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EFFECTS OF TRAINING IN SELECTED CHEMISTRY SUMMER INSTITUTES IN IOWA AND MINNESOTA IN 1964

by

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Approved by Committee:

[Signatures]

Dean of the Graduate Division
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CHAPTER I

INTRODUCTION

The federal government spends millions of dollars each year supporting science institutes. This study was undertaken to determine the effects of institute training which may be useful to educators and legislators who are required to justify these expenditures. The students today have to be trained specialists to secure employment in the world of tomorrow. The colleges and the government must be confident that participants are implementing learned skills in the secondary school.

Harvard's Fletcher G. Watson has stated the following points about science institutes:

The National Science Foundation is underwriting numerous institutes designed to help teachers gain greater technical competency in science and mathematics. The assumption is that greater "command" of the subject by the teacher will ultimately result in "better" performance by the pupils. We shall assume that no teacher can work effectively in a subject which he does not understand. But what is meant by "understanding"? It implies such a familiarity with the assumptions, the evidence, and the concepts in the subject that the teacher can play freely with their interrelationships and structure the instruction in many ways. This competence requires time and experience beyond what usually is available in a first introduction to the study.

Colleges now use quite recent interpretations of complex experimentation. Frequently this interpretation is novel to the teacher, who must struggle to
comprehend these results and ideas. Will he then be competent to handle them flexibly in his teaching? Or is he likely to present them merely as the latest scientific dogma from the authorities?\(^1\)

The scientist of the future must be motivated to think, rather than just memorize a group of facts about the science of chemistry, so it is important to determine whether the institute participants are using the new discovery method of teaching that they have been taught.

If schools are going to educate a sufficient number of scientists and engineers, one must be certain the secondary students are receiving the best instruction possible. These future scientists will have to find methods of combating radiation illness, solving the food problem, water shortage problem, the population problem, eliminating the disease problem, providing materials for the future populations, and provide technology to explore outer space.

I. THE PROBLEM

Statement of the problem. The purpose of this investigation was to determine the effects of training upon the teacher, the changes in course of study, and new methods of instruction developed as a result of participation in selected summer chemistry institutes held during 1964 in Iowa and Minnesota colleges.

The following specific problems were investigated:

1. Were the participants of these institutes motivated to expand their activities by encouraging students to attend summer science institutes for high school students, or completing science research projects under the direction of college science professors?

2. Were the teacher-participants using the instructional materials, including mimeographed materials and lecture notes, received at the institute?

3. Were the incidental experiences of the institute, such as films, guest speakers, and field trips of value in the following year's instructional program?

4. Did the institute members improve themselves professionally?

5. Have the instructors developed a new course of study which required the discovery method of learning?

6. Were these instructors using more laboratory teaching in chemistry?

Purpose of the study. The purpose of this study was to investigate certain effects of the institute on the participants. If a significant amount of change can be determined, this may demonstrate that summer institutes are an efficient method for providing more training for teachers.
Specific effects of the institutes investigated were: Have the participants developed a new or revised course of study? What topics of instruction were deleted or added to the course of study? Were the participants using more demonstrations and laboratory activities to implement their course of study?

One source of information to propose what changes resulted from the training at Iowa State University and St. Thomas College is that the writer attended institutes at each of those colleges. Another source of information that was used to determine areas of specific emphasis that resulted by institute attendance was to examine the objectives of each institute.

The objective of the Iowa State University institute was to "gain experience in solving problems." They also required study on the following topics: "chemical bonding, metals, radiochemistry, nonaqueous solutions, and chemical kinetics." Also, the participants were to "understand the trends in teaching high school chemistry."  

The objectives of the St. Thomas College Institute were to "provide an introduction to analytical and physical chemistry for those teachers of high school chemistry who have not

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1Iowa State University, "Summer Institute for Junior and Senior High School Teachers" (Ames, Iowa: Iowa State University, February, 1964). (An unpublished pamphlet.)
had training in those subjects." Another objective was to "provide a review for those teachers whose contact with the subject has been less active in recent years." The final objective was, "to provide teachers with some first-hand contact with techniques of organic chemistry."¹

Limitations of the study.

1. The participants have had the brief period of two years to inaugurate changes in the chemistry program.

2. This study did not ascertain every aspect of the teaching in which the individual participants conducted their classes. Changes may have been difficult to initiate if adequate facilities and equipment were not available. The pupils that the instructor was assigned to teach may not have been receptive to changes.

