DOCUMENT RESUME

ED 025 435 . 24 SE 006 029

By-Newton, David E.; Watson, Fletcher G.

The Research on Science Education Survey. The Status of Teacher Education Programs in the Sciences, 1965-1967.

Harvard Univ., Cambridge, Mass. Graduate School of Education.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.
Bureau No-BR-8-A-020
Pub Date 68
Grant-OEG-1-7-062406-3149; OEG-1-8-0020-0040-057
Note-133p.
EDRS Price MF-$0.75 HC-$6.75
Descriptors-Biology, Chemistry, *College Science, Curriculum, Earth Science, Educational Programs, Elementary School Science, Elementary School Teachers, Instruction, Physics, *Science Education, Secondary School Science, Secondary School Teachers, Student Teachers, Teacher Characteristics, *Teacher Education

A comprehensive survey of programs for preparing science teachers at colleges and universities in the United States was conducted to provide information on the current status of such programs. Analyzed were (1) the practice teaching experience in these institutions, (2) the methods courses in science education, and (3) the characteristics of the instructors of these methods courses. Some 992 institutions were surveyed and 73 per cent of these returned at least a partial response. The two-part questionnaire was directed both to the person responsible for the overall program and to the instructors of the methods courses in the institution. Over 90 tables present information obtained in the survey. (GR)

BR 8-A-020
PA-24
OE-BR

THE RESEARCH ON SCIENCE EDUCATION SURVEY

THE STATUS OF TEACHER EDUCATION PROGRAMS IN THE SCIENCES, 1965-1967

HARVARD GRADUATE SCHOOL OF EDUCATION
1968

PROCESSING CONTROL RECORD

37-21

for

MUST and MUST - EXPEDITE DOCUMENTS

ERIC FACILITY

Document Identification Number	BR-8-A-020
Date Received from Central ERIC	FEB 3 1969
Date Shipped to Clearinghouse	FEB 6 1969

ERIC CLEARINGHOUSE

Date Received	2-10-69
Clearinghouse Accession Number	SE 006 029
Date Shipped	

ERIC FACILITY

Date Received	Feb 17, 1969
ED Accession Number	
Date Shipped to EDRS	

THE RESEARCH ON SCIENCE EDUCATION SURVEY

The status of teacher education programs in the sciences, 1965-1967

David E. Newton and Fletcher G. Watson

Harvard Graduate School of Education

Study funded by

USOE Research Training Grant #OEG-1-7-062406-3149,
USOE Small Grant #OEG-1-8-0020-0040-057,
The Eugene P. Higgins Fund, and Harvard University

1968

During the past two years a comprehensive study of programs for the preparation of teachers in the sciences has been under way at the Harvard Graduate School of Education. The purpose of this report is to summarize the major findings of that study. The study was both complex and comprehensive, which accounts for the extensive nature of this final report. Some readers may choose to skim the first sections of the report (which deal with the background and methodology of the study) and concentrate their attention on the second section (which contains the results of the study). No references have been made to a number of other studies on teacher preparation programs in the sciences because of our desire to keep this report as brief as possible.

While the report is long, the analysis of data can scarcely be said to be complete. The amount of data is so vast and the variety of analyses which are possible is so great that this report can present only the analysis of basic groups and of the most important sub-groups. It is the intention of the ROSES staff to study more detailed aspects of the data at a later time.

It should be noted that the appendices referred to in this report are not included in the copy you have received. The cost of printing and mailing these additional sections would have been prohibitive. Copies of specific appendices may be had, however, on request from the ROSES office.

The work presented or reported herein was performed pursuant to a Grant from the U.S. Office of Education, Department of Health, Education and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Special appreciation is offered to Alexandra Murphy, Elizabeth Lundquist, Sarah Shabazian, and Jim Giglio for their assistance in proof-reading and typing this report.

The Research on Science Education Survey, A Summary

During 1967 and 1968 a study of programs for the preparation of science teachers has been made at the Harvard Graduate School of Education. The purpose of the survey has been to collect, analyze, and report basic statistical data about the institutions, instructors, and students involved in these programs.

The study consists of two parts. In Phase One, a pair of questionnaires was mailed to 1) the person responsible for the science education program at each of 992 institutions (Booklet A), and 2) to the instructor(s) of the science methods course at each institution (Booklet B). In Phase Two, a series of visits were made to 37 colleges and universities in 22 states engaged in the preparation of science teachers. The institutions were selected (not randomly, but purposefully) to represent all sizes and types of schools, as well as to provide geographical distribution. Three activities were planned at each institution: 1) an interview with the instructor(s) of the science methods course(s), 2) interviews with a random sample of students in the science methods course, and 3) observations of the science methods course in session. A pair of student questionnaires, one sent before the methods course began (Booklet X) and one sent after the course was completed (Booklet Y), was mailed to the students enrolled in the methods courses at these institutions.

Response Rate

In April of 1967, the questionnaires constituting Phase One of the study were mailed. Each of the 992 institutions received one copy of Booklet A, and 2 to 10 copies of Booklet B, depending on the size of the institution. A total of 333 Booklets A were returned (34%); 667 individuals from 420 institutions returned copies of Booklet B. Some institutions returned only Booklet A, some only a Booklet B, and some both.

A follow-up letter mailed in September, 1967, brought an additional response from 243 institutions (25%) in the form of a postcard reporting minimal information on the institution's science education program. Finally, there is evidence (usually a letter) that an additional 53 institutions (5%) have no program for the training of science teachers. With all three forms of response (returned questionnaires, postcards, and "no program" letters), we obtained some response from 725 institutions for a response rate of 73%.

Degrees in the Teaching of Science

Information on the number of degrees granted in the teaching of various sciences (physics, chemistry, biology, general science, and earth science) was received from 221 of the respondents. Sufficient data from an additional 328 institutions allowed an estimate of the corresponding figures (number of degrees in the teaching of sciences) for all 992 institutions. The reported and estimated totals for each field of science teaching for the two years covered in the study are presented in Table 1. The estimated totals are consistent with the comparable results published by the National Education Association's 1966 report on Teacher Supply and Demand.

TABLE 1

BACHELORS DEGREES IN THE TEACHING OF SCIENCE IN SECONDARY SCHOOLS

Field	1965-66		1966-67	
	Reported*	Estimated#	Reported*	Estimated#
PHYSICS	294	735	279	698
CHEMISTRY	657	1643	719	1798
BIOLOGY	2161	5403	2311	5778
EARTH SCIENCE	159	398	183	458
GENERAL SCIENCE	511	1278	548	1370
Totals	3782	9455	4040	10,100

*Reported by 221 institutions

#Estimated for 992 institutions in the Research on Science Education Survey

Course Requirements for Prospective Science Teachers

Course requirements for degrees in the teaching of science vary considerably among institutions and among the various sciences. Generally speaking, as Table 2 shows, the science requirements are highest for biology and lowest for earth science.

If courses in other sciences are also required, the usual pattern is to demand about eight hours in a second and/or third science. About 70% of the institutions, for example, reported requiring biology majors to take eight or more hours in chemistry; 40% reported requiring eight or more hours in physics. It is not uncommon, however, to find that no hours are required in other fields of science. For example, 17% of the responding institutions did not require their biology teaching majors to study any chemistry; 42% required no physics; and 34% required no mathematics. Comparable results for requirements in other teaching fields are summarized in Table 3 on the following page.

TABLE 2

SEMESTER HOURS IN MAJOR FIELD REQUIRED FOR DEGREE IN TEACHING OF VARIOUS SCIENCES

Field	25% of respondents	50% of respondents	75% of respondents
TEACHING OF BIOLOGY (N = 210)	26	30	34
TEACHING OF CHEMISTRY (N = 195)	24	30	33
TEACHING OF PHYSICS (N = 170)	24	28	32
TEACHING OF EARTH SCIENCE (N = 83)	20	25	31

Characteristics of Science Methods Instructors

Science methods instructors who responded to the survey were distributed fairly evenly among the four teaching ranks: instructor (11%), assistant professor (30%), associate professor (27%), and full professor (29%). The instructor of the science methods course was most likely to be located either in the department of education (44%) or in the department of science (33%). Eleven per cent were members of a separate science education department. Just over half of the respondents (57%) hold a doctorate in either science or education (including science education). Another 14% are active doctoral candidates. The remaining 29% hold a bachelor's or master's degree.

The largest proportion of doctorate majors among the instructors was in science education (47%); about half that number were in science (23%) and the remainder (30%) were in some field of education. Those with a doctorate major in education are most likely to teach only an elementary science methods course, while those with a degree in science are likely to teach only a secondary methods course. Those with a degree in science education usually teach both.

TABLE 3

SEMESTER HOURS IN ALL SCIENCE FIELDS REQUIRED FOR DEGREE IN TEACHING OF SCIENCE

Semester Hours of Credit Required in...	Teaching of Biology (N = 210)	Teaching of Chemistry (N = 195)	Teaching of Physics (N = 170)	Teaching of Earth Science[a] (N = 83)	Teaching of General Science[b] (N = 111)	Elementary School Teaching (N = 144)
CHEMISTRY						
<25%	6	24	0	4	7	0
50%	8	30	8	8	8	0
>75%	13	33	10	10	12	3
PHYSICS						
<25%	0	5	24	3	6	0
50%	5	8	28	8	8	3
>75%	8	9	32	10	10	4
BIOLOGY						
<25%	26	0	0	0	7	4
50%	30	0	0	6	8	6
>75%	34	7	7	8	14	8
EARTH SCIENCE						
<25%	0	0	0	20	0	0
50%	0	0	0	25	3	0
>75%	0	0	0	31	8	3
MATHEMATICS						
<25%	0	4	6	2	2	3
50%	4	8	12	6	6	4
>75%	6	12	16	8	6	6

[a]Does not include 5% of cases in which course requirements are expressed as options among two or more sciences

[b]Does not include 14% of cases in which course requirements are expressed as options

[c]Does not include 10% of cases in which course requirements are expressed as options

Practice Teaching Programs

A diversity of practice teaching programs was reported in the study. The plan most commonly offered to students, and the plan most students followed, was one in which the student practice taught full-time for less than a full semester. Forty-six percent of the responding institutions reported that the practice teaching experience extended over 8, 9, 10, or 11 weeks. About half of the institutions (46%) reported requiring 3 or 4 supervisory visits during each student's practice teaching experience. Another 47% reported scheduling 5 or more such visits. Just over half of the institutions (52%) report paying from $26-100 to school systems for participating in the practice teaching program. Only 6% pay more than that amount. When payment is made, it usually (78% of the respondents) goes entirely to the cooperating teacher.

Essential Attributes of the Science Teacher

A major purpose of the Research on Science Education Survey was to find out what perceptions of the science teacher were held by methods instructors and their students. That is, what attributes and qualities (both cognitive and affective) are regarded as essential in the science teacher by each of these two groups? The 427 instructors who made 4288 responses to this open-ended question mentioned most often the importance of a knowledge of science content (17% of all responses) and an understanding of the nature of science (14% of all responses) as requisites for science teaching. Responses dealing with a command of pedagogical techniques (lecture, discussion, demonstration, etc.) accounted for 20% of all responses, while a familiarity with related teaching skills (evaluation, planning, curriculum study, etc.) comprised 12% of the responses.

Thirteen per cent of the responses emphasized the importance of the science teacher's having certain affective qualities: the "scientific attitudes", a love of science, and a commitment to the teaching profession. Other categories and the proportion of responses each received are shown in the top row of Table 4 , on the following page.

Students responding to Questionnaires X and Y identified the characteristics they regarded as essential in the science teacher. A total of 1446 responses from 311 students to Form X and 808 responses from 165 students to Form Y were received. From a comparison of the bottom two rows of Table 4, it is apparent that the students' image of the science teacher did not change greatly during the time they were enrolled in the methods course.

TABLE 4

ESSENTIAL ATTRIBUTES OF THE SECONDARY SCIENCE TEACHERS AS SEEN BY METHODS INSTRUCTORS AND STUDENTS

Group	1	2	3	4	5	6	7	8	9	10	n[a]
Methods Instructors (N^b = 427)	729 17%	581 14%	288 7%	868 20%	527 12%	150 3%	244 6%	277 7%	539 13%	85 2%	4288
Methods Students (Form X, N = 311)	298 21%	30 2%	116 8%	148 10%	122 8%	9 1%	126 9%	264 18%	291 20%	42 3%	1446
Methods Students (Form Y, N = 165)	177 22%	30 4%	72 9%	80 10%	51 6%	8 1%	63 8%	143 18%	170 21%	14 2%	808

[a]n = number of responses

[b]n = number of respondents

KEY: 1 = Knowledge of science content
2 = Understanding the nature of science
3 = Understanding children and the nature of learning
4 = Command of teaching methodology
5 = Command of related pedagogical skills
6 = Educational theory (nature of science education, etc.)
7 = Objectives of science teaching
8 = "Person-thing" attitudes (e.g., love of science)
9 = "Person-person" attitudes (e.g., love of children)
10 = Liberal education

The students' perceptions of the nature of science teaching were strikingly similar to the instructors' views in some cases, but quite different in others. Students place less emphasis on understanding the nature of science (14% of instructor responses, about 3% of student responses), having a command of pedagogical techniques such as demonstration and discussion skills (20% of instructor responses, 10% of student responses), and having proficiency in related teaching skills such as planning and evaluation (12% of instructor responses, about 7% of student responses). Students gave a greater emphasis to affective qualities such as a love for science and for teaching (about 20% of student responses compared to 13% of instructor responses), and to desirable personality qualities (18% of student responses, 7% of instructor responses).

Nature of the Science Methods Course

Much interest within the profession centers on the nature of the science methods course. What topics are normally included in such a course and what teaching techniques do instructors commonly employ in the course? The subject most frequently mentioned by instructors in describing the nature of their methods courses was "teaching methodology"; 52% of the secondary instructors and 56% of the elementary instructors said they covered "methods" in "great detail" in their courses. The six topics most frequently mentioned as being stressed in the courses were:

Topic	Secondary Instructors	Elementary Instructors
Methods	52%	56%
Planning	50%	52%
Objectives of Science Teaching	42%	40%
Evaluation	35%	23%
Study of Curriculum	32%	26%
Science Content	28%	42%
Resources for Teaching	27%	31%

The teaching technique which the methods instructors reported using most often themselves was the class discussion: 51% of the secondary instructors and 31% of the elementary instructors reported using this technique "very often". The techniques most frequently employed were:

Technique	Secondary Instructors	Elementary Instructors
Class discussion	51%	31%
Student labs	27%	38%
Student demonstrations	25%	29%
"Mock" teaching	21%	17%
Construction of teaching units	19%	19%
Lecturing	11%	11%

Students' responses to the same questions on topics and teaching techniques were similar to those reported by the instructors themselves. The correlation coefficients for the topic lists and the techniques lists for the two groups (instructors and students) were 0.95 and 0.88 respectively. The only important difference in the two lists was in the amount of lecturing reported. Whereas instructors reported lecturing as being only the sixth most frequently used technique, students saw it as the second most frequent (30%). There is, apparently, some difference of perception as to what constitutes a lecture and how much lecturing actually takes place in the science methods course.

Characteristics of Methods Students

The "typical" respondent to the first student questionnaire was a male student (61%), between 20 and 25 years of age (65%), single (71%), and from a household in which the father was either a businessman or a skilled laborer (39%). Half of the respondents (49%) were seniors, 32% were graduate students, 15% were juniors, and the remaining 4% were special students. Only 15% of the respondents were majoring in science education. The most popular majors were the biological sciences (41%) and the physical sciences (21%). Ten per cent of the respondents were majoring in some other discipline; most commonly this was physical education.

Of the 203 students interviewed, 102 (50%) reported that they definitely planned to teach high school science when they graduated. The next largest group (36, 18%) were men who, because of possible military obligations, had no definite plans for the following year. It seems likely that anywhere from one-eighth to one-fourth of the students will not become high school science teachers.

The "New" Secondary Science Courses

The study of the "new" courses in secondary science (PSSC, BSCS, CHEMS, CBA, etc.) might be expected to be an important part of the science methods classes. About half of the methods instructors who responded to the questionnaire said they gave some attention to at least one of these courses. A smaller number (see Table 5, on the following page) reported studying these courses "intensively".

A similar pattern emerged from the instructor interviews of Phase Two. Of 57 instructors who described the content of their methods courses, only 31 (54%) reported including a study of the "new" courses. The median emphasis in these 31 classes amounted to about 15% of the available class time.

In spite of the relatively limited attention paid to the "new" courses (as reported by the instructors), it seems clear that science educators support the philosophy of inquiry teaching in general and of the "new" courses in particular. Less than 10% of the instructors interviewed failed to express enthusiasm for, or at least commitment to, inquiry teaching as a desirable teaching style. Students have apparently picked up this attitude from their instructors, as they mention "a use of inquiry teaching" as the most important quality that they would expect their methods instructor to look for in a high school teacher.

However, both instructors and students reflect some concern about the implementation of the "new" courses in actual school classrooms. Some instructors referred to the practical difficulties and limited success they had seen in introducing these courses into schools in their own area. Students themselves gave little evidence of being enthusiastic about teaching the "new" courses. Many of them expressed the feeling that the courses would not be practical in "real" schools because of the administrative problems, lack of time, or lack of the "right" kind of students.

TABLE 5

THE "NEW" SECONDARY SCIENCE COURSES AS TOPICS IN SCIENCE METHODS COURSES

	Secondary "Some"	Secondary "Intensive"	Elementary "Some"	Elementary "Intensive"
BSCS	68%	21%	5%	1%
PSSC	47%	8%	2%	0%
CBA	40%	4%	0%	0%
CHEMS	50%	10%	2%	0%
ESCP	25%	3%	7%	0%
IPS	18%	3%	3%	1%
TMS	7%	1%	3%	0%
AAAS	7%	2%	39%	9%
ESS	2%	1%	39%	7%
SCIS	2%	0%	27%	2%

Additional Topics

The complete hundred-page report of the Research on Science Education Survey, now available, will be mailed to all individuals who participated in the study. Among other topics included in the report are:

- Student expectations of the methods course and of practice teaching
- Students' perceptions of valuable courses in their science education program
- Allocation of science methods instructors' time
- Changes in the science methods courses, past and future
- The nature of science teaching in 1990
- Research and the preparation of science teachers

If you did not respond during the study but would like a copy of the report, you may receive one by writing to the Research on Science Education Survey, Harvard Graduate School of Education, Cambridge, Massachusetts, 02138.

INTRODUCTION

Improvement of science education in the United States has long been hampered because basic statistical data about programs for the preparation of secondary science teachers and about programs for the preparation of elementary teachers in the sciences are meager.

Several earlier studies share the common inadequacies of being limited in scope. Either they focus on a limited population, or they deal with only a selected portion of the teacher preparation program. A large scale analysis of the science education profession _in toto_ has, to the best of our knowledge, never been completed.

In an attempt to locate, collect, analyze and report some of this important statistical information, a group of doctoral students* at the Harvard Graduate School of Education have designed and carried out, during 1967-68, a study of science education programs in American colleges and universities. Known as The Research on Science Education Survey (ROSES), the study has received financial support from Harvard University, the Higgins Fund, and from the United States Office of Education.

The Research on Science Education Survey had two phases. _Phase One_ was a questionnaire survey of science education programs in institutions of higher learning for the academic years 1966-67 and 1967-68. _Phase Two_ was a series of visits to a selected sample of colleges and universities for the purpose of studying at first hand the local program in secondary science education.

---

*Mrs. Dorothy Terman, currently at the State University of Iowa; Mr. Gary Anderson, currently Assistant Professor of Education and Administrative Assistant in Collegial Studies at McGill University, Montreal, Quebec, Canada, and Mr. David Newton, Harvard Graduate School of Education. They have been advised by Professor Fletcher G. Watson.

CHAPTER ONE: Design of the Survey

I. Phase One: The Questionnaire Survey

A. Methodology

1. Design of the Questionnaire

The purpose of the questionnaire survey in Phase One was to collect data on four major items:

(1) characteristics of institutions with science education programs.

(2) characteristics of the practice teaching experience in these institutions.

(3) characteristics of the methods courses in science at these institutions.

(4) characteristics of the instructors of these methods courses.

Questions in all four areas were drafted, revised, and rewritten a number of times by the committee working as a whole. Finally, the draft version of the completed questionnaire was submitted to members of the staff and other doctoral students for their comments, criticisms, and suggestions. Eight critiques of the draft copy were obtained in this way.

The questionnaire consisted of two parts, A and B. Part A, directed to the attention of the person responsible for the overall program in science education (chairman of the department, senior professor, dean of the school, etc.), requested information on items (1) and (2) listed above. Part B, intended for the instructor (s) of the science methods course (s), requested information on items (3) and (4) listed above.

2. Selection of the Population

The ROSES study was intended to collect a complete census of data on all programs of science education in the nation. For such a study, the committee needed a complete and accurate list of all institutions having such a program. A search of such a list proved fruitless; to the best of the committee's knowledge, no such tabulation of programs in science education exists.

As a first approximation, then, the committee used for its initial mailing list the most complete roster of institutions which would be likely to have such programs. The list that was used was that of the Harvard Graduate School of Education used for mailing information on the Harvard Prize Fellowship program for the year 1965-66. This list included 992 colleges and universities in the fifty states and the District of Columbia which were believed to have programs for the training of science or mathematics teachers.

Unfortunately, the names of specific faculty contacts at many institutions were not accurate. This occurred for two reasons. Because a high rate of turnover and assignment changes occurs, the proper contact at an institution for 1965-66 would not necessarily be at the same institution the following year. Even if he were, another instructor might have the responsibilities in science education. Furthermore, the contacts listed for some institutions on the Prize Fellowship roster were administrative personnel (deans, assistant deans, department chairmen, etc.) who had general responsibility for the science education program, but who often had little or no direct involvement with the program.

The committee's supposition that those questionnaires which were improperly addressed (because of the above reasons) would be directed to the appropriate faculty member was not entirely justified. In some cases, however, the questionnaires were returned with instructions that they be sent to another office, department, or school on the same campus. Possibly, in other cases the questionnaires addressed to the wrong sources were destroyed.

3. Distribution of the Questionnaires

The first mailing of questionnaires A and B was made during the second week of April, 1967.* A single copy of form A and at least two copies of form B were sent to each of the institutions on the roster. In many cases, when it was expected that there might be a science education program of considerable size, additional copies of form B were also enclosed. Covering letters for both forms A and B (Appendices A and B) and stamped, self-addressed return envelopes were also included in each packet.

4. Follow-up Mailings

Four weeks after the original mailing had been made, a follow-up post card (Appendix C) was sent to all current non-respondents. A second follow-up mailing, sent out about October 15, 1967, consisted of a letter which briefly reviewed the nature of the ROSES study and invited those who had not replied to complete copies of questionnaires A and B. A self-addressed post card included with the letter attempted to solicit some minimal data about the institution (Appendix D).

B. Response Rate

One of the most difficult methodological problems in this study has been the

*About two dozen schools missed in the first mailing were sent their questionnaires in September, 1967.

determination of response rates. There are two major aspects of the problem. The first is in deciding what constitutes a response. It is apparent that not every institution included in the original mailing list is, in fact, a member of the population for the ROSES study. Some institutions have no science education department, no program for the training of science teachers, no science methods courses, and no graduates in science teaching. Such institutions cannot be defined as part of the ROSES population on the basis of any criterion.

But, for many other institutions, the issue is not so clear. Some colleges and universities report the preparation of only a "handful" (ranging from a lower limit of one) of science teachers each year. Such institutions may or may not have a formal program for the preparation of these teachers. That is, they may or may not have a specific science methods course, a specified program for the prospective science teacher, and/or designated advisors for science education. For example, some colleges and universities have almost no formal provisions for the "processing" of prospective science teachers, yet report a half-dozen or so graduates in science teaching.*

On the other hand, there are a few cases in which an institution reported the existence of a program for the training of science teachers (i.e., course requirements are listed, methods courses are described, etc.) but had no graduates in science teaching during the period covered by the ROSES study. Clearly the way one defines a "program for the preparation of teachers in science" will significantly alter the response rate and the estimate of completeness.

The determination of response rate is also affected by the differential response rate for Questionnaires A and B from the same institutions. Some institutions returned a copy of questionnaire A, but no copy of questionnaire B. Conversely, some methods instructors returned their copy of questionnaire B, but the department chairman (or other contact) failed to return his copy of questionnaire A. Finally, a large number of schools have returned a copy of questionnaire A and one or more of form B. However, it has come to light during the visits of Phase Two of the ROSES study that in some institutions some instructors returned a questionnaire B while others did not. Thus, because the data collected are incomplete in various ways, there is no single number which can be given as the response rate for the ROSES study. Instead a breakdown on classes and number of responses is given in Table 1.

---

*One explanation for this phenomenon is the possibility of the respondents having misread or misinterpreted the original questionnaire.

TABLE 1

RESPONSE RATE, PHASE ONE

Population: 992 institutions		
A. Total number of Booklet A's returned	333	34%
1. Booklet A, but no corresponding Booklet B received	36	4%
2. Booklet A with at least one corresponding Booklet B received	297	30%
B. Total number of Booklet B's returned	677	
1. Booklet B, but no corresponding Booklet A received	123 institutions 174 individuals	12%
2. Booklet B with at least one corresponding Booklet A received	297 institutions 503 individuals	30%
C. Total number of postcards returned	243	25%
1. Number of these later completing Booklets A and B also	27	3%
2. Number of these not completing Booklets A and B also	216	22%
D. Institutions from which evidence is available that no science education program exists	53	5%
E. Total number of responses received (A + B1 + C2 + D)	725	73%

Number of Booklet B's received per institution	
Institutions from which 1 Booklet B was received	242
Institutions from which 2 Booklets B were received	125
Institutions from which 3 Booklets B were received	40
Institutions from which 4 Booklets B were received	5
Institutions from which 5 Booklets B were received	6
Institutions from which 6 Booklets B were received	1
Institutions from which 9 Booklets B were received	1

TABLE 2

RESPONSE RATE, BY STATES

STATE	BOOKLETS A RECEIVED	DISTINCT BOOKLETS B RECEIVED	POSTCARDS RECEIVED	LETTERS: "NO PROGRAM" RECEIVED	TOTAL NUMBER OF RESPONSES	POSSIBLE NUMBER OF RESPONSES	PERCENTAGE OF RESPONSES
Alabama	4	2	2	0	8	16	50%
Alaska	0	0	0	0	0	1	0
Arkansas	5	1	1	0	8	14	57%
Arizona	2	1	1	0	4	4	100%
California	15	4	13	4	36	46	78%
Colorado	5	0	3	0	8	10	80%
Connecticut	4	1	5	1	11	14	79%
Delaware	0	1	0	0	1	2	50%
D. C.	0	0	3	3	6	6	100%
Florida	3	4	2	0	9	14	64%
Georgia	5	2	7	3	17	24	71%
Hawaii	2	0	0	0	2	2	100%
Idaho	1	2	1	0	4	4	100%
Illinois	16	5	10	3	34	45	76%
Indiana	7	6	6	0	19	24	79%
Iowa	11	3	8	2	24	27	89%
Kansas	6	1	9	0	16	22	73%
Kentucky	4	3	5	0	12	19	63%
Louisiana	8	1	4	1	14	19	74%
Maine	4	0	2	2	8	11	73%
Maryland	7	0	2	2	11	17	65%
Massachusetts	5	3	9	7	24	37	65%
Michigan	10	5	4	2	21	24	88%
Minnesota	10	5	4	0	19	23	83%
Mississippi	2	3	2	1	8	15	53%
Missouri	5	5	8	1	19	26	73%
Montana	5	0	0	0	5	8	63%
Nebraska	7	6	0	0	13	16	81%

TABLE 2

RESPONSE RATE, BY STATES (cont.)

