teachers and ten group activity ratios were calculated for the control group of teachers. Four group activity ratios were calculated for each group before the methods course, two during and four after. Ten group laboratory ratios and ten group questioning ratios were also calculated for both groups. Group activity ratios are graphed in Figure 1, group laboratory ratios in Figure 2, and group questioning ratios in Figure 3.

The graph in Figure 1 compares the experimental group of teachers with the control group of teachers on the group activity ratios. The experimental group of teachers increased during and after the methods course. The control group of teachers did not increase as much, but were higher before the methods course.

The graph in Figure 2 compares the experimental group of teachers with the control group of teachers on the group laboratory ratios. The experimental group of teachers had a substantial increase in group laboratory ratio during and after the methods course. The control group, however, had only a slight increase.

Table VII: Analysis of Questioning Ratio Changes

Experimental	Control
$\bar{X}_e = -0.028$	$\bar{X}_c = -0.001$
$s_e^2 = .027$	$s_c^2 = .019$
$N_e = 15$	$N_c = 15$

Ho: $X_e = X_c$

$$t = \frac{\bar{X}_e - \bar{X}_c}{s_{(\bar{X}e - \bar{X}c)}} = -.487$$

$t_{critical}$ (= .05) = 2.145

$\therefore$ Fail to reject H_o

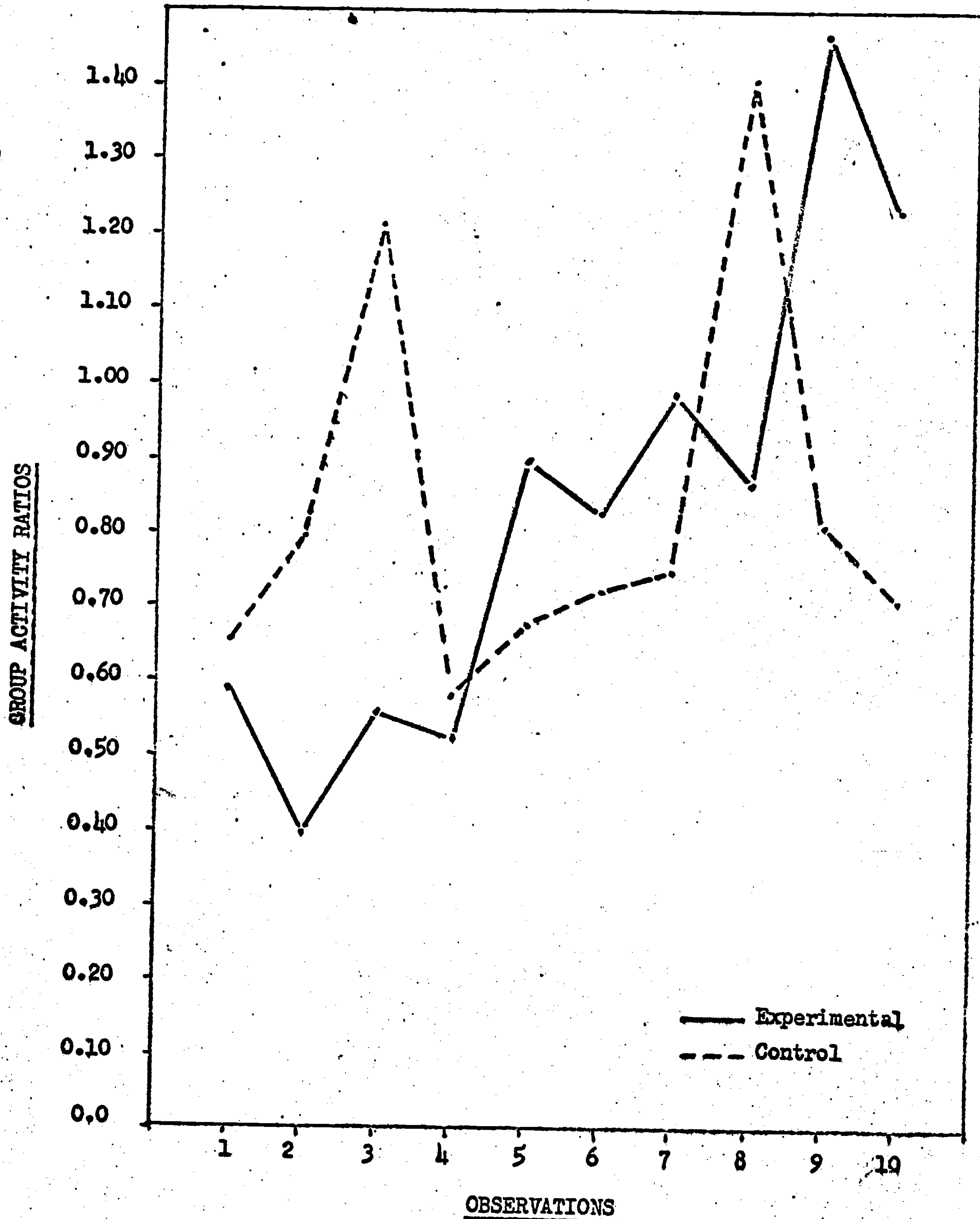

Figure 6. GROUP ACTIVITY RATIOS

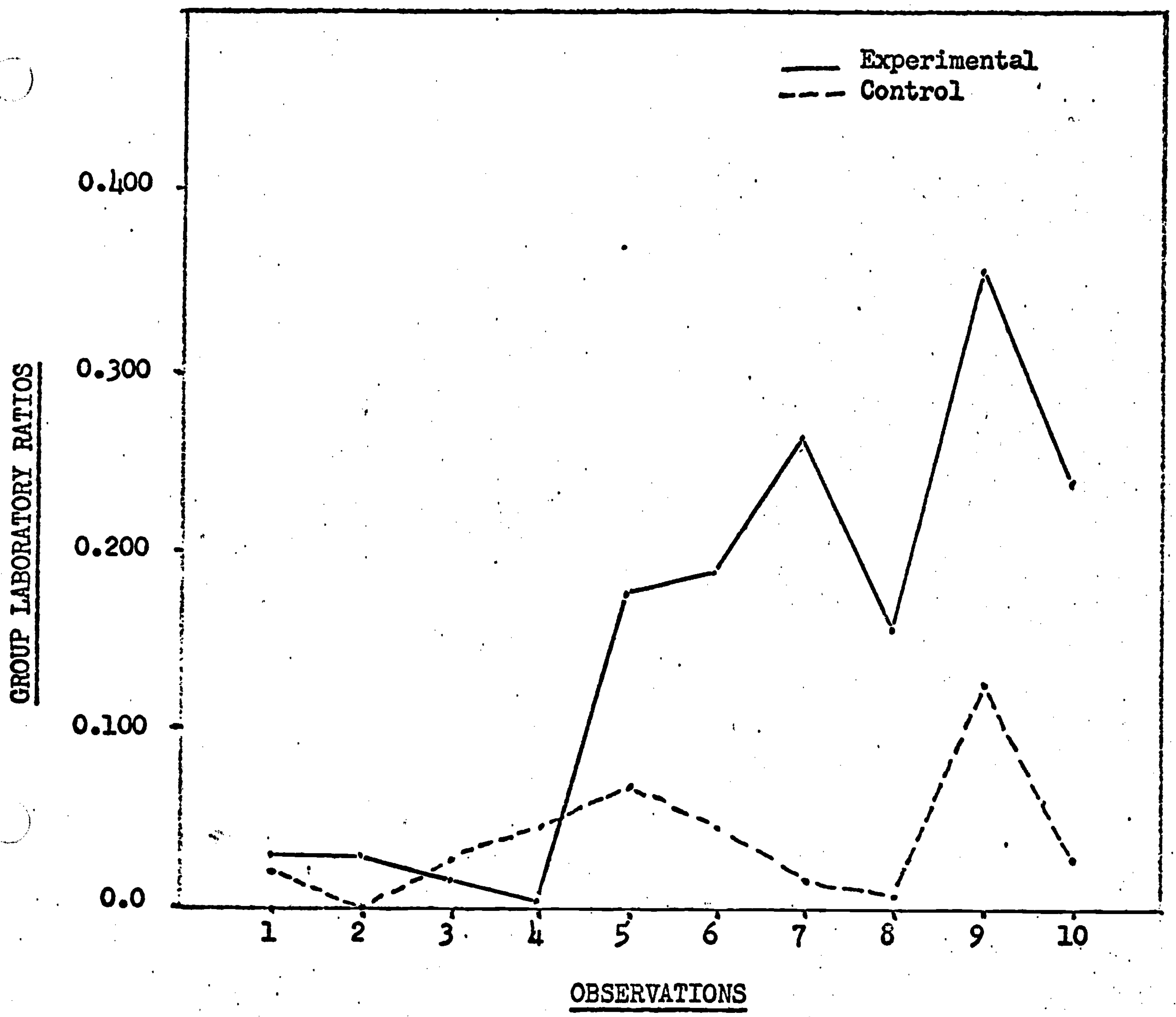

Figure 2. GROUP LABORATORY RATIOS

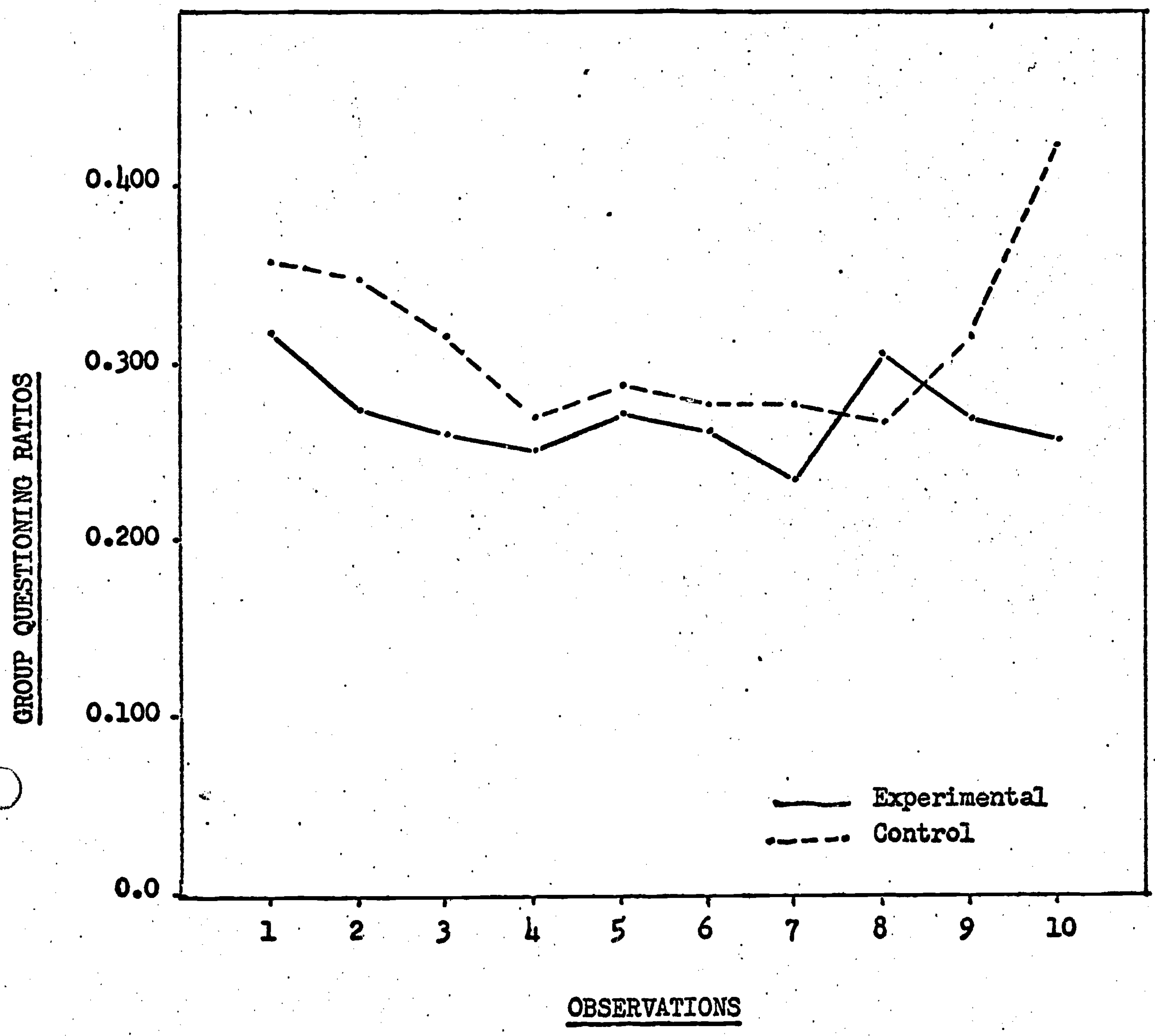

Figure 3. GROUP QUESTIONING RATIOS

The graph in Figure 3 compares the experimental group of teachers with the control group of teachers on the group questioning ratios. In general the group questioning ratios calculated for the control group of teachers were higher than the group questioning ratios calculated for the experimental group of teachers. Group questioning ratios fluctuated for both groups, but did not indicate any relevant trends.

DISCUSSION

In general, results indicate that after teachers of the experimental group had had the inservice science methods course there was a distinct and measureable change in their teaching techniques. There was no significant change for teachers of the control group who had not taken the inservice science methods course. Results shown in Chapter IV may be summarized as follows:

1. After the methods course experimental teachers used indirect activities to a greater extent than before the methods course. Only two experimental teachers had negative activity ratio changes. The mean activity ratio change for experimental teachers was significantly (.05) greater than the mean activity ratio change for control teachers when the t-test was applied to the difference in means. Also, a graph of group activity ratios calculated throughout the study shows a substantial increase for the experimental group of teachers during and after the methods course; and only a slight increase for the control group of teachers.