3. The following factors for evaluation were not considered in this study: confidence, enthusiasm, learning efficiency, and the amount of motivation the participant demonstrated when he returned to the classroom.

Procedure. The procedure section has been organized into a step by step process according to the order in which this step occurred, as follows:

Step 1--School selection and population. Iowa State University and St. Thomas College were selected for this study. These two institutes were selected because the institutes provided a review of the basic concepts of chemistry. The teachers that attended these institutes are from all over the United States, but the upper midwest was the most highly represented.

The population studied consisted of forty-five science teachers who attended one of two selected institutes in Iowa and Minnesota during the summer of 1964.

Step 2--The questionnaire. A questionnaire was used to gather data. The questions in the questionnaire were divided into seven sections. The questionnaire was designed to measure only those changes that resulted from the institute training.

Section one requested answers from the participants about the phases of instruction which were added, omitted, expanded, or reduced because of attendance at the institute. This section related to expansion of science activities for high school students and new courses of study which required the discovery method of learning.

1See Appendix A for the questionnaire.
Section two related to teaching chemistry by the laboratory method and developing new courses of study that required the discovery method of learning.

Section three required responses that revealed the changes in the methods of presentation that related to answering the question concerning the laboratory method of teaching and the discovery method of learning.

Section four related to answering questions directed to the skill of the participant in applying the principles which were the main goal of the institute. This aided in answering the question concerning the teacher-participant's use of instructional material received at the institute, and related to answering a portion of the basic problem of determining the effects of training upon the teacher.

Section five required answers that aided the writer in discovering the participant's application of learning experiences, such as films, hearing guest speakers, and participation in field trips. These answers were related to the question concerning the value of incidental experiences at the institute.

Section six requested the respondent to state his present professional status. This section related to the problem concerning a gain in professional status by attendance at an institute.

Section seven required responses of the participant as to his continued informal and formal education which aided in
answering the problem concerning the respondent's professional status.

The questionnaire employed both objective and subjective types of questions. A list of members and their addresses was requested from the institute directors of St. Thomas College and Iowa State University. A cover sheet was used to seek the cooperation of the participant.¹

**Step 3—Validation and mailing.** Validation of the questionnaire was accomplished by discussing each question with several fellow 1964 summer chemistry institute members. The participants, who aided in the validation, offered comments on the following listed items:

1. Clarity of each question.

2. Does each question have the same meaning to each participant?

3. Was there enough variety in the choices of multiple choice questions to cover the many situations that a respondent may be trying to describe?

4. Did the question relate to an after-effect of an institute?

5. Was the question significant to members of both institutes?

¹See Appendix B for the cover sheet of the questionnaire.
The questionnaires were mailed to all participants. A follow-up letter was mailed to the non-respondents.¹

Step 4—Compiling the data. A tabulation chart was constructed to organize the data received. Table I was constructed to show the effects of training upon the teacher. Table II was constructed to record any changes in courses of study. Table III was a tabulation of excellent methods now being used as a result of participation at an institute. Table IV was used to record the respondents' opinion of enrichment activities at the institute. Table V was used to record any gains in professional status as a result of attendance at an institute. Table VI was constructed to illustrate the amount of ability to explain chemical concepts that was gained by attending an institute. Table VII was constructed to tabulate the changes in course activities and content taught as a result of attendance at an institute. Table VIII was used to record the specific changes in content of chemistry courses as a result of attendance at an institute.

¹See Appendix C for the follow-up letter.
CHAPTER II

SURVEY OF THE LITERATURE

The survey of the literature was divided into three areas of primary consideration. One area describes the efforts of the National Science Foundation toward the improvement of the teaching of science. A second probes the nature and extent of such improvements made by instructors of science and mathematics as a consequence of completing the work offered by an institute. These two areas necessarily overlap to some degree and will be treated as one area. The third area involves research into advanced instructional methods currently being put into practice in the teaching of chemistry at the secondary level.