STATE	BOOKLETS A RECEIVED	DISTINCT BOOKLETS B RECEIVED	POSTCARDS RECEIVED	LETTERS: "NO PROGRAM" RECEIVED	TOTAL NUMBER OF RESPONSES	POSSIBLE NUMBER OF RESPONSES	PERCENTAGE OF RESPONSES
Nevada	1	0	0	0	1	1	100%
New Jersey	6	3	6	1	16	19	84%
New Hampshire	3	1	1	1	6	8	75%
New Mexico	2	1	2	0	5	5	100%
New York	31	7	10	3	51	72	71%
North Carolina	10	1	10	0	21	33	64%
North Dakota	3	1	2	0	6	8	75%
Ohio	18	6	6	1	31	42	74%
Oklahoma	5	3	4	0	12	15	80%
Oregon	6	3	3	1	13	15	87%
Pennsylvania	25	7	19	3	54	69	78%
Rhode Island	2	0	1	1	4	6	67%
South Carolina	5	2	6	1	14	19	74%
South Dakota	6	1	3	0	10	12	83%
Tennessee	11	2	7	2	22	32	69%
Texas	13	8	9	0	30	48	63%
Utah	3	0	2	0	5	5	100%
Vermont	2	0	2	2	6	8	75%
Washington	5	1	2	1	9	15	60%
Virginia	9	2	7	2	20	26	77%
West Virginia	1	4	1	0	6	16	38%
Wisconsin	12	6	2	1	21	27	78%
Wyoming	1	0	0	0	1	1	100%
Totals	333	123	216	53	725	992	74.00%

C. Analysis of the Data

The analysis of information gathered in questionnaires A and B presented two quite different problems. Most of the questions in forms A and B called for numerical answers. These data could be translated almost directly from the questionnaires to IBM punch cards for computer analysis using the Data-Text System prepared by Dr. Arthur Couch at Harvard University.

Questions P in Booklet A and Q in Booklet B,* however, were not of this type. The answers to these questions were qualitative, subjective judgments of the priorities of elements in the education of a prospective science teacher; they possessed no inherent quantitative component. Nevertheless, to group and organize the 5000 responses to these important questions, it was necessary to convert them into some quantitative or semi-quantitative form.

The method devised for converting these subjective, qualitative statements into at least semi-quantitative, nominal data is as follows: A tally sheet (see Appendix E for an example) for responses in each of the three major areas (Knowledges, Skills, Attitudes) was prepared. As each questionnaire was read, the respondent's replies in each of the three categories were listed in the appropriate columns. In almost all cases, the respondent's verbatim responses were recorded. If a reply was similar to a response already recorded (as was often the case), it was not listed a second time. In this way, a complete listing of all unique responses to questions P_A and Q_B was prepared. The final listing contained roughly 300 responses in the category of "Knowledge", 375 responses in "Skills" and 550 responses in "Attitudes."

The total list of some 1225 unique categories of objectives was too unwieldy to analyze. Therefore, an attempt was made to consolidate similar categories by combining them in such a way as to reduce the number of distinct groups while still retaining classes with a significant meaning within themselves. This was accomplished by means of a crude, subjective kind of factor analysis. In the process, the original arbitrary divisions of "knowledge objectives", "skill objectives", and "attitude objectives" were essentially destroyed. In their place, a new classification scheme with 85 divisions emerged. These categories, it is believed, faithfully represent the diversity of replies by respondents and, at the same time, form a list of manageable size. This list of "Elements in the Education of a Science Teacher" (Appendix F) has proved to be most valuable in coding the responses from Phase Two, the large majority of which were also of

---

*At later points in this report, these two questions are referred to as the "Rationale" questions.

a subjective, qualitative type. The fairly straight-forward scheme of translation described above is fraught, of course, with many technical and judgmental problems.

II. Phase Two: The Visits

The second section of the Research on Science Education Survey consisted of a series of visits to selected colleges and universities during the fall and winter of 1967-68. These visits had two specific purposes:

1) To collect more complete and valid data of the type obtained in Phase One. Questionnaires A and B of Phase One are subject to the host of inherent problems characteristic of all questionnaires. Both questions and responses tend to be somewhat ambiguous. As an example, the relative allocation of time to various topics in the methods course was requested (question L, page 5, Booklet B). But how to ask such a question while keeping the necessary response time within reasonable limits proved to be difficult. The compromise adopted ("none", "incidental", etc.) is not very satisfactory. A face-to-face confrontation with individual instructors would be more likely to result in clearer, more precise data. In addition, such an interview would allow the collection of additional peripheral data which were not covered in the original questionnaires.

2) To obtain additional data on science education programs by tapping a new source: students enrolled in the programs. Inclusion of students' responses would provide an additional viewpoint and a possible reliability check on some of the data collected by questionnaire. An even better understanding of the structure of any specific methods course, for example, was possible from a comparison between the instructor's stated plan for the course and the student's stated perception of the actual course content. Also, the inclusion of students in Phase Two provided some information about the students (for example, how they viewed the "ideal" science teacher) and how they had been influenced by the science education program in which they had been enrolled (for example, how their perceptions of science teaching changed during the time they were enrolled in the methods course).

A. Methodology*

1. Selection of the Sample

The sample population defined for Phase Two of the ROSES study was somewhat different from that selected for Phase One. The study was restricted, first of all, to programs for the preparation of secondary science teachers only. Some information on elementary science methods courses was collected, but this was entirely incidental to the main theme of the Phase Two visits. Secondly, a

*By September, 1967, only one of the original ROSES committee members was still available to work on this project. The design and execution of Phase Two of the study as well as the analysis of both Phases One and Two, therefore, has been the sole responsibility of Mr. Newton.

somewhat greater emphasis was placed in Phase Two on the nature of the methods course. We felt that by far the greatest impact of an individual science educator on the prospective science teacher was through the methods course. Only rarely does the instructor have continuous and intensive contact with the student in settings other than the methods course (in the academic classroom, as a supervisor during practice teaching, or as an advisor), although there are a number of exceptions. Nonetheless, it seemed that the best way to sample the "atmosphere" and "message" of any particular science education program in the time available was to concentrate on the nature of the methods course. Finally, there was no attempt to make the visits of Phase Two exhaustive (as the questionnaire survey in Phase One was intended to be) or random. Institutions to be visited were specifically selected on the basis of a number of criteria. These were:

1) Geographical distribution: An attempt was made to include schools from every geographic region. Table 3 shows the actual distribution of institutions visited in Phase Two.

2) Large producers of science teachers: A number of schools producing a large quantity of science teachers was included. Probably the best way to detect over-all trends in the preparation of science teachers is to select a fair number of institutions which produce a large volume of science teachers. Nine of the institutions visited had enrollments over 15,000.

3) "Prestige" of the program: Some institutions which might not otherwise qualify for inclusion in the study are important because one or more of the faculty members on the science education staff are well-known, "influential", and active in the profession. These institutions tend to have graduate programs in science education and to emphasize the training of college level science educators of whom many become trainers of teachers. A few institutions of this kind were included in the sample.

4) Small colleges: Relatively few small public or private colleges have a definable program in science education. Nonetheless, it seems likely that a significant proportion of the nation's secondary science teachers come from such institutions. Therefore, five small (liberal arts and/or church-affiliated) colleges were included in the sample.

5) Logistical considerations: Finally, the practical scheduling problem of being able to travel from one institution to another at appropriate times, with the above four factors taken into consideration, placed a further restriction on the schools which could be included in the study.

The final roster of schools to be visited in Phase Two (see Appendix G), then, was a selected and not a random sample. The intention in making the selection was to have a sample which was representative of science education programs throughout the nation, but which would also provide data on the training of a significant proportion of the nation's secondary science teachers.

TABLE 3

GEOGRAPHIC DISTRIBUTION OF SCHOOLS VISITED IN PHASE TWO

Area	Number of Schools Visited
New England	4
Mid-Atlantic	8
Midwest	8
Far West	7
South	8

2. <u>Data-gathering Techniques</u>

Four distinct activities planned as a part of Phase Two were:

a) <u>Distribution of Student Questionnaires X and Y</u>

Student questionnaire X (Appendix H) requested a variety of information from students currently enrolled in a science methods course. Some questions aimed at collecting factual data: the student's age, major area of concentration, hours of work in various fields, etc. Other questions asked the student's opinions or feelings about a number of topics: what the ideal science teacher is like, what he looked for in the methods course, etc. Approximately 35 copies of Questionnaire X were sent to most of the institutions participating in Phase Two with the request that the methods instructor distribute these questionnaires to their students on or before the first meeting of the current methods course.

Questionnaire Y (Appendix I), seeking post-course responses, contained primarily projective questions about the methods course and the practice teaching experience and was mailed at the completion of the semester to individual students who had completed and returned Questionnaire X.

b) <u>Instructor Interviews</u>

Interviews with instructors of science methods courses were a major purpose of the visits to selected institutions. To alert the instructor, the Instructor Interview Schedule (Appendix J) was mailed to instructors about 10 days prior to the actual visit by the ROSES representative. The questions on this schedule were of three types: 1) those dealing with the administrative organization of the local science education program; 2) those which examined the philosophical rationale underlying the science education program in general and the science methods course in particular; and 3) those concerned with the specific methods course currently being offered by the instructor.

TABLE 4

RESPONSE RATE ON INSTRUCTOR INTERVIEWS[a]

Question[b]	Number of responses	Percent Responding[c]
1	59	100%
2	59	100%
3	52	88%
4	52	88%
5	48	81%
6	52	88%
7	49	83%
8	18	51%
9	25	71%
10	29	83%
11	46	78%
12	38	64%
13	46	78%
14	25	71%

[a]Data do not include two universities at which only informal conferences with instructors were held.

[b]Note that some questions are not relevant to all subjects, and therefore, would not have been asked in every case.

[c]Questions 1-7 and 11-13 were asked of all instructors (N=59, which included 3 department chairmen not currently teaching a methods course). Questions 8-10 and 14 were asked only once at each institution (N=35).

To facilitate the recording of responses, an answer sheet was prepared for each of the 14 questions (see Appendix K for a sample). The categories used on this response sheet were those developed in connection with the "rationale" questions from Questionnaires A and B of Phase One.

The ROSES field researcher originally requested a period of two hours for the instructor interview. The time actually allotted by various instructors ranged from a low of 40 minutes to a high of five hours. In a number of cases, restrictions of time precluded completing the whole interview schedule. In such cases, the interviewer determined, on the spot, a "negative order of priority", selectively omitting questions as time decreed. The specific questions omitted were varied from school to school in order to obtain some data on all items. Table 4 shows the response rate for all questions in the instructor interview.

c) Class Observations

At each institution visited, an attempt was made to visit at least one methods course in session. The purpose of these observations was to observe what, in fact, goes on in methods courses; that is, to find out what topics were covered and what methodology was employed by each instructor.

A simple system for recording these observations was devised. Each class period observed was divided into four-minute segments. A two hour class meeting, for example, would be divided into 30 segments of four minutes each. The first and final eight minutes in each observation were defined as DEAD (no observations were made). This was to prevent the record from being contaminated by such peripheral matters as getting the class started late, being interrupted by administrative announcements, etc. Starting with the third 4-minute block, and during each successive odd segment (the 5th, 7th, 9th, 11th, etc.), the observer recorded the topic under consideration in the class (see Appendix L for the record sheet) and the teaching technique in use at the time (see Appendix M). At the conclusion of the observation, the time spent on each topic and the time devoted to each technique were totaled. In addition, a brief descriptive summary of the nature of the class, its composition by sex, the physical condition of the classroom, etc., was prepared.

Although the even 4-minute segments were originally intended to be DEAD segments, an important use for them became apparent early in the study. The lecture-discussion type of class referred to (in this report) as the "modified lecture" so common in high school teaching was found to be equally prevalent in college science methods courses. It seemed desirable, therefore, to do some interaction analysis in these classes in order to learn something about the nature of the teacher-student interchanges. Utilization of the Flanders Interaction Analysis System would undoubtedly have been both useful and illuminating. Since the field researcher, however, had not been trained in its use, he developed ad hoc, a simple scheme of somewhat similar dimensions. According to this scheme, the observer simply recorded during the even 4-minute segments the length of time the instructor spoke and the length of time each student spoke. Although this gives virtually no information on the quality of the classroom remarks, it does provide some indication of the relative quantities of time taken by both instructor and students during the class period.

d) Student Interviews

From the student Questionnaires X which had been returned by each institution to ROSES, a small number of students were selected as a sample for personal interviews during the field researcher's visit. These student interviews were intended to provide more complete and accurate data of the type requested in Student Questionnaire X. These interviews were scheduled to last about 30 minutes each and that interval was only rarely exceeded. A verbatim copy of the questions asked in these interviews is to be found in Appendix N. A sample response sheet is giver in Appendix O.

The students selected to be interviewed at each institution were those who had indicated a preferred time for the interview which corresponded to vacant intervals on the over-all schedule for each institution. Thus, in making up the time schedule for any one institution, the course observations and instructor interviews were first listed. Then, student interviews were scheduled for the remaining time blocks in the institution's schedule. Thus, the method for selecting students was not random. On the other hand, there does not seem to be any serious source of bias in the technique of selection.

3. ROSES Correspondence

Each school selected for inclusion in Phase Two of the study received a series of four standard letters (Appendices P-S).* The first letter, sent in May of 1967, was the original letter of invitation. It described the character of the ROSES study, indicated the committee's desire to include the institution,# and formally asked permission to visit. Upon receiving a favorable reply from an institution, a second letter confirming acceptance and dates for the visit was sent. Early in the fall of 1967, the package of student questionnaires X, a schedule card, and a covering letter were sent to each participating institution. Participants were

*For those schools which were added late, special letters incorporating the information in the four standard letters were sent.

#Only one of the institutions invited to participate declined. One other accepted but had to be replaced because of scheduling conflicts.

asked to distribute the questionnaires on or before the first class meeting of the methods course and to return the schedule card (listing preferred times for the instructor interviews and course observations) to the ROSES office. Finally, the fourth letter, announcing the arrival of the field researcher and including a copy of the Instructor Interview Schedule was sent about 10 days before the scheduled visits.*

4. The Visits

The series of visits began on 14 October 1967 and continued without interruption until 11 February 1968. Four other visits to New England area institutions were completed during the months of February and March. Normally, the field researcher spent two or three days at each institution, interviewing both students and instructors and observing methods courses in session. At many institutions, instructors or department heads also arranged other observations, visits to facilities, or conferences with other interested parties.

The generous cooperation which the field researcher received from both the students and the faculty is greatly appreciated. Almost without exception, both groups gave their time without complaint and, in many cases, with considerable interest and enthusiasm. Although the preliminary arrangements at a particular institution were sometimes confused, or even chaotic, the time spent during the visit itself was almost always employed to the maximum advantage of the researcher. Whatever success the study may have is a direct reflection of the support of these participants.

Some attention should be given, however, to some of the logistical and methodological problems which arose during the course of the visits. In two instances, for example, a misunderstanding arose during correspondence between the ROSES staff and the institution to be visited. As a consequence, the field researcher arrived at the institution to find no methods courses in session during the current semester. In each case, conferences were arranged with instructors who had taught the science methods course during the previous semester. In a third instance, the final examination schedule was unexpectedly moved up a week so that again no classes were in session and students were not available for interviews. In a fourth case,

*The logistical problems associated with Phase Two may not be apparent from this rather straight-forward listing of procedures preceding the actual visits. In point of fact, with the field researcher away from the ROSES office continuously for a period of 17 weeks and with the reluctance of almost all institutions to return the necessary forms until the last possible minute, there were continuous problems in the schedules at each institution. These obstacles became insurmountable in only one instance. In all other cases, to the best of our knowledge, the visits were regarded by both parties, host and visitor, as profitable and enjoyable.

the interviewer arrived at exactly the midpoint of a professional semester, on the first day students from the methods courses were reporting to their practice teaching assignments. In all of the above cases, instructor interviews were arranged and conducted. In three of the four cases, interviews with students who had already completed the methods course were also arranged.

Because three of the four situations mentioned above involved schools with small science education programs, last minute <u>en route</u> attempts to add new schools to the sample were made. In some cases, these attempts were successful; in others, they were not. This section of the sample (schools with small programs in science education) is probably still under-represented.

The logistical problems mentioned above have resulted in there being some institutions for which the data collected are incomplete. That is, either student interviews, or class observations are missing but the instructor interviews were always completed. In addition, however, a few schools were originally scheduled with the understanding that only an incomplete set of data could be accumulated. These were schools for which only a brief period of time was available for a visit or which were known not to be in regular session during the period of the field researcher's visit. As a result of all these factors, only 17 of 37 institutions yielded all three major data-gathering sources (instructor interviews, student interviews, and course observations). Table 5 provides a record of the type and number of responses received in Phase Two of the ROSES study.

B. <u>Analysis of the Data</u>

The analysis of data from Phase Two presented some unique and difficult problems. The greatest part of the information obtained from interviews, observations, and questionnaires was qualitative and nominal, not quantitative and interval or ordinal. The problems that qualitative data present to the researcher are well known. The researcher who listens to hundreds of hours of interviews with students and faculty comes away with a fairly comprehensive and incisive view of the field he surveys. He is likely to have been deeply impressed by a series of colorful, interesting, sometimes dramatic, albeit subjective responses to his questions. The problem is then to find a way to report these vivid, subjective impressions in a useful and honest way. To be parsimonious, the researcher must make some quantitative analysis of the interview data. But as he quantifies the data, he suppresses much of the feeling and color from the interviews. The problem, then, is to find a technique by which some quantification can be introduced into the data without losing entirely from the data its inherently subjective and innately fascinating character.

KEY FOR TABLE 5

Column A: Institution

Column B: Size

A = over 30,000

B = 20,000 - 29,999

C = 15,000 - 19,999

D = 12,500 - 14,999

E = 10,000 - 12,499

F = 7,500 - 9,999

G = 5,000 - 7,499

H = 2,500 - 4,990

I = less than 2,500

Column C: Type

A = State university

B = State college

C = Private, religious college or university

D = Private, non-sectarian college or university

E = Municipal college or university

Column D: Science Education program

1 = Undergraduate only

2 = Undergraduate and Fifth year

3 = Fifth year only

Column E: Location of science methods course

1 = Science department

2 = Education department

3 = Science Education Department, Related to Science Department

4 = Science Education Department, Related to Education Department

5 = Science Education Department, Unattached

Column F: Number of Instructors Interviewed

Column G: Number of Classes Observed

Column H: Number of Student Questionnaires A returned

Column I: Number of Student Questionnaires B returned

Column J: Response rate for Student Questionnaires

Column K: Number of Students Interviewed

TABLE 5

RESPONSE RATE, PHASE TWO

Institution	B	C	D	E	F
1	C	D	3	2	2
2	E	A	2	2	1
3	G	B	1	1	1
4	A	D	2	2	1
5	B	A	2	3	2
6	C	B	1	1	2
7	B	A	1	1	2
8	G	C	2	2	2
9	F	A	2	3	3
10	H	B	1	1	2
11	F	C	1	2	1
12	H	B	1	1	2
13	C	E	1	2	2
14	H	B	1	2	2
15	B	A	2	2	3
16	I	C	1	1	2
17	H	A	1	1	2
18	E	B	2	1	3
19	H	B	1	4	1
20	F	D	3	2	1
21	G	A	1	2	1
22	H	B	1	1	5
23	A	A	2	2	3
24	G	A	1	1	1
25	E	E	1	2	1
26	E	A	2	4	4
27	H	B	1	1	2
28	I	D	2	2	1
29	I	D	1	2	1
30	B	A	1	1	2
31	E	D	3	2	1
32	F	A	1	2	1
33	D	A	2	3	1
34	E	A	2	4	7
35	E	A	1	1	2
36	I	C	1	1	1
37	G	A	2	5	2
Total					73

TABLE 5 (cont.)

RESPONSE RATE, PHASE TWO

G	H	I	J	K
1	28	15	54%	10
3	19	8	42%	3
1	19	8	42%	14
1	-	-	-	-
1	14	12	86%	6
0	-	-	-	-
2	14	7	50%	8
1	-	-	-	8
3	14	7	50%	10
2	17	0	0%	11
0	-	-	-	-
3	27	17	63%	12
1	-	-	-	-
0	-	-	-	-
4	26	18	69%	9
0	-	-	-	2
0	8	4	50%	4
1	31	3	10%	10
0	7	-	-	12
0	-	-	-	-
1	16	11	69%	7
1	22	7	32%	-
2	-	-	-	4
0	-	-	-	-
2	13	4	31%	8
5	22	18	82%	13
0	-	-	-	3
0	-	-	-	-
0	2	2	100%	2
1	16	2	13%	8
1	14	7	50%	8
0	-	-	-	-
1	-	-	-	6
0	16	9	56%	6
3	16	6	56%	8
0	-	-	-	-
1	12	6	50%	11
42	373	171	46%	203

One possible solution is to prepare extensive narrative descriptions of the programs visited. This has been done, and a sample of the descriptions is contained in Appendix T. These reports, interesting and enlightening as they may be, are demanding of the reader's time. Fortunately, the "85 categories" scheme developed for the analysis of the rationale questions of Phase One also proved to be useful in dealing with Phase Two data. Much of the interpretation of interview and questionnaire responses to open-ended questions has made use of this scheme. Finally, one new analytical tool was developed to handle some of the data from the instructor interviews. This is the Differential Emphasis Index.

The Differential Emphasis Index attempts to give an idea of the relative importance attached to various aspects of teacher preparation in the sciences as seen by the interviews. A good deal of information on this topic has been collected in Phase One of the study. The "rationale" questions in Questionnaires A and B were designed to find out what elements were regarded by members of the profession as being important in the preparation of a science teacher. Questions 1 and 2 in the instructor interview (Phase Two) covered the same points much more thoroughly. These two questions focused on the kind of knowledges, skills, and attitudes a prospective science teacher should develop before (question one) and during (question two) the methods course. They thus represent the instructor's view of the most essential elements in the preparation of the secondary science teacher. Through the interview, it was possible to establish more clearly what the interviewee meant by certain terms and phrases, so that there was little ambiguity in interpreting his responses, and to establish the degree of emphasis the interviewee placed on each of the topics he mentioned.

During each interview, the researcher made an effort to estimate this emphasis by noting the order in which topics were mentioned, the degree of emphasis placed by the interviewee, the length of time each was discussed, the verbal statement of importance, etc. On this basis, the interviewer made a subjective judgment of the relative importance placed on each item mentioned by the interviewee. This judgment forms the basis of the DEI.

The relative emphasis placed on each topic is assigned a point value based on a subjective judgment by the researcher of the way in which the instructor would allocate a total of 40 points (an arbitrary number) among all of the various responses he made to a question. If, for example, the instructor mentioned only a single response to a question, it would be given the value 40. If, in another case, he mentioned five topics, one of great importance, two of lesser importance, and two of minor importance, they might each be assigned the point values of 16, 8,8,4,and 4 respectively.

Next, all responses of a similar nature were grouped together and their point totals added.* Finally, the relative emphasis in each field was calculated by dividing the number of points in each field by 40. The results of this analysis are given in Chapter Two, page 83.

*See page 8 for a description of the way in which the 85 elements in the preparation of a science teacher were collapsed into 10 major categories for this and other purposes in the study.

CHAPTER TWO: Results

I. Booklet A

A. Characteristics of the Institution

The 333 institutions who returned Booklet A were classified as public colleges or universities (140, or 43%), as private, non-sectarian colleges or universities (49, or 15%), as private, church-affiliated colleges or universities (128, or 40%) or as some other form of institution (6 or 2%). The majority of institutions responding were relatively small, reporting a full-time student population between one and five thousand. The distribution of responses by enrollment is shown in Table 6. Of those institutions responding, 194 (62%) currently are accredited by NCATE; 121 (38%) are not.

TABLE 6

DISTRIBUTION OF RESPONSE BY ENROLLMENT, PHASE ONE

Enrollment	Number	Percent
Less than 1,000	75	23%
1,000 - 5,000	145	45%
5,000 - 10,000	49	15%
10,000 - 20,000	38	12%
more than 20,000	13	4%

Most science education programs (programs for the preparation of science teachers and science methods courses) are administered through the Division (college, school, or department) of Education or through the Division of Science. Thirty-one of the responding schools (10%), however, did report the existence of a separate and independent Department or Division of Science Education. The number of full and part-time members in these 31 separate departments of science education is given in Table 7.

In addition to undergraduate programs for the preparation of science teachers and methods courses for prospective elementary and secondary school teachers, most universities and colleges also offer graduate and in-service programs in science education of one kind or another. About one third of the respondents reported offering a 5th year teacher training program for graduates of liberal arts colleges. Of the 115 institutions (36%) indicating the existence of such a program, 92 (29% of the sample) offered a specialized program for the preparation of secondary science teachers in the 5th year. In addition, 22 (7%) offered graduate degrees for elementary science specialists.

TABLE 7

FULL - AND PART-TIME MEMBERS OF DEPARTMENTS OF SCIENCE EDUCATION

Number of department members	Number of schools reporting this number of full-time members	Number of schools reporting this number of part-time members
1	7	9
2	1	10
3	4	3
4	4	1
5	8	2
6	2	1
7	3	1
more than 7	2	1

In-service science education programs are also common among the responding institutions. Summer science institutes were the most popular form, with 126 institutions (40%) reporting such a program. NSF Academic Year Institutes were available at 63 institutions (20%), university extension courses at 87 (27%), and programs in which school teachers are released part-time from their regular teaching duties at 22 (7%) of the schools.