2. After the methods course experimental teachers used laboratory experiences to a greater extent than before the methods course. Only two experimental teachers had no change in laboratory ratios. They were not observed teaching with laboratory experiences before the methods course or after. The mean laboratory change for experimental teachers was significantly (.05) greater than the mean laboratory ratio change for control teachers when the t-test was applied to the difference in means. Also, a graph of group laboratory ratios calculated throughout the study shows a greater increase for the experimental group of teachers during and after the methods course than for the control group of teachers.

3. After the methods course experimental teachers spent the same proportion of their talking in asking questions as

before the methods course. Eight experimental teachers had negative questioning ratio changes and seven had positive questioning ratio changes. The mean questioning ratio for experimental teachers was slightly negative but was not significantly (.05) different from the mean questioning ratio change for control teachers (also slightly negative) when the t-test was applied to the difference in means. The graph of group questioning ratios shows only small variations for either group throughout the study.

Based on these results it may be concluded that the fifth-grade teachers participating in the methods course used certain techniques to a greater extent after the course than they did before when compared to a control group. More specifically, after the methods course experimental teachers used indirect activities as measured by the activity ratio change and laboratory experiences as measured by the laboratory ratio change more often than before the methods course. Since indirect activities, especially laboratory experiences, were emphasized in the methods course, changes found in the experimental teachers' techniques can be attributed to their participation in the in-service science methods course.

Some laboratory experiences observed in experimental teachers' classes after the methods course were those prepared for the methods course by the investigator or a participating teacher. Usually these experiences when used were first revised by the teacher to meet the needs of his class. However, many laboratory experiences observed in experimental teachers' classes after the methods course were not those prepared for the course. Although the format in the laboratory experiences resembled that specified in the methods course, the activity and subject matter topic was different. The inference is that after the course participating teachers not only used laboratory experiences developed for the course, but also applied skills learned in the course. They devised laboratory experiences for other topics they were required to teach.