I. INSTITUTES SPONSORED BY THE NATIONAL SCIENCE FOUNDATION AND FOLLOW-UP STUDIES CONCERNING THEIR EFFECTIVENESS

Stevenson, in a study of an Academic Year Institute at Ohio State University, found the following ten observations to be generally characteristic of participants on their return to their teaching duties:

1. The participants made marked advances in course work.
2. Principals and superintendents approved of the 
   Institute, and apparently showed an employment
   preference for its graduates.
3. Increase in knowledge of the subject area did not
   tempt participants to seek better-paid employment 
   by leaving the teaching profession.
4. Institute training tended to qualify the partici-
   pants for more advanced teaching positions, which
   many obtained.
5. The participants did make changes in their methods
   of teaching, and did select new course content.
6. The participants saw a need for certain advanced
   courses not offered by the Institute.
7. The Institute did have a constructive influence.
8. The Institute did increase the participants' interest
   in pursuing advanced education, often in obtaining 
   advanced degrees.
9. Less progress was made than the participants had
   expected toward advanced degrees, but other goals
   were decidedly attained.
10. The Institute did fulfill the goals of the National
    Science Foundation.1

In his dissertation, Daara suggested that investigation
be carried out to ascertain

   (1) why teachers who could benefit are not applying
      for summer institutes, (2) what changes are made in
      schools to which summer institute participants return,
      and (3) what changes the summer institute has effected
      in the participants themselves.2

Daara received the following responses from a total of
119 of 130 institute participants. Their replies indicated

1E. E. Stevenson, "A Follow-up Study of the Participation
   of an Academic Year Institute Held at Ohio State
2F. T. Daara, Jr., "An Investigation of Certain Aspects
   of the Chemistry Section of the N.S.E. Summer Institute Held
   at University of Alabama from 1957 to 1962," Dissertation
   Abstracts, XXIV, p. 4052.
that the expanded knowledge of chemistry gained through the Institute made them more capable of stimulating high school students to enter a science career. However, Daara also found that junior high school teachers experienced difficulty understanding concepts presented at the Institute and in trying to motivate students on the junior high school level concerning chemical subjects.¹

Heideman investigated a University of Wisconsin Academic Year Institute in which 147 teachers of science and mathematics participated between 1955 and 1959. Among others, he listed these specific benefits gained from this program:

1. A greater ability to originate new ideas.
2. Higher capability of creating new teaching concepts and an increased desire to try new teaching methods.
3. An increased effectiveness in laboratory techniques.
4. An increased ability to set up experiments.
5. A more favorable attitude toward the teaching profession.²

From these observations, Heideman concluded that the "'basic' courses designed specifically for the A.Y.I. program were of

¹Ibid.
greatest value" to the participants. Pointing up the need for continuing professional self-development by the classroom teacher, the authors of Planning for Excellence in High School Science have stated that he "should belong to scientific societies, visit research and field facilities, enroll in graduate-level courses in advanced science, study books and journals, attend conferences, develop hobbies, and also carry on research" if he is to "remain qualified in the profession." 2

In his study of New York City High School teachers who attended summer science institutes, Schenberg noted that the participants found the training interesting and stimulating. According to their own evaluation, they were brought up-to-date on the latest advances in the fields they were teaching. They were taught many techniques which they were able to put into immediate use in their classrooms. Members were enabled to motivate their students better than in the past. 3 Furthermore, the value of the institutes was not limited to those who participated, but rather utilized by them in the following

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1Ibid.


ways to benefit other teachers and talented students through institute training:

1. They made their lecture notes and other mimeographed material available to other teachers in their schools.
2. They made speeches at department meetings.
3. They acted as "consultants on methods for presenting new topics to other teachers."
4. They prepared bibliographies.
5. They constructed "equipment useful for all teachers in the department."
6. They started teaching advanced courses.
7. "They suggested changes in present syllabi and the purchase of new equipment."
8. They wrote articles for scientific journals.
9. They "stimulated other teachers to attend summer institutes." 1

Barner and Edmund wrote that teachers today are overloaded with education courses, to the detriment of their actual knowledge of their subject. Corroborating this, in a study of the academic backgrounds of a sampling of science institute participants, they found that members of the group had taken "a mean of twenty-eight semester hours of professional education courses, while a mean of seventeen point nine semester hours of content had been completed." 2 This supported the National Science Foundation intent to teach content, rather than methods of teaching science.

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1Ibid., p. 114.
Sarner and Edmund also surveyed the same participants to determine whether "their objectives had been satisfied by science institutes." They gave the following results:

91% were satisfied with the increase in knowledge of content.

23% were satisfied with the value of field trips.

91% were satisfied with the exchange of ideas concerning teaching methods.

54% now had a greater feeling of confidence in teaching science.