A wide variety of science methods courses, as shown by Table 8, are available at the institutions reporting in the ROSES study.

Table 8 must be read with some degree of caution. The wording of the question in Booklet A, it now seems, was somewhat ambiguous. The question asked which methods courses were"available" at the institution. It is now apparent that a course might be "available" without having had anyone actually enrolled. This would be the case, for example, in many small liberal arts colleges. In such institutions, there are relatively few teacher candidates as a rule, and, consequently, little demand for science methods courses. When such a candidate does appear, there is usually someone in the science department with the interest or preparation to offer a methods course. In this sense, a methods course is "available" whenever an appropriate instructor is on the staff. Whether this very broad interpretation of the term "available" was actually employed by many of the respondents, we do not know.

TABLE 8

KINDS OF SCIENCE METHODS COURSES AVAILABLE AT REPORTING INSTITUTIONS

Kind of Course	Secondary level	Elementary level
General Methods of Teaching	59%	44%
General Methods in Science	48%	58%
Methods in Biological Science	35%	---
Methods in Physical Science	27%	---
Science Methods Combined with Mathematics Methods	7%	14%
Science Methods Combined with Non-Mathematics Methods	1%	6%

In addition to this methodological error in the questionnaire, there was a good deal of "noise" generated by the respondents themselves. There are at least a half dozen cases in which a respondent reported in Booklet A that there are no methods courses available at any level in his institution and then reported in Booklet B that he himself teaches at least one such course. Either as a result of careless phrasing in the questionnaire or as a result of misunderstanding on the part of the respondent, then, an additional source of error must be considered in reading the above table.

The total number of persons in science methods courses at any one institution is likely to be quite small. Table 9 reports the number of instructors of elementary and/or secondary science methods courses at each of the responding institutions. It is apparent that the vast majority of institutions (75%) have less than four instructors in science methods for elementary and secondary school.

B. Degrees in the Teaching of Science

1. Reported Totals

The number of prospective teachers of science being graduated each year in the United States is of the greatest interest to many individuals involved in science education concerns. Reasonably complete data can be reported for the institutions which returned Questionnaire A. This questionnaire requested information on degrees in the teaching of physics, chemistry, biology, earth science, general science, and in elementary teaching and elementary science specialty for the academic years 1965-66 and 1966-67, at both the bachelors and masters levels. The essential portion of this data is reported in Figures 1 through 5.

TABLE 9

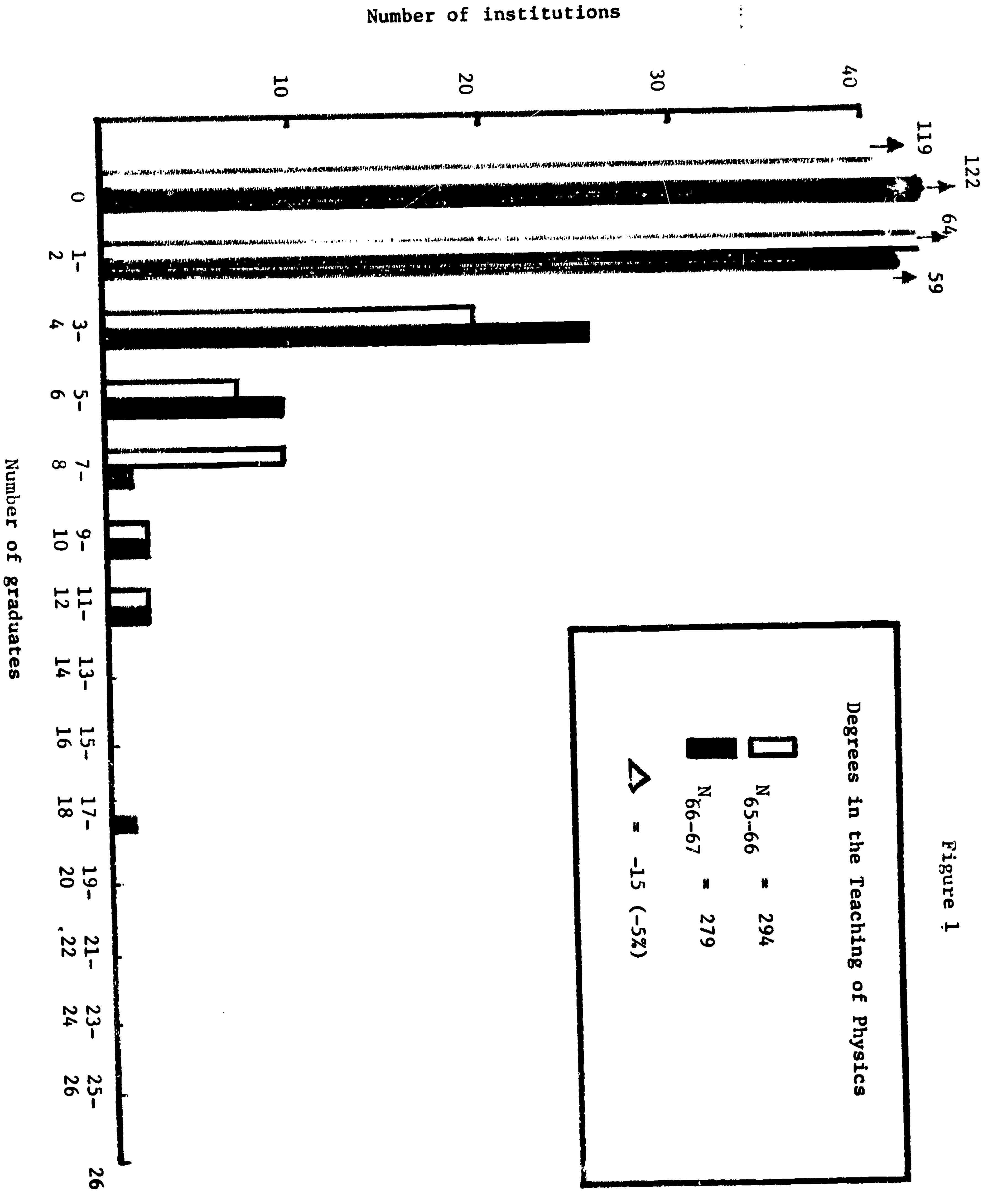
NUMBER OF ELEMENTARY AND SECONDARY SCIENCE METHODS INSTRUCTORS AT RESPONDING INSTITUTIONS

Number of Instructors	Number of Institutions
1	64
2	102
3	51
4	28
5	23
6	9
7	7
8	3
9	0
10	3
more than 10	3

In each of the graphs, the number of degrees in the teaching of the specified field is plotted on the horizontal axis against the number of institutions reporting each category on the vertical axis. In Figure 1, for instance, the third pair of bars shows that 20 institutions granted either 3 or 4 degrees in the teaching of physics for 1965-66, while 27 institutions granted that number of degrees in the year 1966-67. The figures also list the total number of degrees granted in each field for each of the two years covered by the study, the absolute change in numbers (Δ = y) and the percentage change in degrees.

Figures 1 through 5 show that by far the largest number of degrees are being granted in the teaching of biology, there being about 50% more degrees in this field than in the teaching of all other sciences combined. The next most popular fields are chemistry, general science, physics, and earth science in that order. Only twelve institutions report having granted any degrees in the category of elementary science specialist. Ten of these twelve granted 5 or fewer degrees in this area; one institution granted 10 such degrees, and another 12.

The number of graduates in various fields of science teaching increased somewhat between the years 1965-66, with degrees in the teaching of physics being the sole exception. The largest percentage increase was in the field of earth science, a factor that may reflect both a rapidly increasing interest in earth


Number of institutions
10
20
30
40
119
122
64
59
0
1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
21-22
23-24
25-26
26
Number of graduates
Figure 1
Degrees in the Teaching of Physics
N 65-66 = 294
N 66-67 = 279
Δ = -15 (-5%)

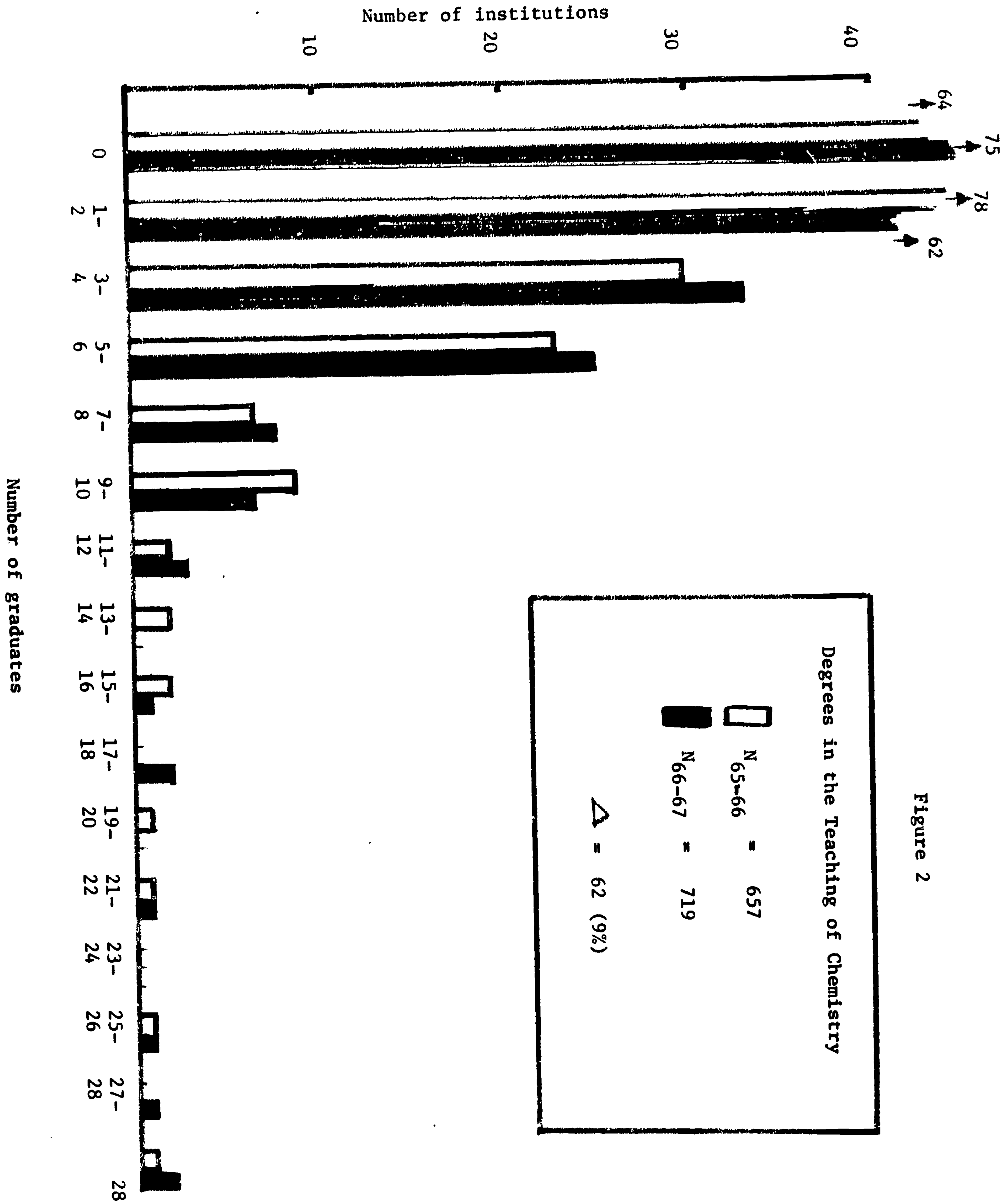


Figure 2
Degrees in the Teaching of Chemistry
N_{65-66} = 657
N_{66-67} = 719
Δ = 62 (9%)
Number of institutions
10
20
30
40
64
75
78
62
0
1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
21-22
23-24
25-26
27-28
28
Number of graduates

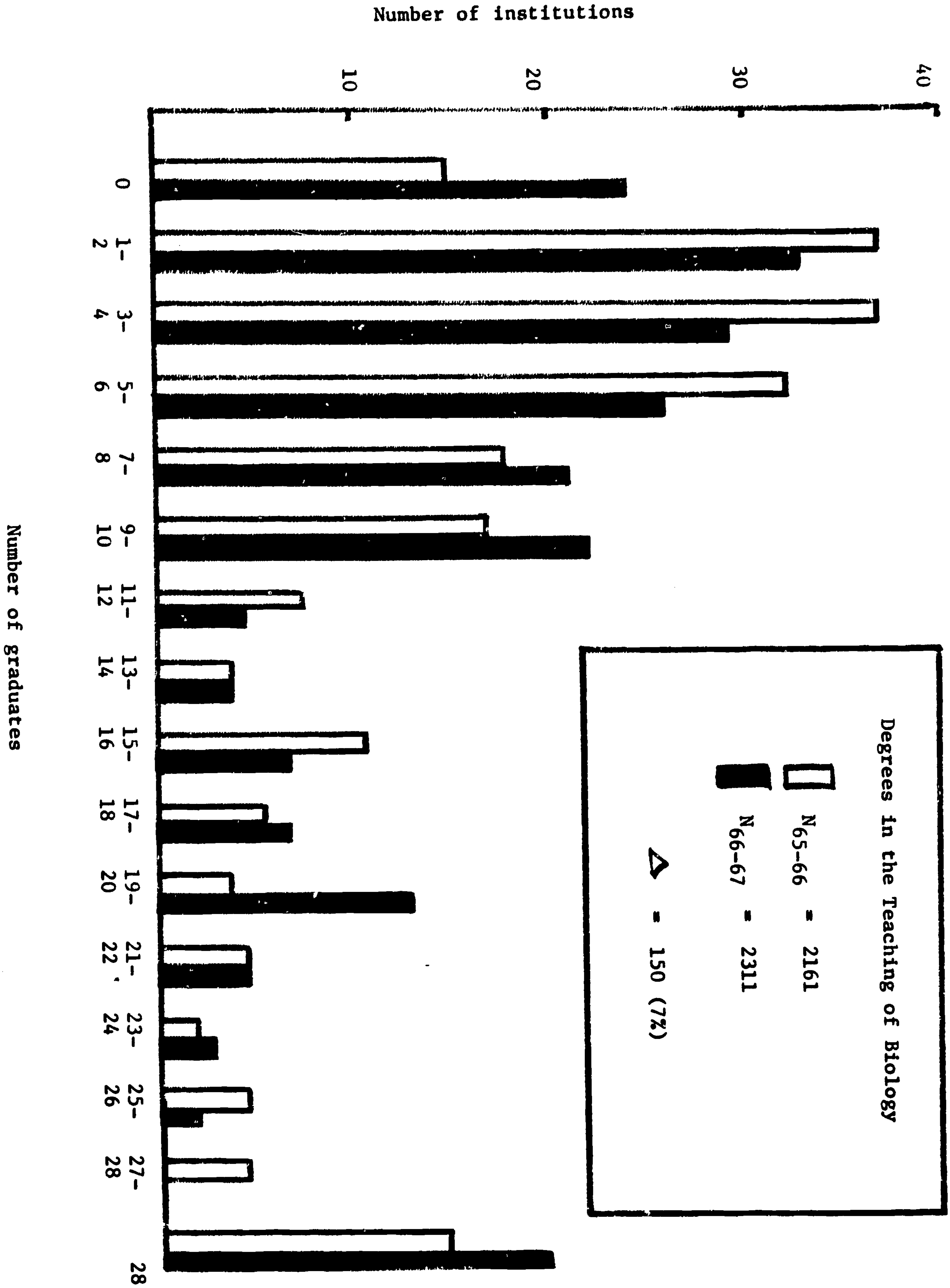

Number of institutions
10
20
30
40
0
1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
21-22
23-24
25-26
27-28
28
Number of graduates
Degrees in the Teaching of Biology
N_{65-66} = 2161
N_{66-67} = 2311
Δ = 150 (7%)

Figure 3

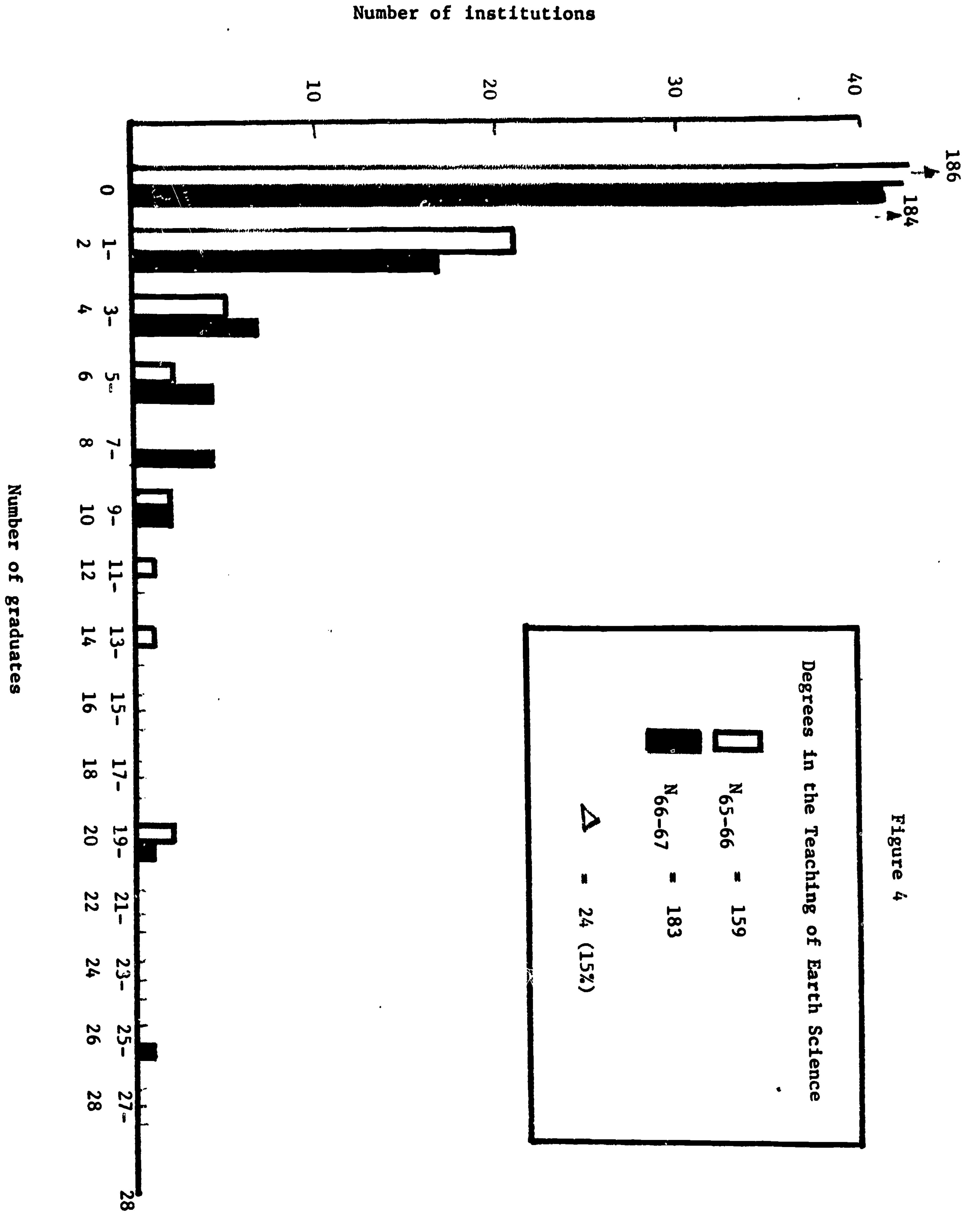
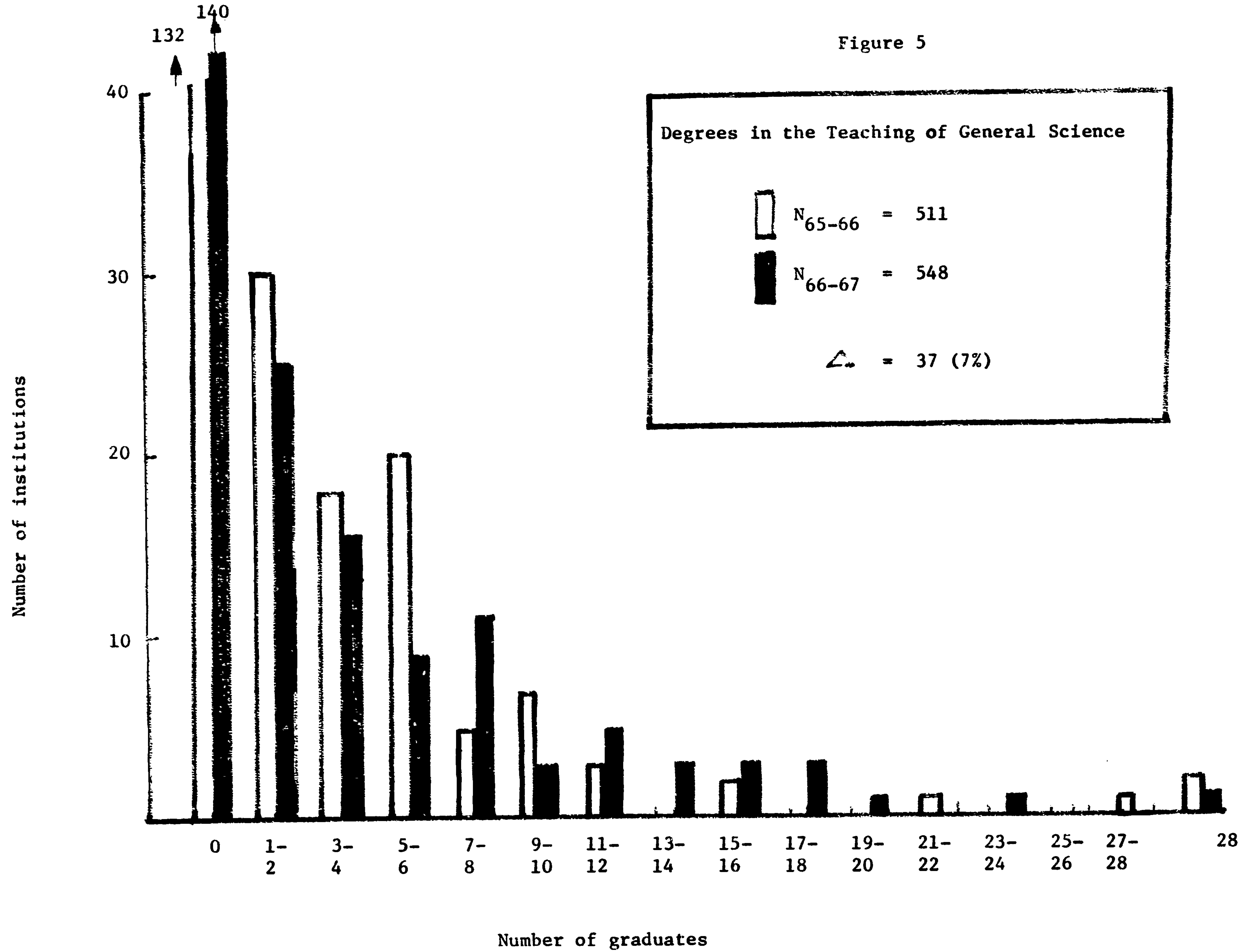


Figure 4
Degrees in the Teaching of Earth Science
N_{65-66} = 159
N_{66-67} = 183
Δ = 24 (15%)
Number of institutions
10
20
30
40
186
184
0
1- 2
3- 4
5- 6
7- 8
9- 10
11- 12
13- 14
15- 16
17- 18
19- 20
21- 22
23- 24
25- 26
27- 28
28
Number of graduates

Figure 5


Degrees in the Teaching of General Science
N_{65-66} = 511
N_{66-67} = 548
∠ = 37 (7%)
Number of institutions
10
20
30
40
132
140
0
1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
21-22
23-24
25-26
27-28
28
Number of graduates

science in the schools and a relatively small base (N = 159 for 1965-66). The downward trend in the number of physics teachers being graduated stands in fairly sharp contrast to the upward trend ranging between 7 and 10 percent in the other major fields of science teaching.

The general pattern of masters degrees in the teaching of the various sciences is quite similar to the pattern for bachelors degrees (see Table 10). Again, the largest number of degrees were awarded in the teaching of biology with considerably fewer degrees in the teaching of chemistry, teaching of physics, and teaching of earth science (in decreasing order). One difference is that a relatively large number of masters degrees in the teaching of general science were awarded. In fact, this represents the second largest group of masters degrees awarded after degrees in the teaching of biology. In addition to these "regular" degrees in teaching, a total of 24 masters degrees for elementary science specialists were awarded in 1965-66; and 39 in 1966-67.

An interesting pattern in the awarding of masters degrees in the teaching of science is the tendency of a relatively small number of institutions to account for a disproportionate number of degrees. In the teaching of physics, for example, four institutions (5% of the respondents, 12% of those that awarded <u>any</u> masters degrees in physics) accounted for 76 (54%) of the masters degrees reported for 1965-66. The same pattern holds true for 1966-67 when four institutions accounted for 71 (50%) of the masters degrees in physics. The same trend is apparent in the awarding of masters degrees in the teaching of general science. In 1965-66, the top 20% of the institutions who reported any degrees of this type accounted for 64% of all degrees; in 1966-67, the 3 (10%) most productive institutions awarded 48% of all masters degrees in the teaching of general science. Similar patterns occur for each of the other three teaching fields of chemistry, biology, and earth science.

2. Estimated Nationwide Totals

An estimation of the national production of new science teachers can be obtained from the data reported, by extrapolating in the following way:

1) Of 333 Booklet A's returned, only 221 contained information on the number of graduates in science teaching. In the vast majority of cases, the blank responses probably indicate the lack of any graduates in science education (this is confirmed by an investigation of the rest of the booklet). In a few cases, however, the respondent simply failed to answer the question. About four-fifths of the blank responses came from small, liberal arts colleges where there are probably few if any graduates in any of the categories. The remaining

20% of the blanks are from institutions of considerable size so that there almost certainly were some significant number of graduates from these institutions. The additional number of graduates in science teaching from these blanks is estimated by comparing the number of students in science methods courses at these institutions with the number of students in methods courses at institutions which did report on graduates. This produces an additional factor of 15% of the reported total. Thus, if g is taken as the number of graduates actually reported by 221 institutions in Booklet A, then .15 g is the correction factor for the second group of blank (non-zero) respondents. The total number of graduates estimated for all 333 schools returning Booklet A, then is 1.15 g.