Observations of teachers' classes were made by three observers, working independently. Unfortunately, an observer had to tell teachers, in advance, when he would come to the school to observe. At the beginning of the study teachers were instructed not to make special preparations or lesson plans for classes observers were to visit. Teachers were to do whatever they had planned to do before being contacted by an observer. There is some evidence that some teachers probably did not prepare special lessons and also that after the methods course some experimental teachers used laboratory experiences in science lessons not visited by observers: (1) At the end of the study several teachers remarked that a better impression of elementary science teaching would have been obtained had they prepared for the visits. (2) One teacher from the experimental group was upset because no observer visited when he was using laboratory experiences. (3) Several experimental teachers, after an observation, described incidents that had occurred in a laboratory experience earlier in the week. Some gave the investigator a copy of the procedure and asked him to make comments on it. (4) Several times observers watched television programs, went on field trips, and sat through tests. It seems unlikely these lessons were planned for the observer's visit. In view of human nature it would be difficult to say that not one teacher prepared a special lesson or behaved differently when observers visited their science classes. Would the results have been the same if observers had made unannounced observations? Did experimental teachers prepare special lessons? Future investigators should arrange to visit without giving advance warning. If full cooperation of teachers and principals is acquired, few ill affects should result from observers coming unexpectedly and results of the investigation will be strengthened. Possibly some scheme could be devised so teachers would not even know the observer was present.

Subject Matter

The study was conducted within one school year so no effects would result from teachers acquiring a different set of students. However, teachers did not teach the same areas of subject matter before the methods course and after the methods course.

After each observation the observer recorded the subject matter considered during the lesson. On the basis of subject matter each class was categorized as biological science, earth science, physical science or "other." The category biological science included the study of plants, animals and health; earth science included geology and astronomy; physical science included chemistry and physics; and "other" included fire prevention, conservation and subjects which could not be classified in the first three categories.

Biological science was observed more often than any other science. Physical science was second, earth science third and all others fourth. However, the percent of classes with high activity ratios was nearly the same for all four areas. The major difference between the science areas was in use of laboratory experiences. High laboratory ratios were more prevalent for physical science classes and were less prevalent for classes in biological and earth sciences. Future investigators might consider studying the feasability of preparing and teaching laboratory experiences in different areas of science.

CONCLUSIONS

After the methods course teachers from the experimental group used indirect activities as measured by the activity ratio change and laboratory experiences as measured by the laboratory ratio change more often than before the methods course. Teachers from the control group did not change significantly. Since indirect activities, especially laboratory experiences, were emphasized in the methods course, changes in techniques used by teachers from the experimental group can be attributed to their participation in the in-service science methods course. Furthermore, teachers not only used laboratory experiences developed for the methods course but also applied skills learned in the course. Teachers devised laboratory experiences for other topics they were required to teach.

The implication seems to be that if teachers are required to prepare lessons based on laboratory experiences and teach these lessons in a methods course then they will use laboratory experiences to a greater extent in their own classes. But more important, some will devise new laboratory experiences for topics they are required to teach. Instructors of methods courses should consider involving teachers to a greater extent in methods courses. They should require teachers to devise laboratory experiences which can be used in elementary school science classes and to teach the peer group methods class using these laboratory experiences.

SUMMARY

The major goals of this study were (1) to develop an instrument which measures the ratio of time a teacher spends teaching with indirect activities (activities in which the teacher acts as a co-ordinator learning experiences) to time he spends teaching with direct activities (activities in which the teacher is imparting knowledge); (2) to devise an in-service science methods course which would encourage fifth-grade teachers to use indirect activities when teaching science; (3) to measure the effects of the methods course on the teaching techniques of participating teachers.

The instrument, "Activity Categories," consists of 11 categories which describe general types of activites used in science classes. The first six categories--laboratory experiences (open-ended and structured), group projects, student demonstrations, student reports and student talking--are classified as indirect activities. During indirect activities the teacher acts as a coordinator of learning experiences. The emphasis is on student participation. In direct activities--workbook work, teacher demonstration and lecture--knowledge is imparted to students by the teacher, textbook or other device. Two categories are not classified direct or indirect; i.e., teacher questioning and general havoc. In the classroom a numeral is recorded at certain time intervals throughout the science lesson (every five seconds in this study). This numeral designates the category which describes the activity occurring during that interval of time. A series of numerals is thus obtained which may be used to calculate the ratio of time a teacher spends teaching with indirect activities to the time he spends teaching with direct activities. This ratio is termed "activity ratio." Two other derived measures may also be calculated. The "laboratory ratio" measures the percent of time a teacher spends with laboratory experiences. The "questioning ratio" measures the time a teacher spends asking questions.

Thirty fifth-grade teachers from Syracuse, New York, area school systems volunteered to participate in the study. Fifteen teachers were randomly assigned to the experimental group of teachers and fifteen teachers served as a control group. Only experimental teachers were given the methods course during the study.

In the methods course teachers discussed the rationale for using indirect activities, especially laboratory experiences. The instructor of the methods course had prepared several lessons based on laboratory experiences which could be used in fifth-grade science classes. He demonstrated how to teach using laboratory experiences by teaching the lessons to the class. Each teacher was also required to prepare two lessons based on laboratory experiences and then teach the lessons to the class.

The investigator and two associate observers made independent observations of the teachers' science classes. Each of the 30 teachers was seen by two of the three observers. All were observed ten times while teaching science, four times before the methods course, twice during the course and four times after the methods course was given to experimental teachers.

After the methods course experimental teachers and control teachers were observed while teaching science. Activity ratios, laboratory ratios and questioning ratios were calculated with data obtained after the course.

Increases in activity, laboratory and questioning ratios after the course with respect to before were termed ratio changes. Mean ratio changes for experimental teachers were compared with corresponding mean ratio changes for control teachers. Differences in the means were tested by applying the t-test and using a 0.05 level of significance.

In general results show the in-service science methods course caused a change in teaching techniques of participating teachers as measured by the activity categories.

1. After the methods course experimental teachers used indirect activities to a greater extent than before the methods course. The mean activity ratio change for experimental teachers was significantly (.05) greater than the mean activity ratio change for control teachers.

2. After the course experimental teachers used laboratory experiences to greater extent than before the methods course. The mean laboratory ratio change for experimental teachers was significantly (.05) greater than the mean laboratory ratio change for control teachers.

On the average the methods course did not affect the percent of talking time that experimental teachers spent asking questions. The mean questioning ratio change for experimental teachers was essentially zero.

It was concluded that participating teachers did use different techniques after the methods course. They made greater use of indirect activities, especially laboratory experiences. Furthermore, many of the laboratory experiences observed in classes of experimental teachers after the methods course were different from those prepared for the methods course by the investigator or the teachers. Evidently teachers applied the skills learned in the methods course to other topics they were required to teach.

These conclusions must be tempered by the possible effects of two factors. Since observers were required to notify teachers, in advance, that they would visit a certain class, some teachers may have prepared special lessons. Also, laboratory experiences were used more often when the subject area was physical science and teachers from the experimental group were abserved teaching topics in the area of physical science more after the course than before. If laboratory experiences are used to a greater extent in classes where the subject matter topic is Physical Science, perhaps teachers in the experimental group normally use laboratory experiences to a greater extent during the second semester.

REFERENCES

Book

1. Flanders, Ned A., Interaction Analysis in the Classroom, Revised Edition, Michigan: The University of Michigan School of Education, 1964.

2. Gage, N. L., Handbook of Research on Teaching, Chicago: Rand McNally & Co., 1963.

3. Hays, William L., Statistics for Psychologists, New York: Holt, Rinehart & Winston, 1963.

Article

4. Brittain, Clay V. and Edithgene Sparks, "Changes in Teaching Difficulties Reported by Teachers Completing an Inservice Course in Science," Science Education, IXL, 1965, 152-156.

5. Fischler, Abraham S. and Nicholas J. Anastasiow, "In-Service Education and Science (A Pilot) the School Within a School," Journal of Research in Science Teaching, III, 1965, 280-285.

6. Fowler, H. Seymour, "Evaluation of an Institute for the Training of Elementary School Science Resource Teachers," Journal of Educational Research, LIII, 1960, 358-359.