In a questionnaire, Parker and Adams asked school principals to evaluate improvement in the instruction given by participants in science institutes after they had returned to their teaching duties. When asked, "In your opinion, is the individual a better teacher because of participation in the NSF institutes?", 130 responded affirmatively as against only six negatively. The principals offered in explanation of what improvements had specifically been noted the observation that former participants had 

(1) greater knowledge of subject matter, (2) more interest and enthusiasm, (3) greater

\footnotesize
\begin{itemize}
  \item[1] Ibid., p. 32.
  \item[2] Ibid.
\end{itemize}
self-confidence, (4) more awareness of trends." They also reported that the teachers had improved their laboratory instruction, particularly with respect to the use of laboratory equipment.

When further asked, "To what extent has attendance at the institute increased career interest in science among the teacher's pupils?", ninety-two indicated that such interest had increased, while twenty reported no change. The main reason cited was that the "teacher's classes were more interesting." Another result they mentioned was an increase in participation in science clubs and fairs, as well as in the use of demonstrations and research for students. Finally, "a majority of those responding indicated greater pupil demand for the teacher's classes after institute attendance."

Fowler reported that forty-five participants in a Pennsylvania State University science resource institute gained ability to:

1. Provide leadership in science curriculum planning.
2. Conduct in-service training programs in science for teachers in their own building.
3. Give aid to individual teachers in their system in the form of subject matter, and help set up experiments.
4. Identify school needs in terms of equipment and reference material.
5. Maintain contact with professional organizations concerned with the improvement of science education.

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1 Ibid. 2 Ibid., p. 130. 3 Ibid. 4 Ibid.
6. Develop instructional material in conjunction with their colleagues.¹

After a survey of participants in an earlier Academic Year Institute also at Pennsylvania State University, Yon found that they were enabled to achieve such personal gains as "advances in professional status, advancement in position, attainment of individual goals, a gain in prestige, and an acquisition of background material necessary to do a better job in secondary school science teaching."² He also reported that these teachers promoted science in the public school by:

1. Delivering talks to student groups.
2. Organizing science clubs.
3. Fostering curriculum revision.
4. Explaining results of institute programs to teachers at their meetings.
5. Delivering addresses to public gatherings.
6. Writing newspaper and magazine articles, promoting science fairs, helping with science workshops and institutes.³

As a result of a study of the participants in eight summer science institutes in Louisiana, Parker observed that:

1. 61 per cent had Master's degrees or earned them while enrolled as participants in the program.
2. 25.2 per cent showed an increase of interest in professional organizations and publications in science.

³Ibid.
3. 50 per cent reported that their teaching assignment had changed after attendance at the institute, with a shift toward a full-time science teaching program.

4. 93.2 per cent believed that they could better motivate students toward careers in science as a result of their attendance at the institute.

5. 99.5 per cent were of the opinion that they were better teachers as a result of their attendance at the institute. They attributed this to an increased knowledge of subject matter in the sciences.

Parker also queried the principals of the participants with respect to the teachers' performance since the institute and reported these results:

1. 91.3 per cent believed that teachers who attended the institutes were more enthusiastic in their teaching and were better teachers because of their participation in the program. They cited increased knowledge in science and ability to make better use of laboratory equipment as being especially valuable.

2. One-half reported that the participating teachers were more active in science fairs, science clubs, and in the utilization of teaching aids as a result of institute work.

They urged expansion of the program into other subject areas.

In a follow-up project on teachers from 1,91 randomly selected schools who participated in institutes, Orr and Young found that they were more satisfied with their jobs, and "engaged in more professional activities, such as reading.

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2. Ibid.
Journals, holding office, and belonging to professional societies.  

It was relevant and interesting, in the light of the numerous, varied and far-reaching results which institutes have made in virtually every area of the professional lives of the participants, to note that accomplishments were usually in excess of the instructional aims professed by the institutes. It should be especially useful to evaluate the results of the institute at St. Thomas. The purposes of the program in chemistry were conservatively written as follows:

To provide an introduction to analytical and physical chemistry for those teachers of high school chemistry who have had no formal training in these subjects.  
To provide a review for those teachers whose contact with the subjects has been less active in recent years.  
To develop an understanding and appreciation for the quantitative and theoretical aspects of chemistry.  
To provide an opportunity for the participant to acquire basic laboratory techniques in physio-chemical measurement.  

It is not a purpose of this Institute to specify what shall be the chemistry content of high school courses in chemistry or to deal with the methods of presenting chemistry to high school students.  