TABLE 10

MASTER'S DEGREES IN THE TEACHING OF SCIENCE (Reported by 78 respondents)*

Field	1965-66	1966-67
Physics	140	143
Chemistry	170	188
Biology	531	595
Earth Science	39	78
General Science	208	180
Elementary Science Specialist	24	39

*An additional 224 respondents reported no masters degrees in the teaching of science.

As a result of the second follow-up reminder letter, 216 postcards were returned to the ROSES office. These contained minimal data on the science education programs at the responding institutions and reported a total of 2909 graduates with degrees in the teaching of science during the academic year 1966-67 at both the masters and bachelors level. At first glance, since the number of postcard responses (216) was approximately equal to the number of Booklet A responses (221), it would seem that an additional correction factor of g would be required to adjust for those institutions responding by postcard. In fact, this is not quite true. The total number of graduates with a degree in the teaching of science in the postcard sample was 2909. The corresponding figure for Booklet A respondents was 5540. Thus the number of graduates per institution was about half as great for the postcard respondents (13.5 graduates per institution) as for the

Booklet A respondents (25.1 graduates per institution). Thus the proper correction figure for the postcard institutions should be 0.5 g rather than 1.0 g.

About half of all the institutions in the nation produced no information at all on the number of degrees in the teaching of science either through Booklet A or through the follow-up postcard survey. Again, it might seem that the proper correction figure for this block of approximately 500 schools would approximately be (500:221) or 2.27. However, if one extrapolates the trend in number of graduates reported per institution as illustrated in the responses to Booklet A and to the postcard survey, a much different result is obtained. In the first place, it is probable that most of the institutions failing to respond to any of the three ROSES requests for information would have no science education program and few or no graduates in the teaching of science. Further, the number of graduates per institution reported in Booklet A (25.1) and in the postcard survey (13.5) would probably continue to decrease in this final group of non-respondents. Assuming that this trend continues monotonically, one estimates a figure of about 6 graduates per institution for this group. With an actual total of 443 non-responding institutions, this would yield an estimated total of 2658 graduates, again about one-half the total reported by the Booklet A respondents. Thus, the correction factor for this group would also be about .5 g.

The complete expression estimating the total number of graduates then would have the following factors:

g = number of graduates reported in Booklet A (known) (221)
.15g = correction for blank Booklet A's (112)
.50g = correction for postcard respondents (216)
.50g = correction for non-respondents (443)

Thus the total correction factor to estimate the number of graduates with degrees in any one field of science teaching would be 2.15 g.

Table 11 provides a summary of the total number of degrees in the teaching of each science for both years of the ROSES study as actually reported in the study and then as estimated by the above formula.

Information on doctoral degrees in science education was also solicited in Booklet A. Only 24 (8%) of the institutions responding reported any such degrees. The distribution of responses in this category is given in Table 12 below. In all, a total of 85 doctoral degrees in science education were granted in 1966-67 by the responding institutions. An examination of the nature of the missing institutions supports the conclusion that these results approximate the actual national total.

TABLE 11

BACHELOR'S DEGREES IN THE TEACHING OF SCIENCE, 1965-1967

Area	1965 - 66 Reported	1965 - 66 Estimated	NEA*	1966 - 67 Reported	1966 - 67 Estimated
Physics	294	735	505	279	698
Chemistry	657	1643	1284	719	1798
Biology	2161	5403	5483	2311	5778
Earth Science	159	398	-	183	458
General Science	511	1278	3603	548	1370
Total	3782	9455	10,875	4040	10,100

*Reported in the NEA Research Division's "Teacher Supply and Demand in Public Schools, 1966."

There are two differences in the way NEA and ROSES collected and reported their data. First, NEA includes under "general science", some students who have majored in biology, chemistry or physics. The complete number of graduates in physics teaching, therefore, is 505 plus an undetermined number listed under the category of "general science." Second, the source of data for the NEA study are officials in each state department of education who collect this information from institutions in their state who offer courses leading to the standard certificate for the state. The ROSES study collected data directly from colleges and universities.

TABLE 12

DOCTORAL DEGREES IN SCIENCE EDUCATION, 1966-67

Number of doctoral degrees granted in science education	Number of institutions
15	1[a]
7	1[b]
6	1[c]
5	3[d]
4	3
3	2
2	5
1	7

[a]Ohio State University
[b]Oregon State University
[c]Pennsylvania State University
[d]Columbia University, University of Iowa, New York University

C. Course Requirements

Course requirements for various degrees in the teaching of science are of general interest and significance. While information on the topic is not particularly difficult to collect, the reporting of that information presents a serious problem. If every institution specified a given number of hours to be taken in the major field and a given number in each of the minor fields in order to qualify for a degree in the teaching of science, the data could readily be reported. However, commonly institutions require x number of hours in the major field and then a total of y hours distributed over two minor fields, or z hours in field A or in field B, or some combination of these. In addition, an institution may offer various kinds of majors leading to degrees in teaching, each major having its unique course requirements. For degrees in the teaching of general science, the diversity is especially great. Commonly the general science requirements are "x hours distributed over 3 fields with a minimum of y hours in at least one field", or "a regular major in one science and two minors in any other fields of science." Similarly, the science requirements for the general elementary teacher usually are in the form of options among the various sciences. For example, the students may have to take one course in biology and one additional course in either chemistry or physics. Or she may have to take six hours in any two sciences or some variety of other arrangements.

A thorough analysis of this whole problem cannot be handled adequately in the limited space available in this report. A brief description of the data collected in the ROSES study appears in Tables 13-18 which list the course requirements in biology, chemistry, physics, earth science and mathematics for a number of science teaching majors and for the elementary school teacher.

D. Programs in Student Teaching

A wide diversity of practice teaching plans have been found. The length of time students are involved in this experience ranges from six to forty weeks (see Table 19). These figures in themselves are not, however, very illuminating, since students may do their practice teaching either full or part time and for a full semester, for less than a semester, or for more than a semester. Table 20 indicates that the most popular of these plans is the one in which students practice teach full time during less than one semester. More than half of the responding institutions (54%) reported offering this plan. Fifty percent of the institutions reported that this plan was selected by a majority of the secondary school science practice teachers last year. A seminar related to practice teaching experience is required of students in about a quarter (23%) of all responding

Table 13

Course Requirements, Teaching of Biology (in semester hours)

N = 210

	< 18	18-21	22-25	26-29	30-33	34-37	> 37
Biology	17 / 8%	4 / 2%	30 / 14%	31 / 15%	72 / 34%	37 / 18%	19 / 9%

	0	1-3	4-6	7-9	10-12	13-15	>15
Chemistry	36 / 17%	3 / 1%	15[a] / 7%	64[b] / 31%	34 / 16%	16 / 8%	36 / 17%
Physics	88 / 42%	3[c] / 1%	24[d] / 11%	68[e] / 32%	12 / 6%	2 / 1%	2 / 1%
Earth Science	163 / 78%	13[f] / 6%	15[g] / 7%	9[h] / 4%	0 / 0%	0 / 0%	0 / 0%
Mathematics	72 / 34%	24 / 11%	67[i] / 32%	24[j] / 11%	17 / 8%	2 / 1%	0 / 0%

Superscripts refer to cells in which additional schools require a student to take x number of hours in either one of two sciences. For example, a school may require a student to take 8 hours in either chemistry or physics. In this table, the number of institutions which have this option in each cell is as follows:

a = 3	c = 1	e = 4	g = 4	i = 1
b = 3	d = 5	f = 1	h = 2	j = 2

Table 14

Course Requirements, Teaching of Chemistry
(in semester hours)

N = 195

	18	18-21	22-25	26-29	30-33	34-37	>37
Chemistry	11 / 6%	9 / 5%	36 / 19%	32 / 16%	62 / 32%	24 / 12%	21 / 10%

	0	1-3	4-6	7-9	10-12	13-15	>15
Biology	109 / 56%	10 / 5%	24 / 12%	37 / 19%	8 / 4%	4 / 2%	3 / 2%
Physics	43 / 22%	1 / 1%	16 / 8%	89 / 46%	31 / 16%	8 / 4%	6 / 3%
Earth Science	167 / 86%	7 / 4%	11 / 6%	6 / 3%	1 / 1%	0 / 0%	3 / 2%
Mathematics	33 / 17%	11 / 6%	39 / 20%	38 / 20%	36 / 19%	14 / 7%	24 / 12%

Table 15

Course Requirements, Teaching of Physics (in semester hours)

N = 170

	≤ 18	18-21	22-25	26-29	30-33	34-37	≥ 37
Physics	24 14%	7 4%	35 21%	28 17%	41 24%	25 15%	10 5%

	0	1-3	4-6	7-9	10-12	13-15	≥ 15
Biology	103 61%	6 4%	17 10%	35 21%	2 1%	4 2%	3 2%
Chemistry	57 34%	3 2%	13 8%	54 32%	24 14%	8 5%	10 6%
Earth Science	138 81%	9 5%	11 7%	7 4%	2 1%	0 0%	3 2%
Mathematics	27 16%	3 2%	20 12%	25 15%	26 15%	17 10%	52 31%

Table 16

Course Requirements, Teaching of Earth Science (in semester hours) N = 83

	< 18	18-21	22-25	26-29	30-33	34-37	> 37
Earth Sciences	13 / 16%	12 / 15%	18 / 22%	14 / 17%	13 / 16%	7 / 8%	6 / 7%

	0	1-3	4-6	7-9	10-12	13-15	> 15
Biology	26 / 31%	4 / 5%	13 / 16%	28[a] / 34%	3 / 4%	2 / 2%	5 / 6%
Chemistry	19 / 23%	2 / 2%	9 / 11%	32[b] / 39%	13 / 16%	0 / 0%	4 / 5%
Physics	18 / 22%	5 / 6%	8 / 10%	26[c] / 31%	16 / 19%	2 / 2%	4 / 5%
Mathematics	20 / 24%	8 / 10%	24 / 29%	20 / 24%	6 / 7%	0 / 0%	4 / 5%

For explanation of superscripts, see footnote, Table 13. In this table:

a = 2 b = 4 c = 4

Table 17

Course Requirements, Teaching of General Science* N = 111
(in semester hours)

	0	1-4	5-8	9-12	13-16	17-20	20
Biology	6 / 5%	2 / 2%	37[a] / 33%	17 / 15%	14 / 13%	4 / 4%	11 / 10%
Chemistry	7 / 7%	4 / 4%	39[b] / 35%	23 / 21%	12 / 11%	5 / 5%	1 / 1%
Physics	8 / 8%	4[c] / 4%	47[d] / 42%	22 / 20%	5 / 5%	3 / 3%	1 / 1%
Earth Science	39 / 35%	8[e] / 8%	31[f] / 28%	10 / 9%	2 / 2%	1 / 1%	1 / 1%
Mathematics	21 / 19%	18 / 16%	41 / 37%	11 / 10%	1 / 1%	1 / 1%	2 / 2%

*Tabulated figures do not include 14 institutions (13%) at which there are no specific course requirements for the general science major but rather there are "field" requirements (e.g., "20 hours in one science and 10 hours each in two other sciences.").

For explanation of superscripts, see Table 13. In this table:

a = 4 c = 1 e = 1

b = 4 d = 4 f = 1

Table 18

Course Requirements, Elementary School Teaching* N = 144
(in semester hours)

	0	1-4	5-8	9-12	13-16	17-20	20
Biology	8 6%	43 29%	60[a] 42%	7[b] 5%	0 0%	1 1%	3 2%
Chemistry	65 45%	26[c] 18%	5[d] 4%	1[e] 1%	0 0%	0 0%	1 1%
Physics	31 21%	47[f] 33%	17[g] 12%	1[h] 1%	0 0%	0 0%	1 1%
Earth Science	72 50%	29[i] 20%	8[j] 6%	1[k] 1%	0 0%	0 0%	1 1%
Mathematics	21 14%	43 28%	58[l] 40%	5 4%	0 0%	0 0%	0 0%

*Tabulated figures do not include 10 institutions (7%) at which there are no specific course requirements for the elementary school teacher but rather there are "field" requirements (e.g., "8 hours in one science and 4 hours in each of two other sciences").

For explanation of superscripts, see Table 13. In this table:

a = 5	c = 6	e = 4	g = 21	i = 4	k = 3
b = 3	d = 22	f = 8	h = 4	j = 12	l = 2

institutions. Approximately an equal proportion (26%) expect students to be enrolled in academic course concurrently with their practice teaching. About one-fifth of the institutions (18%) reported that courses may or may not be taken concurrently with practice teaching, depending upon individual circumstances.

Student teachers in science are assigned to a number of different kinds of schools. Most often, they are local public schools (in 93% of the cases); but universities and colleges may also make use of non-local schools (70% of the institutions), private schools (11%), parochial schools (17%) or even out-of-state schools (11%). The laboratory school is still used by about one fifth of the reporting institutions (19%). Institutions report using both suburban and low income urban schools for practice teaching assignments in about the same ratio (53% vs. 47%, respectively).

Most institutions report having only a small number of practice teachers in science throughout academic year 1965-66 (see Table 22). One third of the respondents (33%) reported 5 or fewer student teachers in science, over one half (57%) reported 10 or fewer. A total of 4412 student teachers in science were reported by these institutions, all but 68 of whom were passed. The 68 failures in student teaching at 31 institutions were distributed as follows: 12 institutions reported one failure, 6 reported 2 failures, 8 reported 3, 5 reported 4, 1 reported 5, and 1 reported 10 failures. The rate of failure for student teaching in science is 1.5%.

The subjects in which the critic teacher with whom a prospective science teacher does his practice teaching are often beyond the control of the university or college. Thus, departmental policies about desirable assignment of practice teachers is of less interest than are the realities of these assignments. Table 23 reports on the kind of experiences which prospective science teachers encounter. The vast majority of practice teachers in science teach only their major or both their major subjects. However, a significant proportion of the science practice teachers are also assigned non-science classes to teach. Since math-science combination assignments are fairly common, this may explain the fairly high number of prospective science teachers who are assigned out of their field.

Of the 18 institutions which offer programs for the preparation of elementary science specialist, the proportion of practice teaching time required in science ranges from a low of 10% (two cases, 12%) to a high of 100% (four cases, 24%; see Table 24 for complete report of these responses). Typically, the general elementary school teacher spends about 10-20% of his practice teaching time in teaching science (Table 25 shows the frequency distribution of these responses).

TABLE 19

LENGTH OF PRACTICE TEACHER EXPERIENCE

Weeks of Practice Teaching	Number of Institutions
6-7	19
8-9	91
10-11	51
12-13	26
14-15	32
16-17	35
18-19	24
over 19	18

TABLE 20

PROGRAMS IN PRACTICE TEACHING

Less than one semester-		One full semester-		More than one semester-	
Full time	Part time	Full time	Part time	Full time	Part time
54% (a)*	10%	18%	37%	1%	7%
50% (b)*	6%	14%	25%	0%	5%

*(a) Percentage of institutions at which this plan is available.
*(b) Percentage of institutions at which this plan is most commonly selected by prospective science teachers.

Even more revealing are data describing the way in which the prospective science teacher spends his time during practice teaching. Table 21 below summarizes the average amount of time spent by a practice teacher in the responding institutions in each of five activities: Observing science classes, observing classes in other subjects, teaching, teaching individuals or small groups, and in non-teaching duties.

TABLE 21

TIME SPENT IN VARIOUS ACTIVITIES DURING PRACTICE TEACHING (in clock hours)
N = 240

	D_1*	D_3	D_5	D_7	D_9
Observing science courses	15	30	40	60	90
Observing other courses	0	0	5	10	30
Teaching	55	95	120	150	200
Teaching small groups	0	16	25	50	80
Non-teaching duties	0	10	20	25	50

*D_1, D_3, D_5, D_7, D_9, represent the first, third, fifth, seventh, and ninth decile points (D_5 = median).

TABLE 22

DISTRIBUTION OF PRACTICE TEACHERS IN SCIENCE BY INSTITUTION

Number of practice teachers in science	Number of institutions
0	17
1-5	86
6-10	67
11-15	28
16-20	18
21-25	18
26-30	12
over 30	44

TABLE 23

PRACTICE TEACHING ASSIGNMENTS IN SCIENCE

Teaching Assignment	Frequency never	sometimes	often	always
Major only	4%	12%	56%	31%
Major and minor	24%	41%	31%	5%
Minor only	73%	24%	2%	0%
Non-science	59%	28%	3%	0%
Non-science only	97%	3%	0%	0%

TABLE 24

ELEMENTARY SCIENCE SPECIALIST: PERCENTAGE OF PRACTICE TEACHING TIME IN SCIENCE (QUARTILE POINTS) N = 18

Q_1	Q_2 (= median)	Q_3
15%	50%	80%

TABLE 25

ELEMENTARY TEACHING: PERCENTAGE OF PRACTICE TEACHING TIME IN SCIENCE (DECILE POINTS) N = 148

D_1	D_3	D_5	D_7	D_9
0%	10%	15%	20%	25%

E. <u>Supervision</u>

Supervision of practice teachers in science is provided under a number of different plans. The practice teacher may be supervised by someone from the college (defined here as <u>the college supervisor</u>) or by someone from the high school (defined as <u>the cooperating teacher</u>). A single practice teacher may be observed and supervised by more than one college supervisor. Such a supervisor may be from the department of science (at 27% of the institutions), from the division of science education (33% of the institutions), from the college or department of education (60% of the institutions) or from school teaching below the college level (12%). One third (33%) of the institutions reported that more than one supervisor from the college regularly visited each student teacher.

Almost universally a college supervisor is expected to visit the practice teachers at least twice during their teaching experience. Only 10% of the institutions reported that this level of supervisory visits was not maintained by all of their supervisors. The median number of visits for each practice teacher in science seems to be about 4. Table 26 reports the number of supervisory visits per practice teacher reported by the responding institutions.

TABLE 26

VISITS BY COLLEGIATE SUPERVISORS

Number of visits	Percent of Institutions
1 - 2	7%
3 - 4	46%
5 - 6	26%
more than 6	21%

The cooperating teacher in the high school normally receives some form of compensation from the college or university in return for his participation in the practice teacher experience. In some cases this may be in the form of a free course at the university (16% of the cases), but most often it is a cash payment. Customarily the payment goes to the school system which allocates some portion of it to the cooperating teacher. Only 15% of the institutions reported that neither the teacher nor the cooperating school system received any remuneration at all for their participation in the program. The amounts of money made available to the school system and the proportions which the cooperating teacher receives are given in Tables 27 and 28.

II. Booklet B

Booklet B of the questionnaire was directed to the instructor of the science methods course (secondary or elementary). Of the 677 Booklets B returned, some were not usable. A number were completed by deans, non-teaching department heads, and other individuals who could not be classed as methods course instructors. Other booklets were incompletely answered; some contained enough information to be included in the study while others had to be omitted.

TABLE 27

AMOUNT OF PAYMENT TO SCHOOL SYSTEM FOR PARTICIPATION IN PRACTICE TEACHING PROGRAM

no payment	free course to cooperating teacher	$1-25	$26-50	$51-100	$101-200	more than $200
15%	16%	12%	28%	24%	4%	2%

TABLE 28

PROPORTION OF PAYMENT TO COOPERATING TEACHER

all	more than half	half	less than half	none
78%	7%	3%	1%	10%

The questions in Booklet B were of two different kinds. Some dealt with personal characteristics of the respondents (where they received their degree, what their plans for the next year might be, what their teaching load was like, etc). Others referred to the course they taught (what topics were covered, what problems existed, what innovations were expected, etc.). Because of the diverse type of questions asked, the responses were treated in two different ways. Responses dealing with personal characteristics of the methods instructor were divided into three groups: those that came from secondary science methods instructors (Group B), those that came from elementary science methods instructors (Group C) and those that came from instructors of both elementary and secondary science methods courses (Group D). The final parceling of respondents placed 241 instructors in Group B, 240 in Group C, and 98 respondents in Group D.

Responses dealing with the nature of the methods course were divided differently: those which referred to the secondary science methods course (Group E) and those which referred to the elementary science methods course (Group F). Generally speaking, Group E (N = 319) contains all of the members of Group B plus those members of Group D who chose to describe the secondary rather than elementary methods course they teach.* Similarly, Group F (N = 280) contains most of Group C plus some members of Group D.

A. Characteristics of the Methods Instructor (Groups B, C, D)

The distribution of respondents according to teaching position was approximately the same in all three sub-groups. Relatively few of the respondents ranked themselves as "instructors". The majority were about equally distributed in rank among assistant, associate, and full professors. (see Table 29).

TABLE 29

TEACHING POSITION OF RESPONDENTS TO BOOKLET B

	Group B (secondary)	Group C (elementary)	Group D (both)
Professors	31%	25%	35%
Associate Professors	25%	29%	29%
Assistant Professors	24%	34%	31%
Instructors	15%	10%	5%
Others	3%	2%	1%

In the case of many other characteristics also, there seemed to be little difference among the sub-groups B, C, and D. For example, the salary ranges were nearly the same for all three groups:

TABLE 30

SALARY RANGE OF RESPONDENTS TO BOOKLET B

	Group B (secondary)	Group C (elementary)	Group D (both)
$18,000 or more	2%	1%	6%
$15,000-17,999	8%	7%	12%
$12,000-14,999	22%	20%	24%
$ 9,000-11,999	38%	43%	43%
$ 6,000-8,999	28%	26%	15%
Less than $6,000	2%	3%	1%

*The design of the Booklet B was such that an instructor who taught methods courses at both the elementary and secondary levels was forced to select only one of the two to describe in detail.

Similarly, the number of years the instructor has been on the faculty of his present institution was about the same for members of all three groups (Table 31 below), as were the instructors' stated plans for the ensuing years. Apparently few members of any of the sub-groups had any plans to leave the institution at which they were currently teaching (see Table 32 below). The large proportion of instructors with intentions of remaining at their current institutions (84%, 87%, and 87%) represents a surprisingly low rate of mobility.

TABLE 31

YEARS OF SERVICE AT PRESENT INSTITUTION

Years of Service	Group B (secondary)	Group C (elementary)	Group D (both)
More than 15 years	17%	11%	18%
11 - 15 years	12%	12%	8%
6 - 10 years	22%	25%	21%
3 - 5 years	25%	21%	30%
1 - 2 years	24%	30%	23%

TABLE 32

PLANS FOR ENSUING YEAR

Plans	Group B (secondary)	Group C (elementary)	Group D (both)
Stay	84%	87%	87%
Move to another university	2%	3%	3%
Move to an elementary or secondary school	1%	0%	0%
Move to industry	0%	0%	0%
Retire	2%	0%	0%
Undecided	3%	5%	4%
Other	9%	5%	6%

The pattern of membership in various professional organizations is about the same for all three groups. The largest number of instructors belong to "general" professional groups like the American Association for the Advancement of Science (AAAS) and the National Science Teachers Association. A relatively small number belong to specialized societies like NABT (National Association of Biology Teachers), (See Table 33 below). Although the pattern of membership in various organizations is the same for all groups, the actual numbers enrolled is quite different. As is to be expected perhaps, those who teach only secondary science methods courses are somewhat more likely to be a member of scientific and science-related organizations like AAAS, NABT, AAPT, and ACS.

TABLE 33

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

Organization	Group B (secondary)	Group C (elementary)	Group D (both)
AAAS	50%	31%	54%
NSTA	58%	56%	83%
AETS	23%	16%	38%
AERA	5%	10%	15%
NARST	22%	20%	43%
NABT	28%	7%	29%
AAPT	10%	2%	10%
ACS	16%	5%	7%

A striking difference occurs among the distribution of responses among Groups B, C, and D for other characteristics. A much larger proportion of respondents are affiliated with the department of science in Group B (secondary science methods instructors) and a much larger proportion associated with the school of education in Group C (elementary science methods instructors), as indicated in Table 34.

Although a sizable proportion of the instructors of elementary science methods courses (34%) have not taught in a secondary school, Table 35 shows that many instructors have taught from one to ten or more years in secondary schools. A comparable situation does not exist in the opposite case, for almost none of the secondary science methods instructors have any teaching experience in the elementary school (Table 36). Members of Group C clearly have broader teaching experience than do their colleagues in Groups B and D.

TABLE 34

DEPARTMENT AFFILIATION OF RESPONDENTS

Department	Group B (secondary)	Group C (elementary)	Group D (both)
Education	24%	67%	38%
Science	50%	17%	32%
Science Education	13%	8%	8%
Joint Appointment	10%	8%	18%
Other	3%	0%	4%

TABLE 35

YEARS OF SECONDARY SCHOOL TEACHING EXPERIENCE

Years of Experience	Group B (secondary)	Group C (elementary)	Group D (both)
None	13%	34%	5%
1 - 2 years	8%	17%	8%
3 - 5 years	27%	18%	26%
6 - 10 years	30%	21%	28%
More than 10 years	23%	10%	34%

TABLE 36

YEARS OF ELEMENTARY SCHOOL TEACHING EXPERIENCE

Years of Experience	Group B (secondary)	Group C (elementary)	Group D (both)
None	77%	20%	51%
1 - 2 years	9%	12%	24%
3 - 5 years	8%	23%	13%
6 -10 years	5%	26%	9%
More than 10 years	2%	20%	3%

This study denies a common criticism of science methods instructors (as with all education instructors): that they are too far removed from "reality" and have been away from school teaching so long that they have forgotten what the classroom is really like. Less than one in ten of the secondary science methods instructors (one in twenty-five for Group C and one in thirty-three for Group D) has not taught at the pre-college level. Almost half of the Groups have taught in a school classroom in the last five years.

TABLE 37

YEARS SINCE LAST SCHOOL TEACHING EXPERIENCE

Years	Group B (secondary)	Group C (elementary)	Group D (both)
Less than 5 years	41%	36%	39%
6 - 10 years	22%	33%	29%
11 - 15 years	8%	16%	12%
More than 15 years	18%	14%	17%
No such experience	10%	4%	3%

TABLE 38

HIGHEST DEGREE

Degree	Group B (secondary)	Group C (elementary)	Group D (both)
BA	8%	8%	0%
MA (Science)	18%	8%	4%
MA (Education)	11%	18%	6%
Doctorate (Educ.)	39%	48%	62%
Doctorate (Sci.)	30%	7%	11%
Active doctoral candidate	14%	13%	12%
Other	4%	5%	4%

Most of the methods instructors in all of the Groups either hold the doctoral degree or are actively working towards it. Over half of Groups B and C (53% and

55% respectively), and almost three-quarters (74%) of Group D, already hold the doctoral degree, and another 12% in each of these groups is currently an active doctoral candidate (Table 38). Those concerned with only secondary school teachers (Group B) were much more likely to have taken both their masters and their doctoral degrees (Tables 39 and 40) in the sciences; those concerned with elementary school teachers only (Group C) were more likely to have earned a degree either in elementary education or in some other field of education.