7. Scott, W. A., "Reliability of Content Analysis: The Case of Nominal Scale Coding," The Public Opinion Quarterly, XIX, 1955, 321-325.

8. Sims, Ward L., "The Development and Evaluation of an In-Service Education Program in Elementary School Science," Science Education, XIIL, 1958, 391-398.

9. Washton, Nathan S., "Improving Elementary Teacher Education in Science," Science Education, VL, 1961, 33-34.

10. Weber, C. A., "Techniques of In-Service Education Applied in North-Central Secondary Schools," The North Central Association Quarterly, XVII, 1942, 195-198.

11. Wood, H. B., "In-Service Education of Teachers--An Evaluation," Curriculum Bulletin, No. 81, School of Education, University of Oregon, Eugene, 1950.

12. Brandou, Julian R., "A Study of an Experimental Program for the In-Service Science Education of Elementary School Teachers," Unpublished Doctor's Dissertation, Michigan State University, 1964, Dissertation Abstracts, ( ), 2362.

13. Mork, Gordon, "Effects of an In-Service Teacher Training Program on Pupil Outcome in Fifth and Sixth Grades," Unpublished Doctor's Dissertation, University of Minnesota, 1953, Dissertation Abstracts, XIII, 1953, 522-523.

14. Richardson, Evan E., "Proposals for Improvement of Science Teaching in New Jersey Elementary Schools," Unpublished Doctor's Dissertation," Rutgers University, 1960, Dissertation Abstracts, XXII, 1960, 172.

15. Robinette, Walter R., "A Descriptive Analysis of a Science Education Workshop and Outcomes as Reflected in Classroom Practices," Unpublished Doctor's Dissertation, Alabama Polytechnic Institute, 1957, Dissertation Abstracts, XVIII, 1957, 915.

16. Selser, Will, "An Evaluation of an In-Service Institute for Improving Science and Mathematics Instruction in the Hillsborough County Junior High Schools," Unpublished Doctor's Dissertation, University of Florida, 1962, Dissertation Abstracts, XXIII, 1962.

17. Stefaniak, Edward W., "A Study of the Effectiveness of Two Methods of Teaching Science in Grades Four, Five and Six," Unpublished Doctor's Dissertation, Boston University School of Education, 1955, Dissertation Abstracts, 2121.

18. Wong, H. H., "Elementary Science In-Service Education Programs in Selected California Public School Systems," Unpublished Doctor's Dissertation, University of California, 1954.

APPENDIX A

Part I. Elementary Science Methods Course for fifth-grade teachers.

Rationale

One purpose of an inservice science methods course is to encourage teachers to use indirect activities when teaching science. If teachers are to be encouraged to use indirect activities, they should be able to:

1. State or discuss the rationale for using indirect activities;

2. Describe how to prepare lessons based on indirect activities and how to teach the lessons;

3. Prepare lessons based on indirect activities and teach these lessons.

These statements which describe what teachers should be able to do are acceptable objectives for a methods course.

Methods used by the instructor of an inservice science methods course depend upon and must be consistent with the course objectives. Lecture-discussion techniques are efficient ways to dispense and debate information. If these techniques are used effectively, teachers should learn to discuss indirect activities and the rationale underlying their use. Demonstration techniques are useful to illustrate how to use methods or materials. If demonstration techniques are used, teachers should be able to describe how to prepare lessons based on indirect activities and how to teach using these lessons. But the use of lecture, demonstration and discussion techniques does not insure that teachers will be able to prepare lessons based on indirect activities or be able to teach using these lessons. Although it is possible that some teachers will learn to prepare and teach lessons based on indirect activities, it does not seem probable. If teachers are to be able to prepare lessons based on indirect activities and teach science using these lessons, then the instructor of the methods course should require participating teachers to prepare lessons based on indirect activities and to teach using these lessons. When the instructor observes a teacher teach science using indirect activities the instructor is certain the teacher is able to do it.

This rationale indicates a general outline for a science methods course:

I. Teachers should be presented with the philosophy of contemporary science education and the rationale for using indirect activities. The presentation may be written, verbal or both.

II. Teachers must have the opportunity to discuss the philosophy of contemporary science education and the rationale for using indirect activities. A general discussion should follow the presentation in part I and more specific discussions should follow the activities described below.

III. Teachers should be shown how to teaching using indirect activities. The instructor should prepare lessons based on indirect activities, and then demonstrate by teaching the lessons to the class.

IV. Teachers should have experience in preparing lessons which call for the use of indirect activities and in teaching these lessons.

The Methods Course

One objective of this study was to devise an in-service methods course which would encouarge teachers to use indirect activities when teaching science. This course was developed and taught by the investigator. Twelve meetings were held from 4:30 to 7:30 every Wednesday during January, February, and March, 1967. Each meeting is described below in terms of the major activities which occurred.

Meeting No. 1

The instructor conducted a discussion of several topics including the goals and objectives of science education, ethodology in science teaching, modern thoughts in learning theory, and the curriculum project of the American Association for the Advancement of Science (AAAS), entitled Science--A Process Approach. Next the class discussed the use of laboratory experiences in science classes. (In the class and in this Appendix a laboratory experience is referred to as an activity. All other types of activities will be named.) During the last hour the instructor taught an activity based on the concept, "Acids".

The class atmosphere during the discussion was poor. After the long day in school, the teachers were tired and restless. However, when the activity began, there was a radical change in class attitude. The teachers were enthusiastic and generated many discussions the activity and its use in fifth grade science classes.

Each teacher was given a copy of: Hone, Elizabeth B., Alexander Joseph, and Edward Victor, A SOURCE BOOK FOR ELEMENTARY SCIENCE, Harcourt, Brace and World, Inc., C. 1962, N. Y. This book was to serve as a source of ideas for teachers when preparing assignments and future science classes. The teachers were also given mimeographed materials of several topics pertinent to elementary science education.

Assignment:

January 11, 1967: Read and be prepared to discuss the graphing activities prepared by the instructor.

January 18, 1967: Prepare an activity for presentation to the class. The instructor noted the assignment would be described in greater detail on January 11, 1967.

Meeting No. 2

The class discussed a set of graphing activities prepared by the instructor. Most teachers felt graphing should be taught in math class. All agreed these skills should be applied in science. One teacher suggested using real data with more relevance to the students, rather than artificial data. She noted that students in her class graph their scores on spelling tests.

The pendulum activity was taught by the instructor using an openended approach. Teachers were asked to devise a simple pendulum with a period of one second. No other directions were given. Many had trouble beginning; they didn't know what to do. Some tried to measure the time for a single swing directly. One group tried to use a watch with no second hand. Several groups investigated the effect of changing the weight. This activity turned out to be a content learning experience for all teachers. The instructor answered no questions directly, but asked questions in return to lead teachers to further investigation. The activity lead directly into a discussion of how to teach an activity. Next, teachers were given mimeographed materials presenting the investigator's views of concepts, behavioral objectives, processes in science and motivation.

Ten teachers were given a "heat" kit consisting of directions and materials for seven activities. The instructor taught an activity based on the concept: heat is conducted in metals; some metals conduct heat faster than others. In this activity teachers attach tacks at regular intervals to a metal rod using wax. One end of the rod is inserted in a candle flame. As heat is conducted along the rod, the wax melts and tacks drop off. A graph of distance vs. time may be plotted. The teachers attached the tacks in a variety of ways. One group let the wax harden and stuck the tacks in the wax. Another group first balanced the tacks and then added the wax. No instructions were given for measuring time. One group, having no watch, attempted to count steadily. This propogated a discussion of quantitative and qualitative measurements.

Each teacher was also given a "light and color" kit consisting of directions and materials for six activities. The class was divided into six groups. Each group did a different activity and was aksed to prepare comments on their activity for the next meeting. The meeting lasted past 7:00 and many teachers stayed until 7:30.

Assignment for January 18, 1967:

The teachers were to prepare an activity which they would teach to the class. It was to be based on a concept but emphasize process skills discussed. Objectives were to be behaviorally stated, and the activity was to begin with a "need-to-know."