The staff of the National Science Foundation stated the aims of its institute program even more plainly:

1David Orr and Albert Young, "Who Attends NSF Institutes?", Science Teacher, XXX (November, 1963), 40.  
Some institutes present specialized new topics to teachers already equipped with advanced, up-to-date knowledge of the field; many others treat the material of science and mathematics in special courses designed for experienced teachers whose knowledge of the subject matter is out of date.  

In summary, the St. Thomas College Institute emphasized the mathematics of chemistry, while the Iowa State University Institute emphasized laboratory analysis of compounds and a review of the basic concepts of chemistry.

The National Science Foundation provides a variety of institutes to meet the needs of science teachers who have wide ranges in their educational preparation to teach chemistry.

Because of the great quantity of research and recently developed methods of technology, the editors of the previously mentioned National Science Foundation article revealed that it was necessary for science teachers to be up-to-date if the participants are to efficiently instruct pupils in chemistry.

II. TRENDS IN CHEMISTRY CURRICULA

Many areas of pressure have caused such drastic changes in the content and techniques of adequate chemistry instruction in the secondary school. These are, briefly, the expansion of knowledge in the field, the addition of new facts and the discarding of old, incorrect ideas, a trend so obvious

\[1\text{Staff, National Science Foundation, "National Science Foundation Upgrades the Teaching of Science," Nations Schools, LXV, No. 2 (February, 1960), 75.}

\[2\text{Ibid.}\]
and well-known as to require no documentation. A broad
improvement in teaching techniques as former ones proved
less than satisfactory in teaching traditional materials
and totally inadequate for new ones is the last area of
pressure to be cited.

Commenting on the need for new methods, and reporting
on the basis of research rather than opinion, Lesser asserted
that the "teaching of technical terminology, or by the lecture
method and by the learning of recitation of facts exclusively,
is uneffectual for reaching broad educational goals."¹ Not
only is this flaw still prevalent in the teaching of chemistry
in high schools, reported Davis, but also it has marred the
training of many of the teachers themselves: "Defects in
training chemistry teachers were chiefly practices that were
too dogmatic and unscientific, with too much emphasis on
qualitative and quantitative analysis."²

In efforts to combat outdated course content and
teaching methods, Haworth, director of the National Science
Foundation, stated that in 1964, "thirty-nine million dollars
were spent on science and mathematics institutes,"³ the

¹ Milton S. Lesser, Successful Science Teaching (Engle-
wood Cliffs, New Jersey: Teachers Practical Press, Inc., 1961),
pp. 18-20.

² Ira C. Davis, A Half-Century of Science and Mathematic
Teaching (Menasha, Wisconsin: George Yanta Publishing Company,

³ Leland Haworth, 14th Annual Report of the National
Science Foundation (Washington: Government Printing Office,
1964), p. 3.
largest expenditure by the Foundation on any single phase of education in that year. The Foundation fully bore the expense of institute training for 35,200 teachers, or 16 percent of those then teaching mathematics and science in this country.\(^1\)

Indicative of the concern the National Science Foundation feels toward the problem of upgrading science and mathematics instruction is Haworth's statement that "improvement of courses in science and mathematics and the devices to teach such courses effectively at the secondary school level represents a major goal of the Foundation's educational efforts."\(^2\) He related that the content of former science courses was "antiquated," and that secondary school science and mathematics courses "tended to bear little relevance to science as it is today, and as it is understood by those research scientists who stand in the forefront of their respective fields."\(^3\) For this reason, the Foundation encouraged "leading scientists to become involved in devising new courses of study."\(^4\)

The National Science Foundation sponsored the development of CHE Study. Dr. Paul O'Connor noted that students taught with the CHE approach obtained a better "understanding" than those who were exposed merely to the traditional

\(^1\)Ibid. \(^2\)Ibid. \(^3\)Ibid. \(^4\)Ibid.
course. He described the course as containing "experiments which lead from the qualitative to the quantitative," and said that students "will see how analogies and models are used and modified by scientists." Giving his summary of the essential difference between CHEW Study and traditional methods, Dr. O'Connor explained that in the former the approach enabled students to "reason through and evaluate experimental information rather than solely rely on memorization of topics presented in authoritative fashion." As curriculum reform began, wrote Blackwood, the groups concerned with defects in science programs "were motivated by a concern regarding the fragmentary, descriptive, and technological nature of conventional high school courses." But they did not merely view the situation with alarm, or tell the helpless teacher he should change his philosophy of education. Rather,

each project committee took a fresh look at what it believes should be taught and how it should be taught from the scientist's point of view. Instead of listing general guidelines for curriculum workers and teachers,


2Ibid.