TABLE 39

MASTER'S DEGREE, MAJOR FIELD

Field	Group B (secondary)	Group C (elementary)	Group D (both)
Science Education	16%	15%	38%
Elementary Education	0%	18%	1%
Other Education	18%	37%	14%
Biological Sciences	36%	14%	18%
Physical Sciences	17%	9%	20%
Other	5%	4%	5%
None or none given	8%	3%	4%

TABLE 40

DOCTORAL DEGREE, MAJOR FIELD

Field	Group B (secondary)	Group C (elementary)	Group D (both)
Science Education	30%	29%	62%
Elementary Education	0%	14%	0%
Other Education	9%	20%	13%
Biological Sciences	21%	5%	3%
Physical Sciences	8%	2%	6%
Other	2%	2%	5%
None or none given	30%	29%	11%

The proportion of respondents who taught methods courses at both levels (Group D) and were clearly committed to science education at both levels was much higher than for the members of either of the other Groups. This information provides us, then, with some fairly good evidence as to the nature of Group D: the members are the solid core of fully committed science educators in the nation who have chosen to make science education per se a career.

Tables 41 and 42, indicating the number of years since the masters and doctoral degrees were received by respondents, provokes two interesting observations. The "dip" apparent at about 17-20 years since degree may result from the decrease in college enrollments during the second World War.

TABLE 41

YEARS SINCE MASTER'S WAS RECEIVED

Years	Group B (secondary)	Group C (elementary)	Group D (both)
1 - 4 years	12%	9%	10%
5 - 8 years	18%	19%	23%
9 - 12 years	20%	19%	12%
13 - 16 years	15%	19%	20%
17 - 20 years	8%	15%	6%
More than 20 years	25%	20%	26%
Active candidate	1%	0%	0%
None or none given	1%	0%	3%

Further, the continuous increase in number of doctoral degrees received since the war period probably indicates both a gross increase in college enrollments and an increased emphasis on the importance of the doctorate in college teaching.

Teaching Loads

The questionnaire respondents were asked three questions about the nature of their teaching loads. Responses to the first, concerning the distribution of the instructor's time among various responsibilities, are presented in Table 43. It is apparent from these data that instructors in all three Groups spent the largest portion of their time in collegiate teaching and relatively smaller portions of their time in administrative, supervisory, and research activities. Furthermore, the teaching load of instructors at all levels is fairly heavy. Approximately half of all the instructors reported spending at least 20 hours a week in teaching and planning for teaching.

TABLE 42

YEARS SINCE DOCTORAL WAS RECEIVED

Years	Group B (secondary)	Group C (elementary)	Group D (both)
1 - 4 years	18%	21%	30%
5 - 8 years	13%	13%	13%
9 - 12 years	8%	14%	16%
13 - 16 years	6%	5%	6%
17 - 20 years	5%	4%	4%
More than 20 years	8%	3%	11%
Active candidate	15%	11%	11%
None or none given	27%	29%	10%

The second question asked instructors what portion of their teaching time was devoted to instruction in science education, what portion in education (other than science education), and what portion was spent in other fields. Table 44 shows that a relatively small number of instructors have a full teaching load in science education.

Finally, the numbers and kinds of science methods courses offered by instructors in all three sub-groups are summarized in Table 45. Roughly one-fourth of all elementary science methods courses were taught in combination with some other subject, usually mathematics. In less than 2% of all cases, the second subject was social studies, English, some other subject, or some combination of these.

B. <u>Characteristics of the Methods Courses</u> (Groups E and F)

For the study of the methods courses offered, the replies were sorted into two groups: Group E for secondary science methods courses and Group F for elementary science methods courses. Table 46 gives the kind and number of courses included in each of the groups: In both groups the majority of courses are "pure" science methods courses. In group E, for example, 278 of the 319 courses (87%) are general methods of teaching science or special methods of teaching biological or physical science courses. In group F, 205 of 287 of the courses (71%) are pure elementary science methods courses.

TABLE 43

DISTRIBUTION OF INSTRUCTORS' RESPONSIBILITIES (in hours per week)

Duties	Group	0	1-4	5-9	10-14	15-19	over 19
	B	1%	2%	9%	19%	17%	52%
TEACHING	C	1%	4%	10%	21%	21%	43%
	D	0%	2%	8%	15%	27%	48%
	B	7%	29%	28%	21%	7%	8%
ADMINISTRATION	C	5%	40%	28%	13%	3%	11%
	D	3%	22%	34%	22%	8%	10%
	B	30%	39%	14%	9%	3%	4%
RESEARCH	C	24%	42%	19%	9%	2%	4%
	D	16%	32%	27%	13%	6%	6%
	B	14%	30%	27%	18%	5%	6%
SUPERVISION	C	19%	23%	26%	15%	10%	7%
	D	9%	27%	27%	20%	11%	5%
	B	80%	3%	9%	3%	1%	3%
OTHER	C	76%	8%	9%	3%	0%	4%
	D	78%	9%	9%	1%	1%	1%

TABLE 44

DISTRIBUTION OF TEACHING RESPONSIBILITIES

Area	Group	0	1-20%	21-40%	41-60%	61-80%	81-99%	100%
	B	30%	3%	7%	7%	22%	29%	0%
SCIENCE	C	73%	1%	7%	5%	6%	6%	0%
	D	46%	4%	14%	16%	11%	9%	0%
	B	81%	4%	4%	5%	4%	1%	0%
EDUCATION	C	41%	5%	14%	12%	18%	10%	0%
	D	77%	5%	5%	8%	4%	0%	0%
	B	0%	43%	3%	13%	7%	1%	12%
SCIENCE EDUCATION	C	4%	33%	26%	13%	9%	2%	14%
	D	0%	16%	19%	27%	15%	2%	20%

TABLE 45

KINDS OF METHODS COURSES OFFERED BY RESPONDENTS

Courses	Group B (secondary)	Group C (elementary)	Group D (both)
Methods of teaching science, secondary	103	-	60
Methods of teaching science, elementary	-	177	79
Methods of teaching biological sciences	73	-	16
Methods of teaching physical sciences	47	-	14
Science methods combined with another subject	13	59	20
General methods of all teachers (non-science)	-	3	0
Other	5	1	7

In both groups there are some courses described as "mixed": courses in which science methods is taught along with some other kind of methods, usually math. In group E the range of time spent on science methods in such courses is from 2% to 98%, with a median of 60% (see Table 47); for group F the range is from 5% to 90%, with a median of 50%. A somewhat more illuminating description of the role of science methods instruction in these "mixed" courses is given in Table 48, which shows the total number of clock hours devoted to science methods in such courses. In both secondary and elementary methods courses, when science methods is taught in combination with some other subject, between 10 and 30 hours of instruction in science methods will be available. This is about half the amount of time normally available for instruction in a "pure" science methods course (see Table 51).

In almost all cases, the science methods course is a two, three, or four semester hour credit course (or its equivalent in term hours). In only 5% of the courses reported was less (1 credit hour in 5 cases) or more (5 credit hours in 8 cases, 6 credit hours in 3 cases) credit granted than the "standard" 2-4 hour range.

In spite of the uniformity of credit hours granted for the science methods course, a considerable range of actual time spent in the classroom was reported. Methods courses were reported to meet for anywhere from one to nine clock hours per week for anywhere from three to forty-eight weeks per semester or year. Tables 49 and 50 provide a summary of these data for all respondents.

TABLE 46

TYPES OF COURSE DESCRIBED

Type of Course		Number of courses
Group E (N = 319)		
General methods of teaching science		146
Methods of teaching biological science		78
Methods of teaching physical science		54
Science methods combined with another subject		15
General methods for all secondary teachers		20
Other		6
	Total	319
Group F (N = 287)		
Elementary science methods		205
Science methods combined with another subject		62
General methods for all elementary teachers		15
Other		5
	Total	287

TABLE 47

PERCENT OF TIME SPENT ON SCIENCE IN MIXED METHODS COURSES

Percent	Group E (secondary)	Group F (elementary)
Less than 20%	7	8
21 - 40%	4	18
41 - 60%	11	37
61 - 80%	4	8
81 - 100%	3	4

TABLE 48

TOTAL CLOCK HOURS ON SCIENCE METHODS IN MIXED COURSES

Hours	Group E (secondary)	Group F (elementary)
Less than 10	7	4
10 - 19	7	17
20 - 29	7	27
30 - 39	4	10
40 - 49	1	8
More than 49	2	4

TABLE 49

HOURS IN SCIENCE METHODS PER WEEK

Hours	Secondary Classes	Elementary Classes
1	5	3
2	73	42
3	109	111
4	52	57
5	32	24
6	18	16
More than 6	8	14

TABLE 50

WEEKS IN SCIENCE METHODS PER SEMESTER / TERM / YEAR

Weeks	Secondary Classes	Elementary Classes
Less than 8	10	11
8 - 9	26	21
10 - 11	55	45
12 - 13	19	25
14 - 15	72	42
16 - 17	57	56
18 - 19	49	61
More than 19	9	6

Table 51 presents the total number of clock hours spent in "pure" science methods courses at both levels.

TABLE 51

TOTAL HOURS SPENT IN METHODS
(Pure Science Methods Courses Only)

Hours	Secondary Classes	Elementary Classes
Less than 30	20	11
30 - 39	87	61
40 - 49	73	42
50 - 59	33	42
60 - 69	27	16
More than 69	25	18

TABLE 52

NUMBER OF STUDENTS IN SCIENCE METHODS COURSES

Students	Secondary Classes	Elementary Classes
1 - 5	55	5
6 - 10	87	77
11 - 15	57	17
16 - 20	36	30
21 - 25	34	60
26 - 30	15	48
31 - 35	12	32
36 - 40	3	28
More than 40	10	43

Class size in science methods courses varies with the level of the course. Secondary methods courses tend to be relatively small:. more than 60% of the secondary science methods courses reported an enrollment of 15 students or fewer. In contrast, almost 80% of the elementary science methods courses had over 20 students enrolled. Table 52 reports class size at both levels.

1. Content Emphasis in Science Methods Courses

An important objective of the study was to determine the nature of science methods courses: the topics included in these courses and the teaching methodology the instructor himself employs. Although the questionnaire was not conducive to the collection of extensive, detailed, or exact information on the nature of the methods course, the results provide some general indication of the over-all emphasis in the content and methodology of these courses.

The respondent was asked to indicate how much emphasis he placed on a number of possible topics, such as "history and philosophy of science", "history of science education", etc. The optional replies were "great detail", "some detail", "incidental", and "none." Table 53 shows the trends in the data. An additional statistic has been derived to indicate more clearly the relative importance of the topics. Responses at the extremes of such a table ("great detail" and "none") are generally believed to be the more significant. The scheme used to weight the responses was to assign the following weights to each of the columns in the table: "great detail" = 6; "some detail" = 4; "incidental" = 3; "none" = 1. Using this method, a single value called Delta could be calculated for each of the topics on the list. The fifth column in Table 53 lists the values of Delta for all 17 topics for both Groups.

Two generalizations can be made from Table 53. First, the relative order of importance of topics in secondary and elementary science methods courses is roughly the same. The correlation coefficients of the two lists are .89 (weighted) and .91 (unweighted). Yet, there are some obvious differences in the two lists. The subject of "content"in science, for example, is of much more importance in the elementary methods course than it is in the secondary. On the other hand, the problem of planning, setting up and running laboratories is discussed in greater detail in the courses for secondary school teachers.

The "New" Secondary Science Courses

One topic which receives considerable attention from methods instructors is the "new" science courses. Each instructor was asked to indicate which of the new courses (a list was provided) he mentioned in his methods courses and which received intensive consideration. The results appear in Figure 6. The four major secondary programs which have been available for several years, PSSC, CBA, CHEMS, and BSCS, are discussed in a majority of the secondary science courses but in practically none of the elementary methods courses. On the other hand, AAAS, ESS, SCIS are considered by a number of elementary methods courses but by almost none of the secondary courses. The intermediate, junior high courses, ESCP, IPS, and TSM, are studied in only a relatively small proportion of the methods courses, and then in the secondary methods level only.

Although close to 70% of the methods courses study BSCS biology curricula, only about 30% of the instructors report studying the course "intensively". Similarly, for the other new courses, less than 10% of the instructors devote intensive consideration to any one. From the evidence in Figure 6 it seems that the attention given to the new courses would have to be described as "introductory" or "descriptive" rather than "preparation for teaching".

2. Teaching Techniques in Science Methods Courses

Analysis of responses to the "methodology" question was done in essentially the same way as that for the content question. The weights assigned to responses reported in Table 54 were: "very often" = 7; "often" = 5; "sometimes" = 4; "seldom" = 3; and "never" = 1. Again, the rank order of items is about the same for both elementary and secondary respondents. The correlation coefficient for the two lists is .97 (both weighted and unweighted).

Figure 6

The "New" School Science Courses as Topics in Science Methods Courses

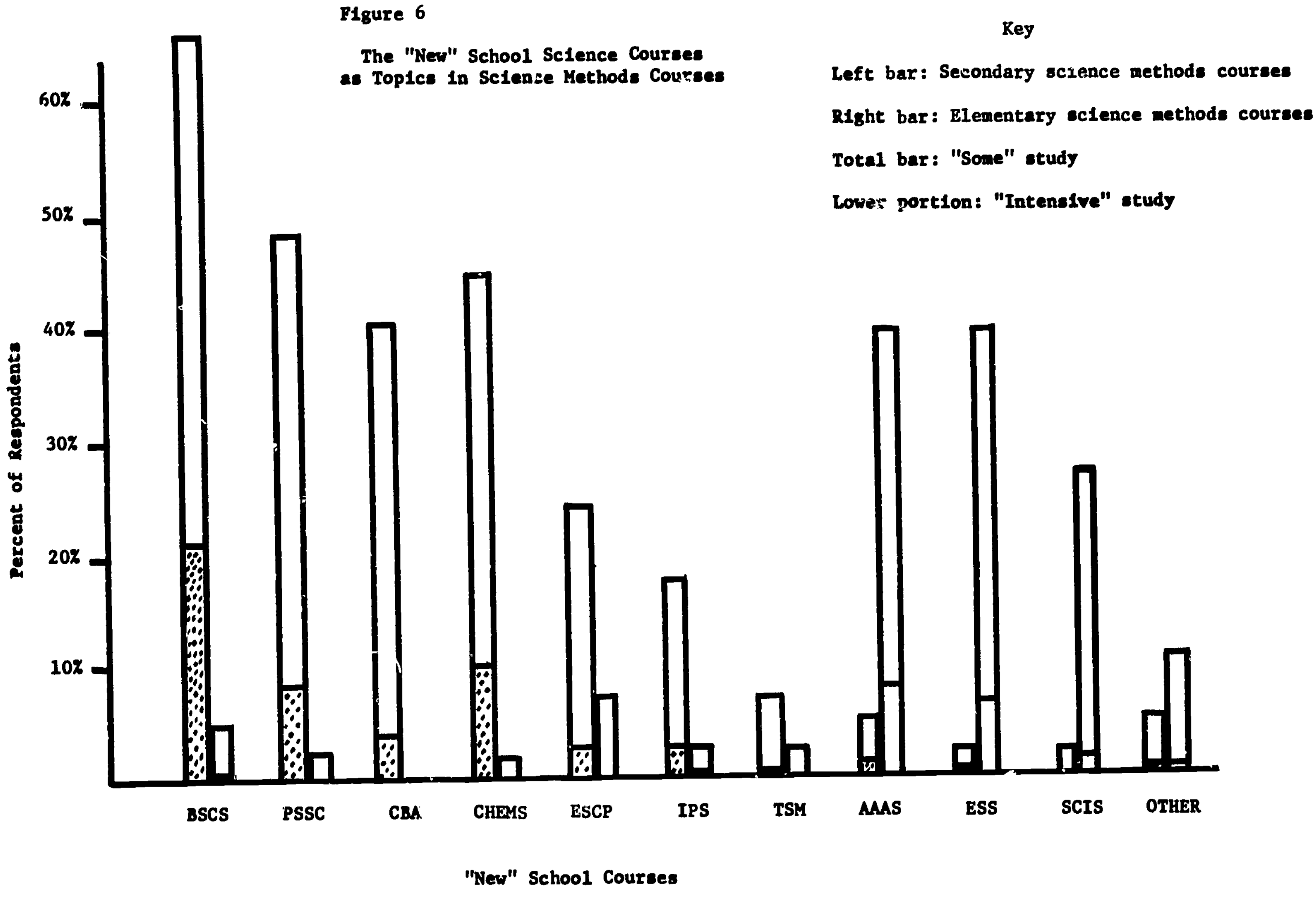


TABLE 53

CONTENT EMPHASES IN METHODS COURSES

Topic	Group	Great Detail	Some Detail	Incidental	None	DELTA
History and Philosophy of Science	Sec.	9%	44%	34%	13%	345
	Elem.	5%	39%	45%	11%	334
Objectives of Science Teaching	Sec.	42%	47%	8%	3%	468
	Elem.	40%	52%	7%	1%	468
History of Science Education	Sec.	1%	32%	46%	22%	292
	Elem.	2%	25%	47%	27%	277
Planning	Sec.	50%	39%	8%	3%	482
	Elem.	52%	35%	9%	5%	481
Individual Differences	Sec.	9%	62%	22%	7%	376
	Elem.	11%	56%	27%	6%	378
Evaluation	Sec.	35%	53%	8%	4%	448
	Elem.	23%	57%	16%	5%	418
Study of Texts	Sec.	23%	53%	18%	6%	411
	Elem.	16%	58%	22%	4%	398
Resources	Sec.	27%	54%	17%	2%	431
	Elem.	31%	51%	17%	2%	438
Study of Curriculum	Sec.	32%	48%	18%	3%	438
	Elem.	26%	47%	22%	5%	414
Discipline	Sec.	9%	40%	38%	13%	339
	Elem.	4%	22%	51%	24%	287
Methods	Sec.	52%	43%	5%	1%	498
	Elem.	56%	36%	6%	1%	501
Facilities	Sec.	11%	53%	30%	6%	376
	Elem.	15%	45%	32%	8%	373
Science Content	Sec.	28%	42%	25%	5%	418
	Elem.	42%	43%	14%	1%	468
Learning	Sec.	17%	41%	31%	11%	370
	Elem.	15%	48%	31%	7%	379
Social Implications of Science	Sec.	10%	41%	39%	10%	353
	Elem.	13%	46%	37%	4%	378
Set-up of Laboratories	Sec.	21%	54%	20%	5%	407
	Elem.	15%	34%	37%	15%	348
Innovations in Teaching	Sec.	18%	50%	27%	6%	392
	Elem.	15%	42%	33%	11%	364

TABLE 54

TEACHING TECHNIQUES EMPLOYED IN METHODS COURSES (Reported in Booklet B, Phase One)

Technique	Group	Very Often	Often	Sometimes	Seldom	Never	Delta
Lecture	Sec.	11%	27%	40%	19%	3%	433
	Elem.	11%	31%	40%	16%	2%	447
Instructor Demonstration	Sec.	5%	29%	51%	12%	3%	424
	Elem.	11%	31%	46%	11%	1%	450
Discussion	Sec.	51%	40%	9%	1%	0%	592
	Elem.	31%	49%	19%	0%	0%	540
Student Laboratory Work	Sec.	27%	25%	29%	10%	9%	469
	Elem.	38%	27%	20%	19%	5%	514
Construction of Teaching Units	Sec.	19%	34%	34%	10%	4%	469
	Elem.	19%	37%	28%	10%	6%	467
Construction of AV Materials	Sec.	9%	23%	40%	19%	10%	399
	Elem.	9%	31%	34%	19%	7%	418
Demonstration ("mock") Teaching	Sec.	21%	23%	23%	15%	18%	414
	Elem.	17%	18%	24%	22%	20%	388
Student Demonstrations	Sec.	25%	39%	26%	6%	5%	494
	Elem.	29%	41%	21%	7%	3%	514
Group Reports and Activities	Sec.	6%	21%	28%	26%	20%	351
	Elem.	8%	18%	34%	23%	17%	368
Term Papers	Sec.	8%	17%	21%	23%	31%	324
	Elem.	7%	12%	22%	23%	36%	301
Analysis of Teaching (by AV Reproduction)	Sec.	8%	19%	27%	19%	28%	339
	Elem.	6%	22%	35%	15%	21%	362
Closed Circuit TV	Sec.	2%	3%	10%	8%	78%	165
	Elem.	1%	2%	11%	13%	73%	174
School Visits	Sec.	14%	22%	26%	14%	24%	376
	Elem.	7%	25%	24%	19%	25%	351
Outside Speakers	Sec.	2%	6%	34%	32%	26%	301
	Elem.	1%	6%	43%	28%	23%	312
Microteaching	Sec.	7%	9%	16%	11%	57%	248
	Elem.	4%	9%	12%	12%	64%	218

The largest differences in teaching methodology are in the use of student laboratories, student demonstrations, and instructor demonstrations, all of which are more popular with the elementary instructors. Class discussion and mock teaching are more commonly used in the secondary science methods courses. Several of the teaching techniques listed in the questionnaire were not popular with either secondary or elementary instructors. The last seven items on the list were seldom used by a majority of the respondents in either group.

The term "mock-teaching" in the list may have been misunderstood by the respondents. The term was intended to describe the classroom practice of having students prepare and deliver trial lessons to their peers. Presumably, this was a popular method in methods classes and would rank high on the final list of teaching techniques used. Actually, the observations in Phase II indicated that the "mock lesson" was the second most frequently used teaching technique in the classes observed. With lecture and class discussion, mock teaching was the only other common form of methodology employed by the methods instructors. The extent to which it was utilized in the classes observed was much greater than would be expected from the Delta value reported in Table 54.

Most of the standard facilities required in the well-equipped science classroom were available in the classrooms of the respondents (Table 55). At least seven out of eight of all respondents reported having available overhead, movie, and slide projectors, water outlets, demonstration tables, and curriculum libraries. However, the newer forms of educational technology, video tape and closed circuit television sets, were available to less than half of the responders.

A textbook was required or recommended by most methods instructors (75% at the secondary level and 83% at the elementary level). Some instructors (roughly a third at each level) suggested a second text and a few even required or recommended a third text. Although the diversity of titles was great, Table 56 lists in decreasing order of popularity the authors and texts most commonly listed in both groups E and F.

C. <u>Rationale for the Teacher Preparation Program in Science</u>.

One question in each questionnaire asked the respondent to comment upon his beliefs about the ideal program for the preparation of a science teacher. This question was intended to reveal the rationale for the institution's training program:

> "One major purpose of a teacher education program is to help students gain the knowledges, skills, and attitudes which they will need in their careers as science teachers. _____Agree _____Disagree

TABLE 55

EQUIPMENT AVAILABLE TO METHODS INSTRUCTORS

Equipment	Group E (secondary)	Group F (elementary)
Video Tape	40%	35%
TV Set	37%	43%
Overhead projector	98%	98%
Movie projector	98%	99%
Slide Projector	98%	98%
Water Outlets	86%	79%
Demonstration Table	88%	79%
Curriculum library	91%	96%
Wood-metal shop	30%	21%

TABLE 56

TEXTBOOKS IN USE

Textbook	Times mentioned
Secondary Science Methods Courses, N = 342	
Brandwein, Morholt, and Joseph: A Sourcebook for the Biological Sciences	49
Thurber and Collette: Teaching Science in Today's Secondary Schools	40
Schwab and Brandwein: The Teaching of Science	21
Richardson: Science Teaching in Secondary Schools	18
Joseph, Brandwein, Morholt, Pollock, and Castka: A Sourcebook for the Physical Sciences	15
Miller and Blaydes: Methods and Materials for Teaching the Biological Sciences	14
No other text was mentioned more than 11 times.	
Elementary Science Methods Courses, N = 272	
Blough, Schwartz, and Huggett: Elementary School Science and How to Teach It	88
Gega: Science in Elementary Education	32
Victor: Science for the Elementary School	28
Craig: Science for the Elementary School Teacher	20
Carin and Sund: Teaching Science Through Discovery	19
No other text was mentioned more than 7 times.	

If you generally agree with this point of view, please list (in decreasing order of importance) those objectives of your own science education program which you believe to be most critical in the development of the prospective science teacher."

Space was then provided for 6 responses under each of three headings: Knowledges, Skills, and Attitudes. A total of 200 instructors responded to the question in Booklet A and 438 responded in Booklet B. In addition, 7 respondents disagreed with the original statement and added brief paragraphs expressing their own views on the preparation of science teachers.

The method by which these responses were analyzed has been discussed in the section on analysis of data from Phase Two. After trials of several complex category systems, the responses were formed into 10 Groups (see Appendix F):

1. Science content: content knowledge, breadth, depth in science
2. Nature of science
3. Nature of students: adolescent psychology, learning
4. Instructional skills: demonstrations, lab work, lecture
5. Related pedagogical skills: planning, evaluation, curriculum
6. Familiarity training: what schools are like, professional organizations
7. The science classroom: objectives of science education
8. Person-person qualities: personality traits
9. Person-thing qualities: attitudes toward science, toward the profession
10. Liberal education

TABLE 57

ESSENTIAL ELEMENTS IN THE PREPARATION OF THE SCIENCE TEACHER

Booklet A Respondents vs. Booklet B Respondents

	Group One	Group Two	Group Three	Group Four	Group Five	Group Six	Group Seven	Group Eight	Group Nine	Group Ten	Total
Booklet A Responses N = 123	223 / 18%	162 / 13%	81 / 7%	231 / 19%	150 / 12%	35 / 3%	48 / 4%	100 / 8%	152 / 13%	29 / 2%	1211
Booklet B Responses N = 361	609 / 17%	494 / 14%	250 / 7%	698 / 20%	423 / 12%	119 / 3%	208 / 6%	242 / 7%	439 / 12%	67 / 2%	3549
Combined Responses* N = 77	134 / 18%	115 / 15%	66 / 9%	146 / 19%	108 / 14%	33 / 4%	37 / 5%	38 / 5%	70 / 9%	21 / 3%	768

*This group includes those instructors who gave the same response on both Booklets A and B

III. Phase Two

A. Observations

During the series of visits which comprised Phase Two of the study, 42 science methods classes were observed. Of the classes observed, 20 (51%) were general secondary science methods courses, 7 (18%) were courses in methods of teaching biological science, 7 others were in the teaching of physical sciences, 2 each (5% each) were in the methods of teaching earth science and in the teaching of general science, and one was an advanced course in methods. As Table 58 shows, class sizes ranged from two to 35. The male-female ratio ranged from a high of 1.0 to a low of .17. Overall, there were 285 male students and 189 female students in these classes.