Meeting No. 3

Each group reported on the "light and color" activity performed the previous week. Then the class discussed the activity. During the week several teachers had performed all activities at home and were able to contribute their experiences to each discussion. For many teachers the activities were learning experiences. Some did not know white light is a mixture of all colors. Only four had seen a diffraction grating before. A few teachers were surprised to learn the image in a camera or eye is inverted. The class discussed these aspects of light and color.

Two teachers gave presentations to the class. These were discussed with special reference to ways each could be improved.

Meeting No. 4 (January 25, 1967)

The instructor conducted a short discussion on observing an inferring. Each teacher was given a piece of sugar and asked to make observations. The instructor wrote these on the board and then asked teachers to name the sense organ used to make each observation. Several of the first list were not observations but were inferences. The difference between observations and inferences was discussed. After this discussion three teachers presented activities they had prepared to the class.

Meeting No. 5 (February 1, 1967)

The teachers initiated a discussion of behaviorial objectives. It began with a single teacher before the meeting and continued for 45 minutes. The remainder of the session consisted of activities presented by three teachers.

Meeting No. 6 (February 8, 1967)

Four teachers presented activities to the class. Another teacher described a science fair project developed by one of his students. This led to a discussion of student demonstrations and group projects. Teachers inquired about suggestions for students who desired to make a science fair project. The investigator emphasized that library reports and charts required little work and yielded little learning. Students should be encouraged to investigate problems such as:

a. What factors affect the period of the pendulum?

b. Do rocks absorb or adsorb water? What factors affect each?

c. What factors affect the balloon rocket?

Meeting No. 7 (February 15, 1967)

Two teachers presented activities to the class. Another teacher described an oral report given by his student. The report was a rather complete description of the birth of a baby. This led to a discussion of student reports and student demonstrations.

The class summarized and discussed activities in general. At this point teachers noted the need to have behavioral objectives, to ask questions rather than lecture and to have concrete experiences for children.

The instructor had prepared a series of activities in the area of astronomy. These activities, written for use in fifth grade classes, were distributed to the teachers. The last activity entitled "Rockets Work on the Principle of Action-Reaction" was conducted by the instructor. The teachers liked this activity. They did not make graphs, but qualitatively worked on problems presented in the activity. The teachers had trouble determining why balloons fly. This was one indication that elementary teachers may need science content courses as well as science methods courses.

Assignment:

Each teacher was asked to prepare another activity to present to the class. They were to develop an original one based on a demonstration they might locate or had used. They were not to rewrite someone else's activity.

Meeting No. 8 (February 22, 1967)

The instructor reported on the book, THE CONDITIONS OF LEARNING, By Robert M. Gagne.* Gagne discusses eight ways of learning. He differentiates between principle and concept which the class had not done. The instructor felt teachers should be aware of this distinction between principle and concept which is made by many authors.

Several astronomy activities were taught by the instructor. The activity entitled "Night and Day" is a demonstration-discussion based on the focault pendulum. The emphasis is placed on asking questions and encouraging student discussion. An interesting development occurred. Each time a question was asked about the turning of the pendulum, opposing answers were given. Eventually the class realized a need to define "turning of the pendulum" operationally. Some were concerned with the plane of the pendulum's swing and others with the twisting of the string. This incident promoted a discussion of operational definitions.

In the activity on triangulation students measure the height of tall objects indirectly. This method is then applied to the determination of the diameter of the moon. Most teachers felt the activity was too difficult. Several were unable to solve proportions when the unknown was in the denominator. After much discussion one teacher suggested both ratios be inverted. This seemed to satisfy most members.

The activities on phases of the moon and planetary distances went well. Many teachers indicated they were going to try them with their own classes. As the meeting ended, one teacher mentioned he had used the balloon rocket activity in his class. After starting the students he went into the hall and watched. He stated, "They never even missed me." He also stated they did very well answering the questions on the sheet.

Meeting No. 9 (March 1, 1967)

The instructor illustrated how a demonstration can be used to lead students in inquiry. The apparatus employed is commonly known as a cartesian diver. A tall cylinder was filled with colored water. A test tube, half filled with water, was inverted and floated in the cylinder. When a rubber balloon, stretched over the top, is pressed lightly, the test tube sinks. Upon releasing the balloon, the test tube rises. The teachers were asked to describe and explain what happened. When a reasonable

*GAGNE, ROBERT M., THE CONDITIONS OF LEARNING, Holt, Rinehart, and Winston, Inc., 1965, N. Y.

conclusion was drawn, the rubber diaphragm was pressed harder. This time the diver went to the bottom where it stayed when the diaphragm was released. After a reasonable explanation was reached, the class discussed how to teach a demonstration. The consensus was children should be asked, not told, and should be encouraged to participate in discussion.

Three teachers presented activities to the class. Each activity was discussed.

Meeting No. 10 (March 8, 1967)

Four teachers presented laboratory-type activities to the class. Each activity was well done and served to illustrate how activities should be prepared and presented.

Meeting No. 11 (March 15, 1967)

The teachers were interested in further information concerning the teaching of chick development in their classes. Mr. Ronald Hay of the Syracuse 4-H Club was invited to talk on this subject. Mr. Hay's presentation included a film, and he had eggs at various stages of development which he opened. The teachers were impressed when they were able to see a beating heart. Several teachers will most likely incorporate this three-week activity into their science class.

Three teachers presented lessons to the class. Each was discussed critically and suggestions for improvement were made.

Meeting No. 12 (March 16, 1967)

The instructor taught two short films. The emphasis was on using films as a basis for inquiry. The films were stopped at several points to permit discussion.

Four teachers presented lessons. All were not able to teach them due to time. The lessons had been mimeographed, however, and a discussion of each was conducted.

The instructor gave each teacher the concept, "Foods may contain starch, proteins and/or fats." They were asked to write a laboratory activity for the concept. Teachers were permitted to take the exam home.

APPENDIX B

ACTIVITY CATEGORIES: AN INSTRUMENT FOR QUANTITATIVELY RECORDING ACTIVITIES IN A SCIENCE CLASS

The third objective of this study was to develop an instrument which measures the ratio of time a teacher spends teaching with indirect activities to time the teacher spends teaching with direct activities. Indirect activities are defined as activities in which the teacher acts as a co-ordinator of learning experiences. Direct activities are defined as activities in which the teacher is imparting knowledge. The ratio of time spent teaching with indirect activities to time spent teaching with direct activities is called the "activity ratio."

"Activity categories" was developed for observers to use when visiting science classes. However, the instrument could also be used by a teacher during his own class or while watching his lesson via a video tape. The instrument is a set of 11 categories (Table I) used to classify all activities which may occur in science classes. Categories include.....laboratory experiences, group projects, student demonstrations, student reports, student talk, teacher questioning, lecturing, workbook work, teacher demonstrations and general havoc.

The Categories

Six categories describe activities considered to be indirect activities. These are openended laboratory experiences, structured laboratory experiences, group projects, student demonstrations, student library research and student talking. During these activities the teacher acts as a coordinator of learning experiences. Emphasis is on student participation.

The first two categories describe laboratory experiences; openended laboratory experiences (Category No. 1) and structured laboratory experiences (Category No. 2). The major difference between openended and structured laboratory experiences is the amount of freedom granted to students. In a structured laboratory experience students have little or no freedom. The procedure is carefully outlined and students are not asked to make any analysis or interpretation of the data. They are only required to make observations. The following examples are structured laboratory experiences:

Example 1. Students are told that foods which contain starch are turned blue by the addition of iodine solution. They are given iodine solution and several foods, told to add a drop of iodine solution to teach food and asked to write the names of foods which turn blue or contain starch.