3Ibid.

most projects have engaged in the difficult, time-consuming, and costly task of developing specific learning experiences for teachers to use with their students.¹

The result has tended toward chemistry curricula selected on the content basis in accordance with the principle that "obsolete information must give way to current knowledge" and that current information "must be judged significant in helping pupils deepen and broaden their understanding of basic scientific principles." Blackwood described a philosophy which stressed "development of skills of inquiry and understanding of basic concepts of science. Gaining an understanding of the 'methods of science' is giving way to understanding the 'methods of scientists.'"²

A major portion of the literature dealing with trends in chemistry curricula in the secondary school is concerned with development and description of CFA, or Chemical Bond Approach, and CHEM Study, or Chemical Education Material Study. Both courses place a considerable emphasis on learning through the discovery method.

The CFA Newsletter gave this description of the CFA Study:

The CFA group is convinced that chemistry is more than facts possessed by chemists, but rather a subject

¹Ibid. ²Ibid.
as practiced in a powerful process for uncovering and extending natural phenomena. The power resides in the combination of ideas and facts or concepts and experiments. As the student finds himself able to participate in the process, he also finds fascination.

Silber wrote this summary of CEA chemistry:

The course is built on the theory that if a student has a real grasp of concepts, theories, and principles with appropriate facts to accompany them, he obtains a much better conception of the feeling of chemistry and what it can do than he does from the learning of many isolated facts.

Blackwood gave the following more specific description of the CEA chemistry instruction course:

The CEA text emphasizes the development of those ideas which provide organization for the experimental observations of chemistry. The electrical nature of matter and the descriptions of chemical bonds in terms of the limiting models referred to as ionic, covalent and metallic bonds are presented. Energy changes accompanying changes in a chemical system are considered. This application of 'free energy' in describing equilib- rium systems is used.

The model for atomic and molecular structure is ultimately related to the periodic system. To aid in understanding this relationship, the text includes atomic size, nuclear charge, ionization, potential, electronegativity, and atomic orbital assignments.

According to the CHEM Newsletter, "It was decided from the very beginning to have a high school chemistry course

\[1\] CEA Newsletter, No. 9, February, 1961.


\[3\] Blackwood, loc. cit.
based on experiment and to have the text thoroughly dependent
upon and integrated in the laboratory experiments.¹

Silber described the CHEM Study course thus:

The CHEM Study course begins by asking the student
to observe a burning candle and to write down all he
sees. Most students make 6 to 12 observations. Then
the teacher refers the class to a page in the text
describing a professional chemist's 53 observations on
a burning candle. The student becomes aware at once
that his powers of observation can be improved. The
first lesson is a starting point for the study of the
production of phase changes—solids, liquids and gases,
combustion, and chemical reactions. CHEM develops
scientific models for the atomic theory and demonstrates
with these models, as well as with laboratory equipment,
how atoms are combined in substances. Four chapters
include work with the periodic table to give the students
an opportunity to note the periodicity of elements. The
last chapter is on biochemistry.²

From this survey of literature, one may note that most
of the research accomplished in this area reveals the
national Science Foundation has caused science teachers to
become more effective by increasing their knowledge of
science, emphasizing what topics are the most significant
to the technological science industry, and by providing a
variety of learning experiences which causes the participants
use a variety of motivating techniques in the teaching of
chemistry.

²Silber, op. cit., p. 10.
CHAPTER III

FINDINGS OF THE QUESTIONNAIRE

For nearly a decade, individuals and groups have been evaluating the effects of National Science Foundation training. These studies have varied in their findings and recommendations, but most writers reported that institutes are effective for improving science instruction. These writers note that the institute is a motivating device, a characteristic which causes the participant to be stimulated in such a way that the enthusiasm generated by the institute is carried over into the high school classroom. As a result of the institute, the participants have a greater knowledge of the subject matter which they are to present to their students. The institute generally causes a portion of the participants to change the curriculum materials used in their courses.