TABLE 58

SIZE OF METHODS CLASSES OBSERVED DURING PHASE TWO (N = 42)*

Number of students	Number of classes
1 - 3	1
4 - 6	8
7 - 9	7
10 - 12	6
13 - 15	2
16 - 18	4
19 - 21	5
over 21	4

*Some classes observed more than once

The total enrollment in the methods course over the 12 month period, June, 1967 to June, 1968, as provided by the instructors, is presented in Table 59. The information contained in Table 59 is different from that in Table 58 since some methods courses meet more than once during the year. Twenty five of the courses observed are, in fact, offered twice during the year. Another 13 meet three times during the year and four meet four times during the year.

1. Physical Facilities

The majority of facilities (26 cases, 68%) were categorized by the observer as being "new", that is apparently less than 10 years old. Another 9 rooms (24%) were regarded as "old", about twenty or thirty years old. Two rooms (5%) were classified somewhere between these two, and one (2%) was "ancient." In most cases the classrooms had arm-chairs or two-man tables and chairs arranged in rows facing the front of the room. For the teaching techniques most commonly observed during the visits (modified lectures, lectures, and mock teaching), this arrangement was usually appropriate. The classrooms seldom seemed very much "lived in." Bulletin boards were not particularly interesting or appealing; live specimens were not apparent; and scientific equipment was not obviously in use.

TABLE 59

ENROLLMENT OVER THE PAST TWELVE MONTHS IN METHODS COURSES OF INSTRUCTORS VISITED DURING PHASE TWO
(Each course may have more than one section) (N = 57)*

Number of students	Number of Classes
1 - 8	5
9 - 16	13
17 - 24	9
25 - 32	10
33 - 40	6
41 - 48	0
49 - 56	5
over 56	9

*Includes data for some courses that were not in session during our visit

Again, in view of the fact that students were seldom actively engaged in the use of apparatus themselves, this is an understandable situation. In spite of the paucity of both physical equipment and biological specimens, the classrooms were almost always well-lit, clean, and pleasant rooms.

2. Time Spent in Methods Courses

Classes varied considerably in the length of time, both in hours per week and in weeks per semester / term/ year. Most frequently the class met for two or three clock hours per week (49% of the cases), but some classes met for as much as 15, 20, or 40 hours a week, as Table 60 shows. The term "clock hour" is somewhat misleading since a "clock hour" may be from forty to fifty five minutes in length. The classes observed during Phase Two actually ran from 40 minutes to three hours in length.

TABLE 60

NUMBER OF CLOCK HOURS PER WEEK THAT METHODS COURSE MEETS
(Classes Observed During Visits of Phase Two)

Hours per week	Number of classes
2	10
3	18
4	12
5	4
6	4
7	2
8	2
over 8	5

The majority of classes observed met for either half a semester (8 weeks), a term (10 weeks), or a full semester (15-18 weeks). The number of weeks spent in the methods course (Table 61) and total time spent in methods (Table 62) is similar to the comparable results for the questionnaire sample (see Tables 50 and 51 for comparison).

TABLE 61

NUMBER OF WEEKS SPENT IN METHODS COURSES (Classes Observed During Phase Two)

Weeks	Number of Classes
Less than 8	6
8 - 9	11
10 - 11	10
12 - 13	1
14 - 15	12
16 - 17	10
18 - 19	3
More than 19	4

TABLE 62

TOTAL HOURS SPENT IN METHODS COURSES (Classes Observed During Phase Two)

Hours	Number of classes
Less than 30	5
30 - 39	16
40 - 49	19
50 - 59	4
60 - 69	6
More than 69	9

3. Content Emphasis in Methods Courses Observed

Methods classes were observed to find out what topics are included in science methods courses. Table 63 lists all of the content topics which were actually observed. The two columns marked "Time" provide a record of (1) the actual number of minutes during which the topic was observed, totaled over all observations and (2) the corrected number of minutes for each topic.

A correction factor was used to convert all observation times to a common class length: a forty minute class period. Thus in a class which actually ran for 80 minutes, all observation times were multiplied by 0.5.

The corrected times recorded in column 2, were used as a basis for calculating the percentages of observation time listed.

Table 63 indicates the predominance of four major topics in the classes observed. The pedagogical problems of lab work (designing, setting up and supervising laboratory exercises), the "new" courses, planning, and evaluation accounted for about 40% of all the observations. The frequency distribution of topics in the methods course, as described by respondents to Booklet B (Table 53), is similar to the frequency distribution of topics actually observed (Table 63). If all of the "methodology" topics in Table 63 are grouped, they clearly become the most common topic encountered during the visits, just as they are the topic most frequently mentioned in Booklet B. Similarly, just as planning, evaluation, and curriculum study rank high in importance in Table 53, these three topics were those most frequently observed. Yet one obvious difference is the absence of "objectives of science teaching" as a topic observed during the visits, although it was the third most frequently mentioned topic in Table 53. The reason for this discrepancy is not difficult to see; one is less likely to offer a specific

TABLE 63

CONTENT EMPHASES IN SCIENCE METHODS CLASSES
(as observed during visits of Phase Two) N = 42

Topic	Actual Time (mins.)	Corrected Time (mins.)	Number of Occasions	Percent of all observation time on this topic
Laboratory work (pedagogy)	150	179.3	8	12%
"New" courses	95	161.1	8	11%
Planning	138	137.0	9	9%
Evaluation	100	123.7	7	8%
Demonstration and lecture-demonstration	115	112.0	6	7%
Analysis of teaching (TV)	74	101.9	3	7%
Nature of science	93	98.9	4	6%
Teaching by inquiry	63	91.0	4	6%
Dead time and Transition	124	74.9	12	5%
Miscellaneous	86	72.8	10	5%
Learning	49	56.9	5	4%
Facilities, equipment, materials	57	51.0	3	3%
Behavioral objectives	64	45.3	2	3%
"Professional" topics	29	44.2	3	3%
Lecture	31	39.6	3	3%
Field trips	16	32.0	1	2%
Content	21	21.7	4	1%
Individual differences	23	21.0	2	1%
Curriculum, general	20	20.0	1	1%
Scientific skills	20	20.0	1	1%
Audio-visual equipment	25	15.5	3	1%
Analysis of "mock" teaching	16	14.6	2	1%

unit or lesson on "objectives of science teaching" than he is on many of the other topics mentioned. Nonetheless, the general question of developing a philosophy of science teaching would be expected to permeate the course.

4. Teaching Techniques in Methods Courses Observed

Instructors of science methods courses commonly used a technique not mentioned in the questionnaire (Booklet B). This was a cross between a lecture, a discussion, and a question and answer period. The exact name given to the technique may be dependent upon whether the instructor himself defines the technique ("a discussion"), the student describes it ("a lecture"), or a disinterested observer catalogues it ("modified lecture").

The "modified lecture" has a number of clear and well-defined characteristics.

1. Although the instructor may overtly and covertly desire to lead a discussion, he still plays a commanding part. Simply on the basis of the number of times he speaks and the total length of time for which he speaks, he is clearly the outstanding (and probably most influential) member of the group.
2. In almost all cases the physical set-up of the room directs attention to the instructor. Rarely are chairs arranged so that the class members can physically confront each other as they would in a discussion; but instead, students are usually facing the front of the room--and the instructor.
3. The interchange of conversation is likely to be teacher-student rather than student-student. It is common to find a student responding to the teacher, the teacher addressing a student, but seldom, a student speaking to another student.
4. The modified lecture often approaches a "substitute lecture" in which the instructor employs student responses to fill in missing words. Thus the students are given the feeling of participating in the lesson, although this is not the case. Actually the instructor has a clear idea of where he is going to go in the lesson and does not allow student participation to side-track his thoughts. He tends to reinforce ("good", "yes") those responses which he needs to further develop his own point, while ignoring those which lead off on a tangent, even though the latter thoughts may be very pregnant.
5. The pattern of teacher talk is quite different from the pattern of student talk. In keeping with the underlying "lecture" nature

of the lesson, the teacher is likely to speak at fairly long intervals, the students at fairly brief intervals.

TABLE 64

TEACHING TECHNIQUES USED IN METHODS CLASSES (as observed during visits of Phase Two) N = 42

Technique	Actual Time (Mins.)	Corrected Time (Mins.)	Number of Occasions	Percent of all observation time on this topic
Modified lecture	478	485.7	19	32%
"Mock" teaching	219	203.3	8	13%
Pure lecture	150	187.3	13	12%
Dead time	146	102.1	13	7%
Group reports	44	88.0	3	6%
Tests	76	85.0	3	6%
Guest speaker	44	80.0	2	5%
Individual reports	59	66.4	5	4%
Discussion	46	63.0	4	4%
Panel (faculty)	24	40.0	1	3%
Visit to school	40	40.0	1	3%
Student laboratory	26	33.1	3	2%
Group activities	24	29.1	2	2%
Av by instructor	4	27.9	2	2%
Student demonstration	5	8.0	2	0.5%
Question and answer	7	4.0	2	0.3%

The reader may recognize this technique as a very common form of teaching encountered at the high school level. Irrespective of opinions as to whether this is a good or bad technique, valid or invalid, note the close parallel between how high school teachers teach and how they were taught in their methods course.

Table 64 shows that the modified lecture was observed in almost half of the classrooms observed, for a total period of time more than two and a half times greater than the next most common teaching technique. If the time spent in "pure lecture" is included with the time spent in "modified lecture", over

40% of all the teaching time is accounted for (the proportion is even greater when the "dead time" is omitted).

The second most popular methodology employed by the methods instructors themselves was "mock teaching" in which students in the methods class assumed the role of high school teacher and taught a science class to their classmates. Beside the two forms of lecture, this was the only other teaching technique commonly observed.

The discrepancies between the information reported in Table 64 and that reported in Table 54 are important. The technique most commonly used in methods courses, as reported by the instructors themselves, was discussion, for which the Delta value of 592 was almost 100 points higher than for any other technique observed. Only when we extend the definition of discussion lesson to include "modified lecture" do the data in the two Tables agree. This illustrates the difficulty of gaining clean data from questionnaires.

Some confirmation of the nature of the modified lecture is found in an analysis of the teacher-pupil-talk patterns summarized in Table 65. On any measure, teachers in the modified lecture situation talk more total minutes and more minutes per speech than do students. On the 20 occasions on which a count was made the average length of time spent in talking by the teacher was 1045 seconds; the average length of time for all students was 305 seconds. In only one class did the teacher talk for less than 200 seconds; in 40% of the classes, the total student talk for all students was less than this figure. In only two classes did the students as a group talk more than 600 seconds; 65% of the classes had more than that amount of teacher talk.

If the total amount of time that the teacher (or all students taken together) spoke is divided by the number of separate speeches he (or they) made, the "average talk" for each can be computed. The highest average student talk was 16 seconds per speech; only three instructors had an average teacher talk record that low. The mean "average teacher talk" was nearly five times the mean "average student talk." This means that in the average case the teacher spoke just about as many different times as all of the students taken together, and the average length of his speeches was about 5 times as great as that of the students.

Whether the modified lecture is a good or bad teaching technique is not the question here. The data in Tables 64 and 65 make clear that science methods classrooms are strongly permeated by teacher talk.

TABLE 65

PATTERNS OF STUDENT AND INSTRUCTOR TALK DURING CLASSES OBSERVED IN PHASE TWO

Patterns	Instructors	Students	Others
Number of Observations	20	20	3
Seconds of Talk:			
Total	20,900	6098	1761
Mean	1045	305	587
Median	985	232	596
Range	29-2669	12-934	356-809
Number of Separate Speeches:			
Total	664	747	80
Mean	33	37	27
Median	27	28	28
Range	4-86	2-92	22-30
Average Seconds of Talk: (in seconds)			
Mean	37	8	21
Median	27	7	21
Range	6-130	3-16	16-27

B. Instructor Interviews

A total of 63 separate interviews with 73 different instructors were conducted. Four of these interviews were with non-teaching personnel and were of such an informal nature that they produced no pertinent data for the study and were not included in the analysis. Of the remaining 59 interviews 10 were conducted with more than one faculty member present, usually the department chairman and the instructor of the secondary science methods course. When both the chairman and the instructor were present, the former usually answered questions dealing with administrative matters and the latter answered questions concerning the specific methods course being taught at that time. The personal data summarized in the introductory sections below refers, in all cases, only to the instructors interviewed; no data for department chairmen are included.

1. Personal Data Regarding Subjects

Fifty of the 59 instructors interviewed were men. Nineteen of the subjects (32%) held only the masters degree. Another 16 (27%) hold the doctor of philosophy and the remaining 24 (40%) hold the doctor of education. Most commonly the instructor's highest degree was in the field of science education. Six of the subjects (10%) had degrees in education and 18 (31%) had degrees in science. Well over half of those interviewed have received their highest degree within the last 8 years. Table 66 shows the distribution of subjects according to the number of years since earning their highest degree.

TABLE 66

NUMBER OF YEARS SINCE HIGHEST DEGREE WAS AWARDED (among 59 instructors interviewed)*

Number of years	Number of instructors
1 - 4	21
5 - 8	15
9 - 12	10
13 - 16	4
17 - 20	5
more than 20	3

*No information for one instructor

Only 21% of the instructors have taught in the elementary school. Nine instructors (16%) have had from 1 to 6 years of experience at the elementary level, and the remaining three (5%) report more than 10 years of experience in the elementary school.

In contrast, about a quarter of the instructors (15 subjects, 26%) have had more than 10 years of secondary school teaching experience. The secondary teaching experience of the 59 instructors is summarized in Table 67. A majority of the interviewees report having had regular, full-time teaching experience in the secondary or elementary classroom within the last 5 years. At the other extreme, almost a quarter have not taught full time at the secondary level in more than 15 years. Table 68 provides a breakdown of subjects according to the number of years since this last full time school teaching experience.

Twenty-three of the instructors were currently teaching a course in the general methods of teaching science; 14 were teaching a course in the methods of teaching biological sciences; 11, a course in the methods of teaching physical sciences; 2, in the teaching of earth science; 3, in the teaching of junior high general science; 1, in the teaching of physics; 1, in the teaching of chemistry; and 3, in the teaching of some other science or science-related subject.

TABLE 67

YEARS OF SECONDARY SCHOOL TEACHING EXPERIENCE (among 59 instructors interviewed)*

Number of years	Number of instructors
None	3
1 - 2	4
3 - 4	17
5 - 6	5
7 - 8	14
9 and over	15

*No information for one instructor

In all of these analyses the instructors interviewed do not closely parallel any one of the three groups (B, C, or D) identified in Phase One. Apparently the subjects in this second part of the study represent some sort of mix among all three of those groups.

TABLE 68

YEARS SINCE LAST REGULAR SCHOOL TEACHING (among 59 instructors interviewed)*

Number of years	Number of instructors
0 (currently teaching)	2
1 - 5	27
6 - 10	10
11 - 15	3
more than 15	11

*No information for 6 instructors

2. Administrative Aspects of the Science Education Program

The science education program at the institutions visited was located within one of three departments: the science department (14 cases), the department or school of education (16 instances), or in a separate department or division of science education (7 cases). In the seven instances in which a separate division of science education exists, the division is most closely connected with the department of science in three instances, with the school of education in three instances, and jointly related to both in one case. In the latter instance the department of science education seems to be an essentially independent and autonomous department within the university.

Twenty one of the institutions visited had only an undergraduate program in science education, 13 had both graduate and undergraduate programs, and 3 had only graduate programs.

At the institutions visited, questions were asked about the way in which science education programs are developed: who was responsible for policy decisions and how such decisions were reached. Two generalizations are possible. First, decision-making with regard to the science education program at some institutions is sometimes informal and often nebulous. A number of the instructors were not clear about such matters as to how course requirements for prospective science teachers were decided upon or who was ultimately responsible for making that decision. Many instructors had little or no role, either formally or informally, in the development of the overall science education program. Their responsibility was primarily in the area of developing their own methods course.

Second, among those institutions where there was a clear focus of responsibility, there was a great diversity of plans for formulating science education policy. Where science education is located in the department of science, the chairman of that department, alone (1 instance), or in consultation with the members of the science department (4 instances) makes policy on the science education program. Whenever there is a separate department of science education or a science teaching center, the department chairman, usually in consultation with his department members, assumes this policy-making role. Even then, however, some unusual arrangements can be found. At one science teaching center, for example, the department of science education was responsible for the elementary and graduate level programs in science education, but the secondary science education program was administered by the department of science.

A fairly common administrative pattern is to have a "Science Coordinator" who makes policy decisions essentially on his own (3 cases, in all of which the coordinator was located in the school of education), with the approval of both departments of education and science (1 case), or in consultation with the chairmen of the individual science departments (in 2 cases). The most frequent arrangement, found at 8 institutions, for developing the science education program is, however, through an interdepartmental committee, a science advisory committee, or some other such group with representatives from both the school of education and the department of science with other administrative and instructional groups sometimes also represented. In this pattern, the interdepartmental committee establishes overall policy, program, and guidelines which are then administered by the separate departments.

3. Relationship Among Science, Education, and Science Education Staffs

Although no specific attempt was made to ask about the relationship between the school of education and the department of science, a fair amount of information was volunteered by the subjects. In 12 instances the methods instructor emphasized the strong and close ties between the two departments and the division of science education. In 7 cases he was anxious to note the strained relations among science, education and science education. In most of the former cases the "strong and close" ties tended to be formal. That is, a number of institutions offered joint appointments to those in science education (4 cases) or arranged for members of the faculty to teach both science and science education courses (mentioned 5 times). A few instructors pointed out that members of the science department were particularly interested in the new courses in school science and had altered their own college level teaching as a result of the introduction of these courses or were offering in-service courses in methods of teaching the new sciences. Finally, instructors at seven of the institutions mentioned that there were "friendly" informal contact between science methods instructors and members of the science department.

Although less frequently mentioned, examples of bad feeling between science and education were much more extreme. Typical of some of these comments are the following:

> "The college of education doesn't trust me because I'm in the department of science and the department of science doesn't trust me because my degree is in education."
>
> "They (the college of education) have no interest or knowledge of what we're doing. The only way we know what's going on in their courses is through students who are in both courses (science education and education)."
>
> "The chemistry department here (a teacher-training college, former normal school) isn't interested in training teachers."

"I've never been over to the education school." (science methods instructor)

In some institutions the science education program is in a very ambiguous position. Being neither science nor education, it is neither fish nor fowl. Some institutions are apparently able to adjust to this situation and make the science education staff feel "at home." Elsewhere this atmosphere does not exist, and the members of the science education staff are likely to have a paranoic, "nobody loves us" feeling. There does not seem to be any clear national trend in either direction among the institutions visited. While some instructors report that relations among departments have improved over the years, others feel that the situation is deteriorating and that the departments are moving farther apart.

The status of the science education staff seems particularly confused in state colleges which have recently been changed from teacher training institutions to all-purpose colleges. Traditionally the science departments in these institutions were devoted almost entirely to the preparation of secondary and elementary school science teachers. Today, with an influx of more science-oriented instructors in the science department, the philosophical outlook of the science department may undergo a drastic change. The newer, more discipline-oriented members of the science department may be more concerned with preparing scientists and candidates for graduate school in science than with the preparation of teachers. In such a department one may find older staff members who have degrees in science but have spent their lives in teacher training, younger staff members who have their degrees in science and have little or no interest in teacher preparation, and younger staff members who have their degrees in science education and are interested in the preparation of prospective science teachers. The frictions which may arise within such a department, let alone between it and the school of education, are not difficult to foresee. As mentioned previously, some institutions have apparently found techniques for handling these inherent troubles effectively.

4. Follow-up Programs

Follow-up programs would seem to be a necessary and integral part of every science education program at the collegiate level. The only really effective way of finding out whether the program is functioning as it was designed to function is to find out how its graduates behave. Surprisingly, there is almost no formal procedure for keeping in touch with the graduates of science education programs in any of the institutions visited. At a number of institutions, the director of placement, the alumni association or a graduate student may carry out some (usually) simple follow-up study of an occupational type: where is the graduate teaching, what subjects does he teach, what is his salary, etc. Twenty-two of the twenty-nine instructors reported no formal plans for follow-up study although sixteen said they had occasional or frequent "informal" contacts with some of their former students. Only one of those interviewed produced from memory any information on his graduates.

Three of the institutions (University of Iowa, University of Toledo, Oregon College of Education) did report having a detailed system for following the progress of their graduates. At the University of Toledo, for example, every three years a lengthy questionnaire is sent to each of the program's previous graduates. The results of this study are available to the science education staff and are apparently, used in the re-evaluation and restructuring of the science education program. This very thorough approach to the study of its graduates is, unfortunately, rare in science education.

5. Practice Teaching Programs

During the interview, questions were asked about the institution's program in practice teaching. These questions provided a cross-check on the responses in the institution's questionnaire. The two sets of data were consistent. During the discussion of the practice teaching program, however, many instructors commented on the effectiveness of the existing practice teaching format. Of the 25 who replied, eight were pleased with the current program. Four others had some complaint, mainly that the cooperating teachers were ineffective.

Frequently the instructors said that the college had far too little control over the selection of cooperating teachers. Particularly in urban areas, where several colleges compete for use of a city's schools for their practice teachers, the college has little or no control over the selection of cooperating teachers. The job is passed out as a political plum (when the financial gain makes it worthwhile), or is distributed arbitrarily by the local principal. The local school system certainly does not attempt to assign practice teachers to poorly trained cooperating teachers; on the other hand, it generally does nothing to guarantee that the teacher assigned will have any particular competence (other than a willingness to take a practice teacher). Instructors agreed that the college usually has nominal veto power over the choice of cooperating teachers, but that otherwise, the selection of such teachers is basically a random selection.

Few of the institutions report having any specific requirements for either the college supervisor of student teachers or for the high school cooperating teacher. In most cases, being on the faculty of education, science, or science education is qualification enough for being a college supervisor. Three institutions reported having requirements of degrees and years of experience for the cooperating teacher, but practical problems often prevented their being applied.

6. Desirable Qualities in the Prospective Science Teacher

The interview with instructors sought to identify his views about qualifications (both cognitive and affective) needed by the prospective science teacher. Two questions in the interview schedule closely paralleled the "rationale" questions in the questionnaires of Phase One (see page 8): 1) what kinds of knowledge, skills and attitudes the instructor would like to have his students possess before they entered the methods course, and 2) what kinds of knowledges, skills, and attitudes the student should acquire during the methods course. To summarize the responses, the analysis scheme developed for the rationale questions from Phase One (described on page 8 of this report) was employed. Each response made during the 59 instructor interviews was recorded as (1) mentioned or (2) emphasized, and then weighted as to the degree of emphasis. All responses were then classified into one of the ten major Groups developed for the analyses and presentation of the rationale questions.

Tables 69 and 70 summarize the results of this analysis. Column A of each table lists the number of times each Group was mentioned. Column B records the number of times the topic was stressed by the instructors. Column C is a weighted sum of columns A and B with each tally in column A being assigned a weight of 1, and each tally in column B assigned a weight of 2. Column D gives the percentage of all responses for each Group. Column E gives the sum of all Differential Emphasis Index scores for each group and shows the relative degree of emphasis assigned to each of the groups by all instructors interviewed. Column F is the per cent of all DEI scores in each Group.

Table 69 shows that about half of the instructors' preferences for pre-methods competencies lie in the area of knowledge of science content. Between them, Groups 1 and 2 account for 42% of all responses. The "science-related" attitudes included in Group 9, including the importance of a love of science and a desire for scientific attitudes in the prospective science teacher, accounting for another 5% of all responses, might also be included in this general category.

TABLE 69

ESSENTIAL ELEMENTS IN THE PREPARATION OF THE SCIENCE TEACHER, PRE-METHODS
(Based on Responses in Instructor Interview)

Group	A*	B	C	D	E	F
1 Content	48	31	110	26%	18.45	31%
2 Nature Science	33	10	53	13%	5.90	10%
3 Students	44	6	56	13%	6.85	12%
4 Instr. Skills	13	0	13	3%	1.60	3%
5 Other Ped.	20	2	24	6%	3.30	6%
6 Familiarity	22	3	28	7%	3.58	6%
7 Objectives	10	0	10	2%	1.53	3%
8 Person-person	29	11	51	12%	6.55	11%
9 Person-thing	35	13	61	14%	8.53	15%
10 Liberal educ.	13	1	15	4%	2.43	4%

TABLE 70

ESSENTIAL ELEMENTS IN THE PREPARATION OF THE SCIENCE TEACHER, METHODS OBJECTIVES
(Based on Responses In Instructor Interview)

Group	A*	B	C	D	E	F
1 Content	15	0	15	5%	2.88	5%
2 Nature Science	18	1	20	6%	4.40	7%
3 Students	19	1	21	7%	4.43	8%
4 Instr. Skill	89	4	97	31%	16.00	27%
5 Other Ped.	45	3	51	16%	7.88	13%
6 Familiarity	43	5	53	17%	12.12	21%
7 Objectives	33	3	39	12%	8.60	15%
8 Person-person	5	0	5	2%	0.70	1%
9 Person-thing	12	0	12	4%	1.28	2%
10 Liberal educ.	2	0	2	1%	0.45	1%

*See text for explanation of these columns.

The two other Groups accounting for more than 10% of the responses were Group 3 (Understanding of the Nature of Students and Ability to Work with Them) and Group 8, which is a collection of various desirable personality traits.*

Table 70 summarizes the instructors' responses to question 2, which focuses on the objectives of their science methods courses. The most frequently mentioned course objective is the development of the basic instructional skills (discussion techniques, use of the laboratory and audio-visual materials and equipment, etc.) needed by the teacher. Related pedagogical skills such as evaluation, planning and study of curriculum (Group 5) taken along with Group 4 accounts for just over 40% of all the objectives ot the science methods courses described by the instructors.