INDIRECT ACTIVITIES	1. LABORATORY EXPERIENCES: OPENENDED	Students are presented a problem to be solved by experimentation. The procedure may or may not be given. They are required to make observations and analyze or interpret their findings.
	2. LABORATORY EXPERIENCES: STRUCTURED	Students are presented a laboratory experiment with a structured procedure. They are not required to analyze or interpret their data. They are asked to make observations.
	3. GROUP PROJECTS	One or more groups of students are working on a science project during the class period. Some may work individually. (not written projects)
	4. STUDENT DEMONSTRATIONS	A student or group of students demonstrate a science experiment or project which they have prepared. (Oral report on science project would be included).
	5. STUDENT LIBRARY RESEARCH, REPORTING, ETC.	(a) A student or group of students give an oral report they have prepared based on reference material. (b) The class works with reference materials for purposes of writing or making reports.
	6. STUDENT SPEAKING	The student contributes verbally by asking a question, answering a question or simply volunteering information.
	7. TEACHER QUESTIONING	Students are asked a question by the teacher.
DIRECT ACTIVITIES	8. WORKBOOK WORK	Students work in class on workbooks, homework, questions from text, art-type work, etc.
	9. TEACHER DEMONSTRATIONS	The teacher presents material by film, filmstrip, record, TV, radio, demonstration, etc.
	10. LECTURE	The teacher reads aloud, expresses his views, gives directions, makes an assignment or asks rhetorical questions. Students are expected to listen. They may interrupt only when they do not understand. Student reading in the text is also included.
	11. GENERAL HAVOC	The class may be cleaning up, settling down or doing nothing. In general, this category should be used sparingly.

Table I Activity Categories. Eleven categories which describe general types of activities used in science classes.

The procedure was specified and students were only required to make observations.

> Example 2. Students are told to plant four seeds. They must give one seed water, sunlight and dirt; the second, only sunlight and water; the third, only sunlight and dirt; and the fourth, only water and dirt. Students are asked to describe what happens.

Again the procedure was specified and students were only required to make observations. They were not asked to explain or draw conclusions from the data.

In openended laboratory experiences students are presented one or more problems. They may or may not be asked to determine a procedure but are asked to analyze or interpret the results. The following examples are openended laboratory experiences.

> Example 1. Students are given three chemicals: iodine solution, water with blue food coloring and water with green food coloring, and several foods. They are told potatoes contain starch and are asked to tell all they can about the foods. Students are also asked to tell what they do and give reasons for their statements about the foods.

> Example 2. Students are asked, "What do plants need to grow?" "How much do they need?" The students are required to plan and carry out experiments to answer the questions. They must describe what they do and give reasons for any conclusions they may make.

In these examples students not only analyze or interpret their observations, but also plan their own procedure.

Three categories describe children working individually or in small groups on a project, demonstration or report. Students are often granted class time to prepare science fair projects or demonstrations for the class. The category entitled "group projects" (No. 3) is recorded when students are preparing projects or demonstrations. When a demonstration, project or oral report on a project is being presented to the class by a student or group of students, the category entitled "student demonstrations" (No. 4) is recorded. In the study of weather at the elementary school level projects are often prepared and then demonstrated. Students make instruments to measure wind velocity, air pressure and precipitation or wind direction and demonstrate them to the class. Many teachers have students prepare and present oral or written reports on various animals. The category "student library research" (No. 5) is recorded when students are working with reference materials to prepare a report or when students are presenting their reports to the class.

The "student talking" category (No. 6) applies to moments when students are making a verbal contribution to the class. They may be expressing their views, reading their notes aloud, telling a story, describing a personal experience, asking a question or answering a question. This category is recorded when students are allowed to speak.

Categories entitled "workbook work" (No. 8), "teacher demonstration" (No. 9) and "lecture" (No. 10) are classified as direct activities. During these activities the teacher imparts knowledge verbally or with some device.

The workbook work category is used to describe situations in which students are filling our workbooks, working homework problems, writing answers to questions, copying pictures or coloring pictures. This category is classified direct because teachers usually ask questions which require students to search for an answer in the textbook or have students color a sketch of some picture hanging in the front of the room. This is just another way of imparting information to students. They are given little freedom to express themselves--to analyze or interpret information. However, if questions are judged by the observer to be thought provoking, a notation is made in the margin of the recording sheet.

Modern technology has provided teachers with instructional aids, audio visual devices and other media which provide teachers with efficient and enjoyable ways to present information. Included as instructional aids are television, films, filmstrips, phonograph records, tape recordings and radio. Category No. 9, "Teacher demonstrations," is recorded when the teacher is using instructional aids. This category is also recorded while the teacher is demonstrating. The following example will illustrate when the category was used. During the study a teacher heated a coke bottle capped with a balloon "to prove air expands when heated." Several times films or filmstrips were shown.

If properly used, instructional aids or a demonstration will arouse student curiosity and provoke discussion or investigation. Situations where instructional aids are used to stimulate inquiry will be short and interrupted by situations which can be classified into an indirect activity category. Unfortunately, demonstrations are seldom used for this to stimulate inquiry. The teacher rushes through the film, filmstrip or demonstration and only asks a question to make sure students are paying attention. The teacher seldom stops the film, filmstrip or demonstration and asks, "What do you think is going to happen?" and "Why do you think that will happen?" or "Why do you think such and such happened?" If he did stop, asked questions and allowed students to express their views, "student talking" (Category No. 6) and probably "teacher questioning" (Category No. 7) would be recorded more than "teacher demonstration" (Category No. 9).

The category entitled "lecture" (No. 10) is recorded when the teacher reads aloud, expresses his views, gives directions, makes an assignment or asks a rhetorical question. The student listens and only interrupts if he does not understand what the teacher is saying. If the teacher writes on the blackboard or overhead projector, the interval is still classified as lecture. These instructional aids are not considered "teacher demonstrations." Students reading the text, aloud or silently, and lulls during a lecture for students to write notes are also classified as lecture. This category describes those activities in which students receive information or directions from the teacher or textbook.

The teacher questioning category (No. 7) is recorded when students are asked a question by the teacher. This category could be considered direct since it describes situations in which students are not participating. However, the teacher is not imparting information but is attempting to elicit student talk. Not classifying this category direct or indirect when calculating the activity ratio has implications to be discussed below. (See "Calculations with Data")

"General havoc" (No. 11) is the category used to describe intervals of time when the class is interrupted. These non-teaching activities include students settling down or cleaning up, announcements on the public address system, visitors at the door, fire drills, handing out homework or materials, moving from the classroom to another location, etc. Periods of silence while the teacher gets materials ready, erases the board or does some other menial task are also classified as "general havoc."

Use of the Activity Categories

In the classroom the observer uses a stopwatch and notebook. The notebook has a copy of the categories and ground rules attached to the inside left cover and a recording sheet (Figure 1) on the right side. Before class, in the spaces provided at the top of the sheet, the observer writes his name, the teacher's number, the date and the time. Spaces on the recording sheet are provided for the observer to record a series of numbers. The spaces, small squares, are arranged into groups of twelve. Twelve squares are filled every minute; each square corresponds to a five-second interval of time. The five-second interval was chosen somewhat arbitrarily.* A four or six-second interval would

---

*While testing the instrument, the recording interval was changed several times. As the interval length is shortened, precision increases. If a one-second interval is used, the instrument is extremely precise. However, as the interval length is shortened, observers must make decisions faster and more often. The five-