The category labeled "Familiarity Training" (Group 6), which includes such topics as knowing factual information about the teaching profession, (i.e., about journals, organizations, etc.), knowing what the practical aspects of classroom teaching are like, knowing the role of science in education, and so on, is the second most popular single Group. A fairly large proportion of the responses in this category (4.35 DEI points, about 7.5% all responses) come from instructors who see the methods classroom as a place for students to practice their teaching skills. Nine of the 59 instructors interviewed thought that anywhere from 25% to 100% of the time in the methods class should be devoted to mock teaching lessons by their students.

Group 7, "Objectives of Science Teaching," including such responses as understanding and writing objectives for science teaching (on a broad scope) and deciding what should be taught and how it should be taught, was the only other Group which received more than 10% of the responses.

7. Content Emphases

The data in Table 71, Content Emphases in Instructors' Courses, were

*No direct comparison between instructor responses in the interviews and responses made to the rationale question from Phase One can be made. The questions in Booklets A and B were phrased in terms of the overall teacher education program. The qualities and competencies which should be developed over a complete four (or five) year program were the subjects of these questions. The interview asked essentially the same question in two parts: i.e., what competencies and qualities should be developed <u>prior</u> to the methods course and what competencies and qualities developed <u>during</u> the methods course. There will be those who claim that the two questions are not equivalent and the results can not be compared. While such a position is understandable, there remains good reason to believe that the two sets of responses should be collected in two ways. Whenever feasible, a copy of the instructor's course outline was examined to find out what topics were covered in the course and how much time was devoted to each topic. When a specific course outline or syllabus was not available, the instructor was asked to provide this information verbally.

Column A in Table 71 reports the number of times each topic (summed according to Groups) was included in the courses. Column B gives the percentage of times each Group was mentioned. Column C is our estimate, in DEI scores, of the relative emphasis given to each topic. Finally, column D presents the percentage distribution of the totals in column C.

Table 71 shows that roughly 60% of the class time in the science methods courses of these instructors was devoted to specific instructional skills and related pedagogical topics. Besides these two, only Groups 6 and 7 produced any significant concentration of responses (of the order of 10%).

Comparison of Table 71 (what instructors actually do in methods classes) with Table 70 (what they say their objectives are) is instructive. The greatest differences occur in Groups 5 (Related Pedagogical Skills) and 6 (Familiarity Training). While Pedagogical Skills (Group 5) was mentioned as an objective of the methods course in only one case out of eight (13% of the time)it appeared in the content of methods courses more than twice as often--(30% of the time).

---

very comparable if not equivalent. The logic behind this belief is as follows: almost without exception the science methods course is taken in the senior year. Only one of the institutions visited offered the methods courses to juniors on a regular basis (although at many schools a student could enroll in this course in his junior year with special permission). In most cases, then, the methods course is followed only by practice teaching and a few (seldom more than two or three) courses in education or science. In view of the very limited contact science educators have with their student teachers, it may be assumed that little or no significant changes are produced in the student during practice teaching as a result of influence.

In essence, this argument indicates that while the phrasing of the two questions on "rationale" from Phase One and Phase Two might yield grossly different responses, it is doubtful whether it will, in fact, have this result. As a simple test of this hypothesis, and for whatever informational value it may have, Table 70* has been prepared for purposes of comparison with the data of Table 57. Table 70* is a simple combination of the data of Tables 69 and 70 in a single formulation of responses to the instructor interviews.

By far the largest share of topics mentioned in this Group fell in the category of study of new science courses. This topic alone accounted for 12% of all responses. On the other hand, the frequency with which Group 6 (Familiarity Training) appeared in the summary of content topics (about 10%) was about half that expected on the basis of the instructors' stated objectives (12% compared to 5%). The difference appears to be a de-emphasis in practice compared to objectives for two topics: practical teaching experience in the methods classroom, and analysis of the teacher's role. Teacher's role in the science classroom is virtually non-existent (0.3% of the responses) as a separate and specific topic covered in the science methods course.

8. Teaching Techniques

The techniques which the instructors interviewed employed in the teaching of their classes (Table 72) were generally similar to those reported in the questionnaires. On the basis of instructor reports, about one-fourth of the time in methods courses is spent in class discussion. The next most frequently used technique is mock teaching with about 20% of the total class time devoted

---

TABLE 70*

ESSENTIAL ELEMENTS IN THE PREPARATION OF THE SCIENCE TEACHER (Composite Table)

Group	A	B	C	D	E	F
1 Content	63	31	125	15%	10.66	18%
2 Nature Science	51	11	73	9%	3.90	9%
3 Students	63	7	77	10%	5.65	10%
4 Instr. Skills	102	4	110	17%	8.80	16%
5 Other Ped.	65	5	75	11%	5.59	10%
6 Familiarity	65	8	81	12%	5.67	10%
7 Objectives	43	3	49	7%	5.06	9%
8 Person-person	34	11	56	7%	7.25	6%
9 Person-thing	47	13	73	9%	9.80	8%
10 Liberal educ.	15	1	17	2%	2.87	2%

to this mode of instruction. "Pure" and "modified" lectures account for another 15% of the teaching techniques employed.

TABLE 71

CONTENT EMPHASES IN METHODS COURSES (As reported in Instructor Interviews)

Group	A	B	C	D
1 Science Content	14	3.4%	2.70	5.2%
2 Nature of Science	23	5.6%	3.20	6.2%
3 Students	25	6.1%	2.40	4.6%
4 Instructional Skills	133	32.4%	15.13	29.1%
5 Other Pedagogical Skills	118	28.7%	15.80	30.4%
6 Familiarity Training	36	8.8%	5.25	10.1%
7 Teacher's Behavior	51	12.4%	5.47	10.5%
8 Person-person Attitudes	3	0.7%	0.30	0.6%
9 Person-thing Attitudes	4	1.0%	0.43	0.8%
10 Liberal education	4	1.0%	1.32	2.5%

If the conclusions about the nature of the modified lecture and the instructors' perceptions of this form of teaching are correct (see page 73), the technique actually used most often by the instructors is a kind of modified lecture which would then account for just over 30% of all the classtime reported in the study. The methodology employed in most science methods classrooms has the instructor located at the front of the room giving a lecture or leading a discussion (41% of the time) or a student presenting a mock teaching lesson to his peers in the class (18% of the time).

9. Changes in Methods Courses with Time

Some attempt was made in the instructor interviews to find out how the methods courses had changed and would be likely to change over time. Of the 52 instructors interviewed, 19 (over one-third) were teaching the methods course for either the first or second time. Of the remaining 33 subjects, 15, or almost half, indicated that there had been no change over the past 5 years in the topics included in the methods course (see Table 73) and 14 reported no change in the techniques of instruction which they employed (see Table 74),

TABLE 72

TEACHING TECHNIQUES IN METHODS COURSES (as reported in Instructor Interviews)

Technique	Number of Instructors	DEI Rating	Percent of all DEI scores
Pure lecture	27	5.03	9%
Discussion	44	15.38	29%
Instructor demonstration	19	3.55	7%
Student lab	13	3.10	6%
Student demonstration	7	1.37	3%
Group activities and reports	6	1.65	3%
Individual activities and reports	7	2.42	4%
AV by instructor	12	2.41	4%
AV by students	3	0.48	1%
"Mock" teaching	31	10.20	19%
Outside assignments	10	1.60	3%
Visits and field trips	12	2.10	4%
Guest speakers	6	0.90	2%
Modified lecture	6	1.65	3%
Real teaching	2	0.75	1%
Demonstration teaching	2	1.25	2%

Of the changes in content which were reported, almost all were in one of two categories: 10 (32%) instructors indicated moving from a more philosophical to a more practical approach. Topics centered on specific methodology played a greater role in these courses in recent years than previously. Nine (29%) instructors reported a greater emphasis on the "new" science courses during the last five years. Only two of the instructors in contrast, saw a tapering off of emphasis on the "new" courses.

The most frequent response to the question on changes in the methodology used in the methods course dealt with various administrative changes in the course, for example, an increase or decrease in the number of credit or clock hours devoted to the course. No single change in this respect was mentioned often enough to indicate a kind of "trend" in changes in the way science methods courses are taught.

TABLE 73

CHANGES IN CONTENT OVER THE PAST FIVE YEARS (as reported in Instructor Interview)

	N	Percent of Respondents	Percent of Responses
First Year Teaching	14	27%	
Second Year Teaching	5	10%	
No change	15	29%	
More emphasis on practical topics	10		32%
Less emphasis on practical topics	3		10%
More emphasis on "new" courses and inquiry teaching	9		29%
Less emphasis on "new" courses	2		7%
More analysis of teaching styles and of the teacher's role	3		10%
Miscellaneous topics	4		13%
$N_{respondents} = 52$		$N_{responses} = 65$	

As to the future, the largest proportion of methods instructors foresee no specific changes in the way they teach their course or the topics included in it. Of those who do plan to make changes in the content of the course (Table 75), the largest number (14 cases, 24%) intend to pay greater attention to pedagogical techniques. That is, the mini-trend toward a more practical (in contrast to more philosophical or analytical) approach to methods noted in Table 73 appears to be projected into the future. With respect to study of the new science courses, there was an even division among those who intended to put greater emphasis on them and those who intended to place less emphasis on them.

About half of all replies regarding changes in methodology (summarized in Table 76) indicated either no expected change at all or a change only in the administrative format of the course (more or fewer credit hours, for example). A considerable proportion of the responses pointed to a greater use of audio-visual devices in the methods course. This meant, in the majority of cases, the use of video tape equipment for recording and analyzing mock teaching, or the use of TV tapes for the study of practicing teachers. Another group of instructors expected to employ more time for laboratory work by the students. This kind of activity is, usually, intended both to acquaint students with the philosophy, content, and methodology of new courses, and to expose students to some of the problems of laboratory preparation in teaching.

TABLE 74

CHANGES IN TEACHING TECHNIQUES OVER THE PAST FIVE YEARS
(as reported in Instructor Interviews)

	N	Percent of Respondents	Percent of Responses
First Year Teaching	14	27%	
Second Year Teaching	5	10%	
No change	14	27%	
Administrative changes (e.g., in credit hours)	11		38%
Greater variety in methodology	3		10%
Use of video tape	3		10%
More student involvement	3		10%
More contact with real classrooms	3		10%
More flexible course	2		7%
Miscellaneous	4		14%
$N_{respondents} = 52$		$N_{responses} = 62$	

10. <u>Improvements in the Science Education Program</u>

About half of the instructors interviewed indicated that they were essentially satisfied with the topics they now included in their courses (Table 77). They would use any additional time which became available to cover the same topics more thoroughly. The change in content of the courses desired by the instructors was most frequently a greater amount of time for studying pedagogical techniques. Fourteen of the respondents would use additional time in the methods course to deal with topics such as setting up and operating student laboratories, locating materials for science teaching, using audiovisual materials, etc. A few instructors felt that the methods course should be devoting more time to scientific topics ranging from the practical problems of using proper scientific techniques in the laboratory to more general problems on the nature of science.

TABLE 75

CHANGES ANTICIPATED IN COURSE CONTENT IN THE NEXT FIVE YEARS

Changes	N	Percent of Responses
None	22	38%
More attention to pedagogical techniques (including more on educational technology, N = 7)	14	24%
The "new" courses (more on them, N = 3, less on them, N = 3)	6	10%
Administrative changes in the school (e.g., modules)	4	7%
Scientific techniques (e.g., preserving specimens)	3	5%
Miscellaneous	9	16%
$N_{respondents} = 48$	$N_{responses} = 58$	

TABLE 76

CHANGES ANTICIPATED IN TEACHING TECHNIQUES IN THE NEXT FIVE YEARS
(as reported in Instructor Interviews)

Changes	N	Percent of Responses
None	18	29%
More use of audiovisual devices (video tape, CAI, etc.)	14	22%
Administrative changes (e.g., credit hours)	13	21%
More time for student laboratory work	9	14%
More time in the schools	6	10%
Miscellaneous	3	5%
$N_{respondents} = 48$	$N_{responses} = 63$	

TABLE 77

ALLOCATION OF ADDITIONAL TIME, CONTENT (as reported in Instructor Interview)

	N	Percent of Responses
No change	21	29%
More time devoted to topics now covered; no new topics suggested	14	20%
More on pedagogical methods (e.g., how to set up and run a lab, N = 7)	14	20%
More on scientific topics (e.g., nature of science, N = 2, scientific techniques, N = 2)	9	12%
More on "new" courses and inquiry teaching	5	7%
More on evaluation	4	6%
Miscellaneous	5	7%

$N_{respondents} = 52$ $N_{responses} = 72$

TABLE 78

ALLOCATION OF ADDITIONAL TIME, METHODOLOGY (as reported in Instructor Interview)

	N	Percent of Responses
No change	20	31%
More observation and participation in real classes	15	23%
More teaching practice ("mock" and real)	10	15%
More student activity (e.g., laboratory work)	8	12%
More independent work among students	4	6%
More field trips	4	6%
More use of education technology	2	3%
Closer contact between methods and practice teaching	2	3%

$N_{respondents} = 52$ $N_{responses} = 65$

The instructors also indicated a strong need for students to have more first-hand contact with real teaching experiences. Twenty seven (43%) of the replies in Table 78 suggest that the students have more teaching practice in the methods classroom or in real classrooms and more observation and participation in actual science classes. The next most frequent change suggested for science methods class methodology would be an increase in the amount of student laboratory work.

Over the past decade there has been an increased emphasis on fifth year programs for the preparation of science teachers. In the nation's two most populated states (New York and California) a fifth year of college work is now required in order to obtain permanent certification. Those interviewed in this study were asked whether they thought an additional year of college preparation were desirable for the prospective science teacher and, if it were, what courses the instructor would include that are not now available to or taken by students. In those institutions at which only an undergraduate program was available, about one-fourth of the instructors said that they did not think another year's work was either necessary or desirable (Table 79). At six of the institutions the fifth year program was already either mandatory or available in a form which the instructor deemed adequate.

TABLE 79

PROPOSALS FOR CONTENT IN FIFTH YEAR (as reported in instructor interviews)

	N	Percent of Responses
Curriculum already exists	6	8%
Fifth year not necessary or desirable	17	23%
Science content courses (e.g., nature of science, N = 4, content courses, N = 15)	23	31%
General topics in education (e.g., educational research, N = 2, curriculum study, N = 3)	8	11%
Learning and educational psychology	6	8%
Measurement and evaluation	5	7%
Pedagogical methods	5	7%
Liberal arts	3	4%
English composition	1	1%

$N_{respondents} = 49$ $N_{responses} = 74$

Of those who did favor a fifth year and made recommendations for the type of courses they would include, a majority suggested additional content courses in science. Sometimes the replies were of a general nature, simply indicating that prospective science teachers needed more preparation in science, but more often the instructors suggested specific courses they felt their students should have. Twenty three of the 51 courses suggested (45%) were in the area of science. Another 24 responses (47%) dealt with education courses, in the broadest sense of the term. Everything from more advanced courses in science methods and courses in educational research to courses in measurement and evaluation, and learning and psychology were recommended.

TABLE 80

PROPOSALS FOR METHODOLOGY IN FIFTH YEAR (as reported in instructor interview)

	N	Percent of Responses
Curriculum already exists	6	15%
Not necessary or desirable	17	42%
Internship or clinical experience	14	34%
"Dry-run" in a "new" course	2	5%
Microteaching	1	2%
"Nuts-and-bolts" methods course	1	2%
$N_{respondents} = 41$	$N_{responses} = 41$	

In suggesting methodological changes in the hypothetical fifth year, instructors once more indicated their desire for greater participation in real teaching experiences by the students. Most frequently the change recommended was an internship or clinical experience in which prospective science teachers would have an intensive and, usually, long-range classroom experience with close supervision, preferably by a representative from the college staff in science education. Of the 18 responses to this part of the question, 14 were of this general nature.

11. Research in Science Education

What is the role of research in science education? To what extent has previous research on the preparation of science teachers influenced the nature of existing methods courses? How much are science methods instructors currently involved in their own research projects in science education? What type of research in science education ought to be taking place? These questions were asked during the interviews. Table 81 shows that 48 responses were made to a question regarding the research which instructors had used in the development of their own methods courses. They mentioned such studies carried out in preparation for and as a result of the new course projects, those reported in the psychological literature by Skinner, Bruner, Piaget, Ausubel, etc., those dealing with the Flanders interaction analysis techniques, etc. Another 19 said that they knew of no research that would be useful in this respect. We are forced to conclude that almost no research on the preparation of science teachers has had any impact on the way science methods courses are taught.

TABLE 81

RESEARCH EMPLOYED IN DEVELOPMENT OF THE METHODS COURSE
(as reported in instructor interview)

	N	Percent of Responses
None	19	28%
"New" course projects	11	16%
Doctoral theses (including the respondent's own, N = 4)	8	12%
Psychological research (Skinner, Bruner, Piaget)	7	10%
Microteaching	5	8%
"Flanders-type" research	4	6%
Miscellaneous (includes articles in JRST, N = 2, Ford Foundation's TEEP, N = 2, Klopfer's HOSC, N = 1, etc)	13	19%
$N_{respondents} = 46$	$N_{responses} = 67$	

Just as methods instructors do not make much conscious use of research, so they do not take a very active part in research studies. When asked whether they were actively engaged in any research at the present time, 19 of the 43 instructors said no. Another 7 replied that they were involved in action projects as, for example, working with communities on curriculum projects. In only a marginal way would these be classified as "research." Thus we conclude that 26 of the 43 respondents (61%) were not engaged in research. Two other instructors were involved in research for their own doctoral thesis. The remaining 15 instructors supplied the list of topics found in Table 82 as the research studies in which they were currently involved. The studies are clearly of two types: "hard" research and survey studies like this.

TABLE 82

SCIENCE METHODS INSTRUCTOR'S RESEARCH (as reported in instructor interview)

Involved in no research	19 (50%)
Action projects	7 (18%)
Thesis research	2 (5%)

Research topics mentioned (10 respondents, 18 topics)

Explanatory styles project	Science background of elementary science methods students
Probabilistic model of teaching	Attitudinal changes in elementary science methods course
Critical points in teaching	Location of earth science teachers in the state of ________
Follow-up of Project Talent data	Legal liability of science teachers
Measurement of attitudes about science	Follow-up of science education graduates
Guilford patterns of PSSC teachers and their students	Characteristics of NSF participants
Advanced organizer based on Ausubel's general model	Effects of elementary science methods course on teacher effectiveness
Age level placement of conceptual schemes	Applications of the semantic differential
Behavioral and attitudinal changes during curriculum change	
Measures of student involvement and its relation to class success	

Most cases of the second kind do not appear to be particularly profound or to have especially wide implication. It is difficult to judge the status of various instructors' research projects, but it does seem likely that in at least a few cases the research is mostly in the planning, or "thinking about," phase. The interviewer developed the impression that participation in research is seldom a significant concern of the science methods instructor.

Although most science methods instructors are not actively engaged in research themselves, they do have a number of suggestions about the type of research which is needed in science education. Out of 109 responses from 31 instructors, the largest single group concerned programs for the preparation of science teachers. Thirty three suggestions dealt with such topics as:

1. What is the effectiveness of various techniques used in teacher preparation? (N = 7)
2. What happens to the graduates of teacher education programs in science? (N = 5)
3. How effective is any given science methods course? (N = 4)
4. What should be the relationship of schools and colleges in teacher education? (N = 2)

5. How can we increase communication among methods instructors? (N = 2)

Twenty responses concerning the nature of the high school science curriculum include such suggestions for research as:

1. What should we teach in high school science? (N = 6)
2. What "hard" evidence can we obtain about the "new" science courses? (N = 6)
3. How can we achieve articulation in school science, 1 through 12? (N = 3)

None of the other groupings of responses accounted for more than 10% of all the suggestions (see Table 83 for an accounting of these responses). The kind of suggestions included in the seven remaining categories included the following:

Teaching techniques:

1. How effective are various teaching techniques? (N = 2)
2. What kinds of questioning behavior should be used? (N = 1)
3. What methods should be used in teaching biology in the secondary school? (N = 1)

TABLE 83

TOPICS SUGGESTED FOR RESEARCH IN SCIENCE EDUCATION (as reported in instructor interviews)

	N	Percent of Responses
Preparation of the science teacher	33	30%
Curriculum in the schools	20	18%
Teaching techniques in the schools	10	9%
Learning	10	9%
Analysis of the teaching act	9	8%
Evaluation	8	7%
Characteristics of students	7	6%
Characteristics of teachers	5	5%
Miscellaneous	7	6%
$N_{respondents} = 46$	$N_{responses} = 109$	

Learning:

1. How does one teach and measure affective learning? (N = 3)

2. How do students learn abstract concepts? (N = 2)

3. At what age level can various scientific concepts be learned? (N = 2)

Analysis of the teaching act:

1. Further research on interaction analysis. (N = 5)

2. What are the various teaching "styles" and how does the teacher develop one of them? (N = 2)

3. How does one teach abstract ideas through inquiry (N = 1)

Evaluation

1. "Research on evaluation" (N = 5)

2. Effect of various teaching styles on learning (N = 2)

Characteristics of students

1. How can we interest more kids in science? (N = 3)

2. What are adolescents like? (N = 2)

Characteristics of teachers

1. What are the characteristics of (good) teachers? (N = 3)

2. What factors prevent teachers from innovating? (N = 2)

12. Science Teaching in the Future

The final question in the interview encouraged instructors to speculate about the future of science education in America. They were asked what they thought science teaching 15 or 20 years from now would be like. How would it be different, if at all, from science teaching in 1968? The most common responses were about a vastly increased role for educational technology. Although such items as computer-assisted instruction and closed circuit television were specifically referred to by some of the respondents, the majority of those who mentioned the new technology felt that electrical "gadgets" of various types would be much more available. Twenty-four (18%) of the responses were of this type.

Often an instructor, who referred to an expanded role for educational technology in the science classroom, added two corollary changes: more individualized instruction for students and an altered role for the science teacher. Specifically, respondents felt that with more "hardware" in classroom, students would be able to work at their own speed and programs would be more tailored to individual differences. The teacher also would have more time to work on a one-to-one basis with students rather than working with larger groups as they tend to do now. All of this implies that the teacher will be less an information dispenser or director of class activities and more a guide, advisor, and orchestrator of learning experiences.

TABLE 84

THE NATURE OF SCIENCE TEACHING IN THE NEXT GENERATION (as reported in instructor interviews)

	N	Percent of Responses
No change expected	11	8%
School science curriculum More inquiry teaching, N = 13 More humane, N = 6 More on social aspects of science, N = 3 More unified science, N = 3	31	23%
Educational technology (wider use)	24	18%
Role of the teacher The teacher as "guide", N = 8 The teacher as "orchestrator", N = 7	23	17%
More individualized instruction	19	14%
Administrative changes (e.g., modules, team teaching)	12	9%
Greater implementation of educational theory (e.g., application of learning theory)	7	5%
Miscellaneous	6	5%

$N_{respondents} = 46$ $N_{responses} = 133$

A few of the instructors felt ambivalent about the future of science education and offered two answers, an optimistic one and a pessimistic one. In their darker moments, these instructors seemed to feel that science teaching twenty years from now would be little different from what it is now. Generally the feeling was that there is a good deal of need for change, but change in education is so slow that it might well not have arrived in a decade or two. In their brighter moments these same instructors had even rosier visions than the "average" respondent. They sensed an enormous potential for change and improvement which educational technology would make available. In their dreams of "the best possible world" they painted scenes of intelligent, highly educated and well-trained teachers using technology as a tool to create imaginative, warm, humane, and exciting school science classrooms. Unfortunately, those who expressed this kind of ambivalence also revealed, when pressed, that they really believed that their pessimistic thoughts were more realistic.

A fairly large group of responses to this "dream question" concerned the way in which the school science curriculum would change. Thirteen respondents felt that inquiry teaching would, by the 1980's , become more widely practiced. Six more believed, somewhat hopefully, that science instruction in the schools would become somewhat more humane. Generally this meant that school teachers would be less oriented toward the discipline to the detriment of personal development of individual students. In a similar vein, three respondents predicted that social aspects of science would shortly begin to play a more important role in the school science curriculum.

The only other group of responses of significant size concerned various administrative changes to be expected. Such devices as the use of modules in scheduling classes and the greater use of team teaching were seen by twelve (9%) of the instructors as being a regular feature of science education in the next decade.

C. Student Questionnaires and Student Interviews

Twenty two of the institutions visited were sent copies of student questionnaire X for distribution to current members of the science methods courses. A total of 373 questionnaires were returned by these institutions (see Table 5). Each student who returned a copy of questionnaire X was, at the end of the course, sent a copy of questionnaire Y. One hundred seventy two questionnaires Y were returned by these students, an overall response rate of 46.2%. Although the overall rate was low, Table 5 shows that for a number of institutions the response rate was quite high.

Information was also collected from students through 203 interviews. Most of the students interviewed also completed questionnaires X and Y.

1. Student Questionnaire X

The "typical" respondent to questionnaire X was a male student (61%), between 20 and 25 years of age (65%), single (71%), and from a household in which the father was either a businessman or a skilled laborer. Other than the 65% who were in the 20-25 age bracket, 14% were younger than 20 years of age, 11% were between 26 and 30, and 11% were over 30. Fifty five (15%) of the respondents were juniors, 180 (49%) were seniors, 116 (32%) were graduate students, and the remaining 13 were special students. The occupational groups most frequently reported for fathers are "business (owner, manager)" (19%) and "skilled labor" (20%). Another 14% of the fathers were classified as being in an academic profession, 14% in a non-academic profession, 11% as being a business employee (clerk, agent, salesman, etc.), 5% as a farmer, and 17% in some "other" occupation.

Only 15% of the respondents indicated that science education was their undergraduate major. By far the largest number of students (149, 41%) are majoring in the biological sciences. The physical sciences were next most popular (77 majors, 21%). Other majors were education (13, 4%), general science (17, 5%), some other field of science (12, 3%) and the humanities (7, 2%). Thirty three of the respondents (9%) mentioned some other major field; most commonly this was physical education. Each student also listed his undergraduate minor, as shown in Table 85.

Participants in the study were asked two questions about their decisions to become science teachers: (1) what factor among a number of choices listed was most influential in directing him (or her) into science teaching as a career and (2) at what age the student selected science teaching as a career.

TABLE 85

MINOR FIELDS OF STUDY (as reported by 364 student-respondents to questionnaire X)

Field	Number
Physical science	81
Biological science	55
Education	53
Science education	27
General science	24
Humanities	24
Other science	23
Other	69

Table 86 indicates that by far the largest number of respondents were unable to specify any particular influence other than a "general interest in teaching" (139 respondents, 33%). As might be expected, the influence of some high school teacher was mentioned most often as the specific factor affecting the student's choice of science teaching as a career.