Teacher No. 17 Science Topic Weather

1:05 Date 11/29 Observer HAAKONSEN

10	10	10	10	*	•	•	•	•	•	•	•	1	10	10	•	•	•	•	•	•	•	•	•	•	2
10	10	•	•	•	•	•	•	•	•	•	•	3	10	10	•	•	•	•	•	•	•	•	•	•	4
10	10	•	•	•	5	8	8	•	•	•	•	5	8	8	•	•	•	•	•	•	•	•	•	•	6
8	8	8	8	•	•	•	•	•	•	•	•	7	8	8	8	•	•	•	•	•	•	•	•	•	8
8	8	8	•	•	•	•	•	•	•	•	•	9	8	8	•	•	•	•	•	•	•	•	•	•	10
8	8	•	•	•	•	•	•	•	•	•	•	11	8	8	8	•	•	•	•	•	•	•	•	•	12
8	8	8	•	•	•	•	•	•	•	•	•	13	8	8	•	•	•	•	•	•	•	•	•	•	14
5	8	10	10	10	10	10	10	10	•	•	•	15	10	7	7	6	6	6	10	10	10	7	7	6	16
6	6	6	6	6	6	6	6	6	7	7		17	10	10	7	6	6	6	10	10	7	6	10	10	18
10	10	10	10	7	7	7	6	6	6	10	10	19	10	6	6	7	7	6	6	6	6	6	10	7	20
7	6	6	10	10	10	10	10	6	6	6	10	21	10	10	10	10	10	10	10	6	6	7	6	10	22
10	10	10	10	10	10	10	10	10	10	10	10	23	10	10	10	10	10	5	5	5	5	5	5	5	24
5	5	•	•	•	•	•	•	•	•	•	•	25	7	6	10	10	6	7	6	7	6	6	6	6	26
6	6	6	6	6	6	6	5	5	5	5	5	27	6	5	5	6	5	5	5	6	6	7	7	7	28
7	7	6	6	6	6	7	7	6	6	6	7	29	6	6	6	6	10	10	6	6	6	6	6	10	30
6	6	6	5	5	5	5	5	5	5	5	5	31	5	5	5	5	5	6	6	11	10	6	6	6	32
6	6	10	10	7	10	7	6	7	6	6	6	33	6	6	4	4	4	4	4	4	4	4	4	4	34
4	4	4	4	4	4	4	4	4	4	4	4	35	4	4	4	4	4	4	4	10	7	6	10	10	36
10	10	10	10	10	7	6	6	10	10	10	6	37	6	6	4	4	4	4	4	4	4	4	4	4	38
~~4~~ 4												39													40
												41													42
												43													44
												45													46
												47													48
												49													50
												51													52

TOTALS 1___ 2___ 3___ 4 39 5 43 6 90 7 32 8 117 9___ 10 134 11 1

Figure 1. COMPLETED COPY OF RECORDING SHEET.

*THE DOTS ARE A CONTINUATION OF THE SAME CATEGORY probably have worked as well. Teachers recording their own classes would need to use a much larger interval; perhaps a one-minute interval. They would not have time to record more often than once a minute while teaching.

When the lesson begins, or just before it begins, the stopwatch is started. It runs continuously throughout the science lesson. Every five seconds the observer notes a single numeral which designates one of the 11 categories. The activity which occurs during the five-second interval determines which category is chosen and hence which number is recorded. If the teacher was asking a question, the observer records a 7, "teacher questioning." If a student was giving a report, the observer records a 5 to indicate the category entitled "student library research." If students were cleaning up after a laboratory experience, the observer records an 11, "general havoc." A series of numbers is obtained. This series of numbers tells what types of activities occurred as well as the order in which they occurred.

Ground Rules

Several ground rules were developed to clarify use of the instrument. Many times two or more activities occur simultaneously or sequentially in the same five-second interval. Since only one number is recorded, only one category is chosen. Two ground rules were developed to provide for the sequential or simultaneous occurrence of two or more activities in the same interval. When activities occur simultaneously, the observer chooses the category with the lowest number (rule 1). For example, the teacher is talking during a film. If the teacher is lecturing or telling students (Category No. 10), the observer records No. 9 (teacher demonstration). If the teacher is asking a question, the observer records No. 7 (teacher questioning). When activities occur sequentially in the same five-second interval, the observer chooses the category which describes the activity occupying the major portion of the interval (rule 2). If this is not possible, the observer chooses the category with the lowest number. For example, the teacher ends his question in an interval and a student begins to talk immediately. If the student talk occupied the greatest portion of the five-second interval, the observer records No. 6 (student talk). If the question occupied the greatest portion, the observer records No. 7 (teacher questioning). If both activities occupied the same portion, the observer chooses the category entitled student talk because its numerical designation is lowest No. 6).

---

second interval was precise and recording data was not too difficult. Future workers may wish to use intervals of some other length. The stopwatches used should be calibrated in terms of the interval length. This will make it easier for the observer to watch the stopwatch and classroom activities.

GROUND RULES

1. When two activities occur simultaneously in a five-second interval, observers choose the category with the smallest number. For example, a teacher may be talking while showing a filmstrip (No. 9). If the teacher is telling the students (No. 10), observers record a 9. If the teacher is asking a question (No. 7), observers record a 7.

2. When two or more activities occur sequentially with a five-second interval, observers choose the activity which occupied the major portion. If this is not possible, observers choose the category with the lowest number.

3. Lulls during a lecture for purposes of notetaking (No. 10). If the lull occurs following a teacher's question, it is recorded as a question (No. 7).

4. If an interval cannot be assigned a number, it is left blank. The situation should be explained in the margin as soon as possible.

6. A test is coded as "T".

7. Laboratory experiments: If a distinction between categories 1 and 2 cannot be made because the directions are nonverbal, then an "L" will be used until the directions can be examined. While students are predominantly reading directions, consider this as Category 10, directions.

8. When Category No. 8 is applicable, the observer should check the materials. If the materials are thought-provoking rather than "look-up-the answer" type, the observer will note this on the reverse side of the sheet.

9. Guest speakers are not recorded. "Guest speaker" is written across the blank intervals.

Table II Ground Rules. Rules to clarify use of the activity categories.

Periods of silence during a lecture or following a question are also classified (rule 3). The lull in a lecture for purposes of notetaking or allowing the information to sink in is coded as part of the lecture. The lull following a teacher's question is categorized "teacher questioning" (Category No. 7).

Occasionally, activities not described by a category will occur. To provide for such situations, it was necessary to add ground rules. The general rule for intervals which cannot be assigned a number is rule no. 4. The interval is left blank, and the observer writes a short description of the activity in the margin of the recording sheet.

Fieldtrips are classified "student library research," Category No. 5 (rule 5). Fieldtrips may range from a trip to another classroom where an exhibit is displayed to a trip to an industrial concern in another city. The travel time is categorized "general havoc" (Category No. 11). Tests are not classified. The observer codes a "T" to denote test (rule 6). Laboratory activities with non-verbal directions are coded "L" until the directions can be examined (rule 7). Usually the teacher gives a copy of the directions to the observer. Guest speakers are not recorded; the interval is left blank and "guest speaker" is written across the blank intervals (rule 9).

Ground rule No. 8 provides for workbook materials which are thought-provoking rather than "look-up-the-answer" type. The observer makes a marginal notation when materials require students to analyze or interpret rather than hunt for answers.

After class the observer writes the subject-matter topic which was studied in the space provided at the top of the page. This information can be used to determine if effects due to subject matter occurred. Perhaps teachers use certain categories of activities when teaching one subject-matter area and other categories of activities when teaching other subject matter areas. Data should be available to measure effects due to subject matter.

On the reverse side of the recording sheet the observer also makes subjective comments about classroom atmosphere. When applicable, he writes a concise phrase to answer the following three questions:

1. In general, what types of questions did teachers ask? Recall? Thought-provoking?

2. Did the teacher have sufficient knowledge of the subject matter? Were students interested?

3. Was the class structured or unstructured; i.e., did students have the opportunity to inquire or were their questions overlooked?

Calculations with Data

Three indices which may be calculated with the data are the activity ratio, laboratory ratio, and questioning ratio. Each ratio is discussed below.

The activity ratio is a measure of the relative amount of time spent teaching with indirect activities. It is the ratio of time spent teaching with indirect activities. (Categories 1 through 6) to time spent teaching with direct activities (Categories 8, 9, 10).* The numerator of the activity ratio is calculated by adding all the five-second time intervals during which activities that occurred were judged to belong to Categories 1 through 6. The denominator, time spent teaching with direct activities, is calculated by counting the number of five-second time intervals during which activities were judged to be described by Categories 8, 9 or 10. Time intervals assigned the number 7 (teacher questioning)

$$\text{Activity Ratio} = \frac{\text{No. of intervals assigned to categories 1,2,3,4,5,\&6}}{\text{No. of intervals assigned to categories 8,9, \& 10}}$$

are eliminated when calculating the activity ratio. When teachers ask questions, rather than lecturing, the activity ratio is larger. The denominator would be smaller (fewer time intervals characterized by activities belonging to Category No. 10 are recorded) and the numerator should increase (more time intervals characterized by activities belonging to Category No. 6 should be recorded because students are being encouraged to talk).

The activity ratio indicates where a teacher is predominately imparting knowledge or acting as a coordinator of learning experiences. If the value of the activity ratio is greater than 1.0, the teacher is using indirect activities more than direct activities. This implies he is acting more as a coordinator of learning experiences and less as one who imparts information. If the value is less than 1.0, the reverse is true.

The laboratory ratio measures the percent of time spent with laboratory activities. It is the ratio of time spent teaching with laboratory activities to total time spent teaching science. The numerator is determined by adding all the five-second intervals

---

*The following categories describe activities classified indirect: (1) laboratory experiences, openended; (2) laboratory experiences, structured; (3) group projects; (4) student demonstrations; (5) student library research; (6) student talking. The following categories describe activities classified direct; (8) workbook work; (9) teacher demonstration; (10) lecture.

during which laboratory experiences (Categories 1 and 2) were judged to have occurred. The denominator is determined by adding all time intervals assigned to Categories 1 through 10. A laboratory ratio of 0.250 indicates the teacher spent one-fourth of

$$\text{Laboratory Ratio} = \frac{\text{No. of intervals assigned to categories 1 \& 2}}{\text{No. of intervals assigned to all 10 categories}}$$

the total class time (excepting "general havoc" time) on laboratory experiences.

The questioning ratio measures the amount of time teachers spent asking questions with respect to the total amount of teacher talking recorded. The numerator of the questioning ratio is determined by adding all the five-second intervals during which activities which occurred were judged to belong to Category No. 7. The denominator is determined by adding all the five-second intervals during which activities that occurred were judged to belong to Categories No. 7 or No. 10.

$$\text{Questioning Ratio} = \frac{\text{No. of intervals assigned to category 7}}{\text{No. of intervals assigned to categories 7 \& 10}}$$

Training Associate Observers

For this study two associate observers were trained to use the activity categories. Each observer was to make one-third of the observations. At the first training meeting the two associate observers were given copies of the categories and ground rules and were told how these would be used in science classes. Before the next meeting associate observers memorized all categories and ground rules. At the second training meeting the investigator and associate observers discussed the techniques of using the rating sheets. It was essential to agree upon which categories should be recorded to describe various classroom activities. The observers discussed various activities and how these would be classified.

During the following week five science classes in a local high school were observed to standardize the performance of all three observers* The particular classes observed were chosen

*High school classes were chosen because rapid verbal exchanges between the teacher and his pupils occur more frequently than in because the students were accustomed to having visitors. The classes were not disturbed by the presence of two or three observers. Two ninth-grade general science classes and three eleventh and twelfth-grade physics classes were observed. General science classes were reviewing chemistry. Physics classes were beginning the study of wave motion.

Both associate observers were seated beside the investigator. They could see his recordings and know immediately how their decisions compared. In the first class observers recorded for ten minutes and then rested five minutes. Three ten-minute periods were recorded. During the rest periods observers were able to discuss differences in decisions. In succeeding classes the recording periods were increased until, at the last meeting, the entire class period was recorded. At the last two meetings observers separated; consequently, observers could not see each other's rating sheet. After each meeting observers discussed various classroom situations and came to an agreement as to how they should be coded.

Estimating Reliability Between Observers

In this study teachers were seen by two of the three observers. Data gathered by different observers making independent observations of the same teachers were combined. Estimates of reliability between the investigator and each associate observer were calculated prior to the study. All three observers visited the same two elementary school science classes and recorded independently. Estimates of reliability were calculated with the combined data from two classes. A coefficient of observer reliability was determined with a method described by Scott (1955, 321-325).

Scott's method for calculating an index of agreement between coders is applicable to nominal scales and is not affected by low frequencies.* The activity categories are scaled nominally and some categories are used infrequently.

---

elementary school classes. It is difficult to record data when different activities occur rapidly because the categories were designed for longer events. The author felt observers trained in high school classes would be able to work with greater reliability in elementary school classes.

*Nominal scales are not ordered on any factor. The numerical designation of categories is assigned arbitrarily.

Scott's index of agreement between coders is a ratio given by $\pi = Po - Pe/_{1 - Pe}$. The numerator of the ratio is the difference between the observed percent of agreement (P_o) and the percent of agreement expected by chance (P_e). The denominator of the ratio is the maximum possible difference between the observed percent of agreement and the percent of agreement expected by chance ($1.0 - P_e$). Calculations of reliability estimates, using Scott's method, are shown in Appendix B.

Table III shows the reliability estimates obtained for each pair of observers before the study. Reliability estimates were greater than 0.88. To maintain high observer agreement, observers discussed unique problems when they occurred. For example, observers discussed laboratory experiences to determine if the activity should be recorded as openended (Category No. 1) or structured (Category No. 2). Observers also met to decide how tests would be recorded. In this case a ground rule was added.

Relability checks were made in the middle of the study (February, 1967) and near the end (June, 1967). Both times the researcher accompanied each associate observer to two classes. The measurement in February indicated a slight increase in reliability between the researcher and each associate observer. Both values (Table III) were slightly greater than 0.91. In June, 1967 the calculations again indicated an increase in reliability. Both values were greater than 0.93. Relatively high reliability coefficients indicates that observers recorded comparable notations for similar teaching situations.

Suggestions for Future Workers

The activity categories were developed to measure the use of various types of activities by science teachers. In general, the instrument was designed for use by an observer of the class. It is, however, possible for a teacher to record his own classes if slight alterations are made in the instrument. A teacher recording his own class should use a large time-interval. He could probably record a number every 60 seconds with out much disturbance to his class. Also, category No. 6 (student talking) and category No. 7 (teacher questioning) would need to be combined. Teachers rarely spend 30 seconds or more asking a question and students seldom talk that long. If categories 6 and 7 were combined into "discussion," periods of talking could then be classified either "discussion" or "lecture."

The categories were used by three observers visiting the same classes. Scott's methods for determining a coefficient of observer agreement was applied to data gathered by pairs of observers. For every pair of observers coefficients were greater than 0.88. These high coefficients of observer agreement indicate that high reliability can be expected between observers using the activity categories.

	Observers A & C	Observers B & C	Observers A & B
Before the study (October, 1967)	.898	.892	.885
During the study (Phase II)	.914	.927	*
At the end of the study (June, 1967)	.943	.935	*

Table III - Estimated Reliability Between Observers

*During the study and at the end of the study Observers A and B could not visit classes together. No reliabilities were calculated for these two observers after the study began.

However, high reliability between observations should not be expected. Teachers would not be expected to use indirect activities exclusively. For instance, a teacher might introduce a topic with laboratory experience on one day, have students do library research the next day and show a film the third day. Applying the activity categories to these lessons would yield a high activity ratio and high laboratory ratio the first day, a high activity ratio, but low laboratory ratio the second day, and a low activity ratio and low laboratory ratio the third day.

For situations where a team of observers will work together, the following training procedure may be useful. The four steps are based on the training procedures used in this study.

1. Observers must memorize the activity categories and ground rules and become familiar with use of the categories in science classes. Until this step is completed, observers cannot adequately discuss the activity categories, ground rules and use of the categories in science classes.

2. The team of observers must discuss each category, each ground rule and the use of the instrument. This discussion should minimize differences in interpretation between observers. Before entering a classroom, observers must agree on how the instrument should be used.

3. Observers should practice recording with the activity categories in actual classroom situations. Record for short periods at first (10 minutes) and discuss problems between these recording periods. If longer periods are used, observers may become confused. The recording periods should be increased gradually until the team is coding an entire class. After each observation inter-observer discussions will be beneficial. Observers can compared recordings and discuss differences resulting from problem situations.

4. Reliability between observers when visiting the same class(es) may be determined by Scott's method. Once a satisfactory reliability is achieved, it should be maintained. Inter-observer discussions of new situations when they arise will help maintain reliability between observers.

If an individual observer plans to make all observations the last three suggestions will need to be altered. Perhaps another individual could work with the observer help him learn to use the instrument.