Most students chose science teaching as a career relatively late, either in college (183 students, 51%) or after college (48 students, 13%). Only about a quarter of the students reported having made this committment as early as high school (103 students, 29%) or earlier (26 students, 7%).

TABLE 86

FACTORS AFFECTING CAREER CHOICE (as reported by 364 respondents to questionnaire X)

Factor	Number
General interest	138
High School teacher	74
Change from science field	46
College teacher	40
Parent	16
Peer	16
Other relative	10
Elementary teacher	3
Other	41
No specific factor	41

Questionnaire X also requested students to report the number of hours they will have completed in three general areas (science, education, and other academic subjects) by the time they complete the degree on which they are now working. The quartile points for both the bachelor's and master's candidates are given in Tables 87 and 88.

TABLE 87

CREDIT HOURS COMPLETED FOR BACHELOR'S DEGREE IN THE TEACHING OF A SCIENCE (as reported in questionnaire Y) N = 225

Area	Q_1	Q_2	Q_3
Education	20	24	28
Science	40	52	61
Other Academics	49	60	70

a. Student Expectations of the Science Methods Course and Practice Teaching Experience

The experiences students expect during the science methods course parallel the general objectives stated by the instructors. When students were asked what kind of things they want to learn as well as what things they thought might have been planned for them, they mentioned topics, as Table 89 shows, most frequently in Group 4 (Pedagogical Techniques) and Group 5 (Related Pedagogical Skills).

TABLE 88

CREDIT HOURS COMPLETED FOR MASTER'S DEGREE IN THE TEACHING OF A SCIENCE
(includes hours earned in undergraduate work; as reported in questionnaire Y)
N = 102

Area	Q_1	Q_2	Q_3
Education	22	26	32
Science	48	70	86
Other academics	51	66	90

The single topic most frequently mentioned by the responding students, 77, was "planning." In decreasing order, other topics were: "teaching methods" (N = 63), "setting up laboratories" (N = 48), "how to motivate students" (N = 43), "methods of evaluation" (N = 36), "sources of information and materials" (N = 34), and "study of curricula in science " (N = 34).

Some topics suggested by students were not stressed by the instructors interviewed. For example, students put greater emphasis on motivation ("how to get students interested in science"). In addition, students saw the methods course as an opportunity to practice teaching skills (N = 15), or to "find out what the problems in teaching science are (N = 24) and how to solve them (N = 14)". When a student mentions such "problems", he usually is referring to fairly specific things as, for example, how much homework to give, what grading system to use, etc.

Almost all of the students' expectations of the practice teaching experience can be classified into one of four categories: (1) Group 6, Familiarity Training, (2) Group 4, Pedagogical Techniques, (3) Self-understanding and self-confidence, and (4) Understanding of children. The largest number of students (53, 30%) looked forward to practice teaching as a chance to "find out what teaching is like," "find out what the problems of teaching science are and how they can be solved," and "how to put educational theory into practice." The second largest group of students, 136 (20%) expected to find out more about pedagogical techniques such as "how to set up labs", "how to maintain discipline," etc. Another group of student responses (24, 14%) focused on practice teaching as a means of bolstering his own self-confidence or deciding whether he was capable of and interested in continuing in teaching as a career. Finally, nineteen responses (11%) were concerned with using the practice teaching experience as a way of getting to know more about children.

TABLE 89

STUDENT EXPECTATIONS OF THE SCIENCE METHODS COURSE

Area		Number of responses
Group 4: Pedagogical methods		278
"Methods", in general	63	
Laboratory set-up	48	
Resources for teaching	34	
Demonstrations	23	
Discipline	19	
"How to teach"	19	
Specific pedagogical techniques	19	
Miscellaneous	50	
Group 5: Related pedagogical skills		214
Planning	77	
Motivation	43	
Evaluation	36	
Curriculum, in general	34	
"New" courses in secondary science	18	
Group 6: Familiarity Training		98
Group 7: Objectives of teaching science		38
"Self-confidence"		18
"New methods of teaching science"		18
"No value in course"		18
Other		54
$N_{respondents} = 292$	$N_{responses} = 736$	

b. <u>The Student's Image of the Science Teacher, Before Methods</u>

The image of the ideal science teacher which the student brings with him to the science methods course probably results from many experiences attained through the years. In questionnaire X students listed the knowledges, skills, and attitudes which they felt to be important in the secondary school science

TABLE 90

STUDENTS' VIEW OF DESIRABLE QUALITIES OF THE SECONDARY SCIENCE TEACHER

	1	2	3	4	5	6	7	8	9	10	n
Questionnaire X	298 / 20.7%	30 / 2.1%	116 / 8.0%	148 / 10.0%	122 / 8.5%	9 / 0.6%	126 / 8.7%	264 / 18.3%	291 / 20.0%	42 / 2.9%	1446
Interview	228 / 20.5%	56 / 5.0%	110 / 9.9%	92 / 8.3%	72 / 6.5%	31 / 2.8%	143 / 12.8%	178 / 16.0%	169 / 15.2%	34 / 3.0%	1113
Questionnaire Y	177 / 21.9%	30 / 3.7%	72 / 8.9%	80 / 9.9%	51 / 6.3%	8 / 1.0%	63 / 7.8%	143 / 17.7%	170 / 21.0%	14 / 1.7%	808

KEY:
1 = Knowledge of science content
2 = Understanding the nature of science
3 = Understanding children and the nature of learning
4 = Command of teaching methodology
5 = Command of related pedagogical skills
6 = Educational theory (nature of science education, etc.)
7 = Objectives of science teaching
8 = "Person-thing" attitudes (e.g., love of science)
9 = "Person-person" attitudes (e.g., love of children)
10 = Liberal education

teacher. Table 90, row 1, shows that considerable diversity exists between those qualities which the student seeks in the ideal science teacher and those which the methods instructor seeks (compare with Table 57). Although both equally emphasize the importance of knowing "science content" (Group 1), the methods instructors are much more concerned about a deeper understanding of the nature of science than are the students (13% vs. 2%). In addition, beginning students mention the importance of the whole range of pedagogical techniques and skills (Groups 4 and 5) only about half as often as do the instructors. Students seem to be much more concerned about the personal qualifications of the instructor, for example, a sense of humor. Similarly, students place much more emphasis than do their instructors (Group 9) on the teacher's interest in and enthusiasm for both science and the teaching profession.

TABLE 91

STUDENT'S PERCEPTION OF INSTRUCTOR'S IMAGE OF SCIENCE TEACHER

	1	2	3	4	5	6	7	8	9	10	n
Student Interview Responses	56 13.6%	15 3.7%	28 6.8%	36 8.8%	35 8.5%	26 6.2%	116 28.3%	48 11.7%	42 10.2%	8 1.9%	410

A relatively large number of students (N = 74) referred to the atmosphere of the science class room. Such suggestions as "teach the practical applications of science," (N = 22), "teach the class at the children's level" (N = 11), and "teach around students' interests" (N = 6) are typical of their personalistic view of the classroom.

2. <u>The Student Interviews</u>

A total of 203 students at 26 colleges and universities were interviewed. Almost all of these students (184, 91%) were enrolled in a science methods course. The other 19 had recently completed the comparable methods course. Only five of the students (2%) had already completed practice teaching, but an additional 30 had taught full-time in public schools, in institutions of higher learning or in the Peace Corps. Of the remaining 168 students, 34 (17%) were enrolled in practice teaching at the time of the interview while 127 (64%) would be enrolled during the following semester or the following year.

a. <u>The Student's Image of the Science Teacher</u>

During the interview students were asked about their perception of the ideal science teacher. Such a question had been included in both questionnaires X and Y. It was also included in the interview to reveal students' perceptions during the methods course, and to permit a comparison of the oral responses with those written. Although the interviews were spread over a fairly long period of time (about four months), an attempt was made to see students near the middle of their methods course. Every student interviewed had attended at least five class sessions.

The greatest differences between the data obtained during the student interviews (Table 90, row 2) and that collected in Questionnaire X (Table 90, row 1)are in Groups 7 and 9. Students tended to place more emphasis in the interview on the importance of the teacher's understanding objectives of science teaching (Group 7) and less emphasis on the importance of holding favorable attitudes toward science and toward the teaching profession (Group 9).

After the student had described the "ideal" science teacher, he was asked to identify the factors in his own background, which he believed influenced the development of his image. Seventy two students (17%) began by noting the undesirable features of various science teachers. In second place in the formation of their ideal image was reference to the instructor of the science methods course. The third most frequent reference was to some particular high school science teacher who served as the student's model.

b. <u>The Student's Perception of the Instructor's Image of the Science Teacher</u>

Since any instructor of the science methods course will have some image of the ideal science teacher, we may ask whether this image is apparent to his students. To answer this question, we asked each student to describe the instructor's image of the ideal science teacher. Table 91 shows virtually no correlation between the students' responses and either the instructors' expressed image of the science teacher (as reported in the questionnaire or in the instructor interviews) or the students' image of the science teacher reported in the interview. Generally the student mentioned the way in which he thought the methods instructor would like to have the science teacher operate in the classroom: "he should teach concepts, not just facts," "he should use the inquiry method", "he should teach the practical applications of science." The next most frequent response, made by 69 students, was: "My instructor would answer this question the same way I did." These responses are interesting because the attributes which the student had listed were often widely divergent from the instructor's responses to the same question. The student's stated image was NOT like that of the instructor's. Why is this so? Three explanations are possible. (1) The student may not know what else to reply. (2) Possibly the attitudes of student and instructor were, indeed, alike on the question. This might be the case if the instructor of the methods course had been able to exert a fairly strong influence on the student's thinking in the brief time in which he was in the course. (3) Perhaps a student enters the methods course with a definite notion of the ideal science teacher. This image acts something like a screen through which the instructor's views are filtered. Those of his views which are consonant with the student's are accepted and, indeed, reinforce the student's own feelings. Those views which are at variance with the student's are simply filtered out and ignored. All three of these explanations for the frequency of this one kind of response were applicable to at least some of the students interviewed.

The interpretation of responses to this question is not clear. At least we may consider whether the methods instructor <u>should</u> project some image of the ideal science teacher for his students. If so, what is the nature of that image? How did the instructor come to have that image, and how can he communicate it in a functional way?

During the interview an effort was made to find whether the student felt that there was any important disagreement between him and the instructor about the desirable chacteristics of a science teacher. Regarding inquiry teaching such a difference of opinion was reported quite often (N = 27). Generally the students felt that they would not place as much emphasis on inquiry teaching. Often they said: "Inquiry teaching is a good idea, but it won't work in "real" situations" or some similar statement. Apparently these students were at least casually informed about inquiry teaching, but were not convinced of its desirability or applicability.

The only other difference reported by more than 10 students was in the emphasis placed on content in science. Of the 15 students who mentioned this topic, most said that they would emphasize science content in the classroom much more than would the instructor of the methods course. They saw their role as being more a dispenser of scientific knowledge than did their instructor.

Finally, a few students (N = 8) felt that their instructor was being hypocritical in recommending inquiry teaching when "down deep" he would really have preferred to recommend the traditional, lecture-demonstration method (which was commonly practiced), and commented that the instructor talked a lot about the inquiry method, but never made use of it in the methods classroom.

c. Courses of Value in the Student's Collegiate Career

During his collegiate career, the prospective science teacher is expected to take courses in three general areas: science, education, and liberal arts. How do students see these courses as being relevant to the teaching tasks they are about to undertake? The student was asked, "What courses or other experiences have you had in college that you think may be useful or valuable to you in your career as a science teacher?"

As might be expected, students see the courses in science as having the most practical value to them as a teacher (Table 92). With only a few exceptions students subscribed to the view that science courses "gave them the knowledge that they needed to have in order to teach science." A few felt that their courses in science had been too specialized and that a survey course in their major field during their senior year would have been desirable. A number also felt that they should have had some exposure to inquiry teaching during their science courses, but that had almost never been the case.

A number of students realized that they had an extensive technical background in science, yet felt that they did not have much understanding of what science was all about. By the time they graduate, most of these students will have had close to 60 semester hours in the sciences. However, few students will have had more than 6-10 semester hours in field or research work, or in courses on the history or philosophy of science.

TABLE 92

MOST VALUABLE COURSES IN THE TEACHER EDUCATION PROGRAM
(as reported in student interviews)

Field	N
Science	
Content courses	205
Field work or research	35
History, philosophy, sociology of science	16
Mathematics	19
Liberal arts	
Philosophy, logic, music, art, etc.	46
Social studies	10
Education	
Favorable comments	115
Unfavorable comments	61
Composition and speech	40
Teaching experience	31
Peace Corps or work experience	10
Extra-curricular activities	6

$N_{respondents} = 203$ $N_{responses} = 594$

Therefore, we would expect these latter courses to be mentioned only 10-15% as often as "content" courses. In fact, research or philosophical courses were mentioned with enthusiasm and sincerity 25% as often as "content" courses. While a student often said: "Well, I guess all my science courses have helped in some way or another", the mentioning of a field study, research, or a course in the history, or philosophy of science was almost always accompanied by an exclamation such as, "The best course I've ever had," or "I never knew what science was all about until I took that course." Formal courses in education such as educational psychology and child or adolescent psychology, general methods of teaching, history of education, philosophy of education, and audio-visual techniques courses were mentioned 115 times. The responses include a number of luke-warm, general statements of the form,"Well, I'm sure my education courses will be of some help, but I don't exactly know how." The remarkable thing about student references to courses in education, however, is not the frequency with which they were commended as being useful, but the high frequency with which they were denigrated as being useless or a waste of time. Although the question was phrased to evoke only favorable responses (i.e., valuable or useful courses), many responses about education courses were negative. In general these students felt that education courses are irrelevant to their future career. A number of students suggested combining all the education courses into a single two- or three-hour course or into one six-week session. This is a severe indictment which cannot continue to be disregarded.

As might be expected, courses like mathematics and composition and speech were mentioned as potentially useful to the future science teacher. However, many students unexpectedly mentioned liberal arts courses, such as art, in very favorable terms. Apparently many a student envisioned himself as something of a Renaissance man. That is, he saw his obligation to students as transcending the dissemination of scientific knowledge. His job included elucidating the relationship of science to other disciplines, the role of science in society, and the relationship of science to other facets of the students' lives. This is the only point in the whole study where either students or instructors emphasized the importance of a liberal arts background for the science teacher.

d. Contributions of the Science Methods Course

Each student was then asked about the ways in which he expected the methods course in which he was enrolled be useful. Table 93 shows the topics most frequently mentioned.

e. Plans for 1968-69

At the conclusion of the interview the student was asked what plans he had for the academic year after graduation: usually this was the following year. Just over half of the students (102, 53%) said that they expected to be teaching high school science. A number said that they also intended to be doing part-time graduate work as well as teaching full-time. The next largest group, 36, who gave no definite answer, were men who were so concerned about their military obligation that they had made no specific plans for the following year. Twenty two students had definite plans for graduate work in science; six others expected to do graduate work in education. No other response was made by more than 12 individuals.

About one eighth of the students expressed serious reservations about continuing as a science teacher. If we total the disenchanted, those expecting to become graduate students (but might later teach), and those expecting to be in the military, we find that about one-fourth of the group would not be teaching the year after graduation. Some of the women might also choose marriage and not teach.

TABLE 93

POTENTIAL VALUE OF THE SCIENCE METHODS COURSE (as reported in student interviews)

Topic	N
1. Planning	44
2. Practice in teaching	43
3. Introduction to "new" courses	41
4. Introduction to inquiry teaching	34
5. "Methods" of teaching science	33
6. Materials and resources in teaching science	27
7. Day-by-day problems of teaching	25
8. Tests and evaluation	23
9. Laboratory set-ups	22
10. Study of objectives in science teaching	17
11. Audio-visual materials	16
12. Opportunity to develop a philosophy of science teaching	15
13. Changed outlook on the nature of science teaching	13
14. Development of self-understanding and self-confidence	13
15. Understanding of the nature of science	10
16. Research in science education	10
17. Analysis of teaching	10
18. Confrontation of educational philosophies	9
19. Introduction to "issues" in science education	8
20. Observation / participation experiences	8
21. Knowledge of children and how they learn	8
22. Knowledge of the profession	6
23. Other pedagogical techniques (nine mentioned)	34
24. No value in the course	8
$N_{respondents} = 203$ $N_{responses} = 477$	

3. Student Questionnaire Y

a. Topics and Techniques in the Methods Courses

Instructors were asked in questionnaire B to describe the topics and techniques which constituted their methods course. A checklist of 17 content topics and 15 teaching techniques was provided, and the instructor was requested to indicate for each the extent to which the topic was covered or the technique employed. An identical checklist of topics and techniques was presented in questionnaire Y to students in methods courses. The two sets of results are shown in Tables 94 and 95. (For comparison purposes, see also Tables 53 and 54.) The ordering of the topics in Tables 53 and 94 are roughly similar, and four of the five highest topics on both lists are the same.

The ordering of emphases on various teaching techniques is also similar in Tables 54 and 95. Students report that lecturing is the second most common teaching technique employed while their instructors rate lecturing fifth. There is the possibility, of course, that the sample of courses represented by student responses is different from that represented by responses to Booklet B. It is also possible that here again the instructor and student may have different perceptions of what constitutes a lecture and what constitutes a discussion.

b. Changes in Students as a Result of Methods and Practice Teaching

The second objective of student questionnaire Y was to have students identify the changes which they felt were produced as a result of their experience (1) in the science methods class, and (2) in the practice teaching experience. With regard to the first half of the question, most students felt that the greatest change they experienced was in pedagogical techniques (Group 4). One hundred ten (30%) said that they were better able to make use of the technical tools of teaching (leading discussions, finding materials, giving lectures, using audio-visual equipment, etc.). Another 80 (22%) responses dealt with the general category of "Related Pedagogical Skills" (planning, evaluation, curriculum study, etc.). The only other category receiving more than 5% of the responses was Group 7, "Objectives of Science Teaching". This group, which received 70 responses (19%), includes such topics as developing a philosophy of science teaching and deciding what ought to be taught in the science classroom and how it ought to be taught. About one-eighth of all respondents, 20 students out of 163 answering this question, reported that the methods course had little or no value for them.

TABLE 94

CONTENT EMPHASES IN METHODS COURSE (as reported in Student Questionnaire Y)
N = 172

Topic	Great Detail	Some Detail	Incidental	None	Delta
History and philosophy of science	9%	31%	48%	12%	333
Objectives of science teaching	48	44	5	2	485
History of science education	4	24	46	26	283
Planning	49	30	12	9	457
Individual differences	8	34	42	16	327
Evaluation	24	47	20	8	404
Texts	24	39	23	15	381
Resources	31	37	23	9	412
Science Curriculum	18	44	28	10	375
Discipline	9	31	37	23	312
Methods	42	38	14	6	453
Facilities	11	37	30	22	322
Content	15	42	29	14	360
Learning	11	37	34	19	331
Social implications of science	10	36	41	13	339
Lab set-up	18	37	26	19	352
Innovations in teaching	15	37	34	15	351

A small proportion of the 215 students responding to questionnaire Y found the question about practice teaching to be applicable. Only 83 of the students had been enrolled in practice teaching and, hence, were able to answer this part of the questionnaire. Of those responses which were received, Group 4, "Pedagogical Techniques," was considered most important by fifty six. Thus students felt that practice teaching, like the methods course itself, was most useful in developing specific pedagogical methods. Group 3, "Understanding the Nature of Students and How They Learn," was the next most frequently mentioned topic with 31 responses (14%). Next in order were Group 5 (Related Pedagogical Skills) with 23 responses (11%) and Group 1 (Knowledge of Science Content) with 22 responses (10%). No student reported not having benefited from the practice teaching experience.

TABLE 95

TEACHING TECHNIQUES USED IN THE METHODS COURSE
(as reported in student Questionnaire Y) N = 172

Technique	Very Often	Often	Sometimes	Seldom	Never	Delta
Lecture	30%	24%	23%	19%	5%	481
Instructor demonstration	5	19	37	23	15	364
Discussion	45	35	12	4	1	564
Student laboratory	19	18	19	15	29	374
Construction of teaching units	11	25	32	12	20	387
Construction of AV aids	6	16	25	20	33	315
"Mock" teaching	23	24	13	10	30	391
Student demonstrations	27	19	22	15	17	436
Group activities and reports	8	12	17	12	51	271
Term papers	7	8	13	15	58	239
Analysis of teaching (on video tape or films)	8	17	28	15	33	328
Closed circuit TV	5	6	14	8	66	216
School visits	4	9	17	17	53	243
Outside speakers	2	1	25	35	38	259
Microteaching	5	5	11	14	65	211

In the question on practice teaching, each student was asked to report the number of times he was observed by and had a conference with (1) his college supervisor and (2) his high school supervisor. The median and mode for Tables 96 and 97 are both 4. Over half (56%) of those responding to this question were observed by and had conferences with their college supervisors four times or less. Thirty three students did not reply to this part of the question, but did reply to the second part (regarding the participation of the high school supervisor). This may imply that a college supervisor was not available, that he was available but made no visits, or that the student chose not to supply this information. High school supervisors, on the other hand, were present for observation of the student teacher about half of the time, on the average (median = 50%, mean = 53.6%), and participated in conferences with the student teacher somewhat more frequently than that (median = 65%, mean = 55.5%) (Tables 98 & 99).

TABLE 96

NUMBER OF VISITS BY COLLEGE SUPERVISOR DURING PRACTICE TEACHING

Number of visits	Number of students
0	3
1 - 2	8
3 - 4	19
5 - 6	5
7 - 8	4
9 - 10	5
over 10	9

TABLE 97

NUMBER OF CONFERENCES WITH COLLEGE SUPERVISOR DURING PRACTICE TEACHING

Number of conferences	Number of students
0	9
1 - 2	5
3 - 4	16
5 - 6	8
7 - 8	0
9 - 10	6
over 10	9

It should be noted that 17 (20%) of the respondents reported that they had been observed everytime they taught and 22 (27%) reported a conference with his or her supervisor every day.

Most students felt that their college supervisors had been helpful during practice teaching. They were not able to point out in questionnaire Y, however, how they were helpful with much specificity. The largest groups of responses referred to the supervisor's helpfulness in offering "suggestions for improvements." (N = 23, 16%). Another group mentioned the supervisor as providing "encouragement and support, lifting my morale" (N = 20, 14%). An equal number saw the specific suggestions about mechanics of teaching ("not talking to the blackboard") as being the supervisor's most important contribution. Sixteen students (11%) said that the supervisor was helpful in providing advice about pedagogical techniques (e.g., techniques of lab set-up). This number of students also reported that they felt the supervisor was able to offer no assistance at all.

TABLE 98

PER CENT OF DAYS OBSERVED BY HIGH SCHOOL SUPERVISOR DURING PRACTICE TEACHING

Per cent	Number of students
0	4
1 - 20	27
21 - 40	3
41 - 60	14
61 - 80	11
81 - 100	27

TABLE 99

PER CENT OF DAYS CONFERENCES HELD WITH HIGH SCHOOL SUPERVISOR DURING PRACTICE TEACHING

Per cent	Number of students
0	5
1 - 20	25
21 - 40	4
41 - 60	7
61 - 80	12
81 - 100	30

The most common suggestion for changes in the supervisor's visits was that they be more specific and less theoretical (N = 17, 22%). Students tended to feel that the supervisors' dealing with general principles did not help them solve the day-by-day problems of teaching science. Sixteen students (21%) reported that they felt no change in the supervisory pattern was necessary;

they were satisfied with the observations and conferences as they exist. A number of respondents (N = 15, 20%) felt that simply having more observations and/or more conferences would be helpful. They referred to the fact that a supervisor who came in only a few times during the semester could not get a very good idea of the kind of classroom the student teacher had, especially when the visits were almost never on successive days. Finally, ten students (13%) suggested that the analysis conferences after the observations be made more critical and more intensive. They thought that the supervisor should be less concerned about upsetting the student teacher and more concerned with a thoughtful, thorough analysis of the lesson.

C. Desirable Qualities in the Science Teacher, Post-methods

The final question in student questionnaire Y returned once more to the question of the student's image of the ideal science teacher. For purposes of the longitudinal analysis, the question was included to see what changes, if any, had occurred in the "collective" image of the students participating in Phase Two of ths study. The responses to this question, tabulated in Table 90, row 3 would seem to indicate little or no change in this "collective" image. The four Groups which differ by more than 1% in the "before" and "after" responses are Group 1 (Science Content), Group 2 (Understanding of the Nature of Science), Group 5 (Related Pedagogical Techniques), and Group 10 (Liberal Education). This says that students after completing the methods course are somewhat less concerned about having science teachers know and be competent with such things as evaluation, planning, and curriculum development, but somewhat more concerned that the science teacher know the nature of science rather than just have a command of subject matter. They would also be more likely after the methods course, to emphasize the importance of subject matter command and less likely to insist upon the teacher's having a broad liberal education. No determination has been made at this point of the significance of these changes in proportions because of the statistical problems in dealing with this kind of data.

It should be pointed out also that a deeper analysis of this data is possible, indeed, is called for, and will be made at a later date. The question of changes or lack of them on an institution-by-institution basis will also be investigated.

Conclusion

The purpose of the Research on Science Education Survey has been to collect, analyze, and report basic statistical data on the nature of teacher education programs in the sciences. It has not been our purpose in this study to evaluate the data collected or to pass judgment on the programs studied. We prefer simply to present the report and allow its readers to form their own opinions on the implications which the study may have for their own programs and for the profession of science education.

It is possible, however, to highlight a few of the most obvious trends in science education today. First, the diversity of programs in science education is very great. Whether one talks about methods courses, practice teaching arrangements, course requirements, or almost any other aspect of teacher preparation programs, there are examples of almost every conceivable pattern to be found somewhere in the nation. Second, the lack of basic, objective evidence on the effectiveness of teacher education programs is striking. The courses and programs described in the report are almost entirely acts of faith with little or no feedback or follow-up information to support the practices that institutions follow. In view of some of the student comments reported in the study, the demand for a further investigation of the effectiveness of these programs seems to be a critical priority. Finally, the isolation of science educators from their colleagues at other institutions seems to have some serious implications for programs for the preparation of science teachers. The chaos in the profession to which we referred above is probably one consequence of the inability of science educators to confer about and agree upon the goals and structure of the teacher preparation program in the sciences. The times call for a strong professional organization to assume a leadership role in the focusing of energy and efforts in science education.