I. GOALS OF THE INSTITUTES

The two institutes selected for this particular study did not provide specific methods of teaching procedures or discuss all subject matter presented in CNS study or CPA chemistry. However, many of the same concepts taught in CNS study or CPA chemistry were discussed and taught at those institutes.
That this is not inconsistent with the national picture is shown by the fact that the major goal of the summer institutes is to strengthen the subject matter competence of teachers, so that they can in turn develop the nation's scientific manpower potential.\textsuperscript{1} To meet this goal, the institutes were developed specifically to instruct teachers with the following type of deficiencies:

1. A teacher instructing students in a course in which he has had only a few hours of preparation at the college level.

2. A teacher who has completed a college program that is quantitatively adequate but has become antiquated and needs to be updated.

3. A teacher who has a recent and good background in the concepts of chemistry but needs to be acquainted with the latest developments and with the methods of teaching new curriculum material now available.\textsuperscript{2}

II. THE INSTITUTES AND THE QUESTIONNAIRE

Two 1944 summer Chemistry Institutes were selected for study: those held at St. Thomas College, St. Paul, Minnesota, and at Iowa State University, Ames, Iowa. These were studied through the use of a survey questionnaire, to determine the effects of institute training upon the teacher.

\textsuperscript{1}Staff, \textit{National Science Foundation}, \textit{op. cit.}, pp. 86-70.

\textsuperscript{2}Ibid., pp. 70-71.
the changes made in courses of study, and new methods of
instruction developed as a result of participation in
selected summer chemistry institutes.

Basically, both institutes presented material that
was new to the participants. Subject matter presented at
Iowa State University dealt with special topics in Qualita-
tive Analysis, Quantitative Analysis, and Organic Chemistry,
while the laboratory sessions centered around finding
unknowns in Qualitative Analysis, and were generally of a
review nature.1

The directors of the St. Thomas College Institute also
selected material that was new to the participants, relating
particularly to the latest discoveries and other advanced
subjects in the fields of Physical and Organic Chemistry.2
Some modern topics discussed were nuclear chemistry, kinetics,
and atomic structure.

Dr. Orlando Kreider of Iowa State University and Dr.
Martin Allen of St. Thomas College, on request, furnished the
lists of objectives on which the foregroup is based. The

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1Personal letter to the writer from Orlando C. Kreider,
Director, 1962 Summer Institute, Iowa State University, Ames,
Iowa, July 11, 1962.

2St. Thomas College, "Summer Institute for Secondary
School Teachers of Biology and Chemistry" (St. Paul, Minnesota:
St. Thomas College, February, 1964). (A pamphlet.)
institute directors forwarded a list of the names of the participants in their respective National Science Foundation summer institutes for 1964. A questionnaire was then prepared and mailed to all participants in the two institutes.

III. RESPONSES TO THE QUESTIONNAIRE

A total of forty-five people were enrolled in the two summer chemistry institutes during the summer of 1964, twenty-one at Iowa State University and twenty-four at St. Thomas College. The questionnaire was mailed to all of these participants, and a reminder letter mailed to those who did not answer within fifteen days. A total of forty-one participants completed and returned the questionnaire. A summary and analysis of the report of returns may be found in Table I.

TABLE I

REPORT OF RETURNS FROM PARTICIPANTS ENROLLED IN THE SELECTED SUMMER INSTITUTES

<table>
<thead>
<tr>
<th>College</th>
<th>Questionnaires Mailed</th>
<th>Returned</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa State University</td>
<td>21</td>
<td>13</td>
<td>85.7</td>
</tr>
<tr>
<td>St. Thomas College</td>
<td>24</td>
<td>23</td>
<td>95.9</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>41</td>
<td>91.1</td>
</tr>
</tbody>
</table>
All but one of the forty-one respondents are active in education at present. Two of them are attending academic year institutes at the time of this writing. Two others were attending academic year institutes in guidance and counseling. Four participants stated that their main responsibility was now that of administration and supervision. One more elderly respondent stated that she was taking a leave of absence because of ill health, thus becoming the only one not currently active in the field. The remaining thirty-two participants stated that they were teaching some area of science. Twenty-six of these thirty-two science instructors were engaged in teaching one or more classes of chemistry, on the average, 2.5 classes each. These twenty-six had an average of sixty-three pupils enrolled in their chemistry classes in 1955-56. Thirty-nine respondents indicated that in the 1955-56 school year they were engaged in professional education in schools that had an average of 31.2 secondary teachers on their staffs.

IV. THE PROBLEMS AND THE ANSWERS TO PROBLEM

The individual problems and a summarization of the answers to each problem will be described in the next section.

Statement of the problem. The purpose of this investigation was to determine the effects of training upon the teacher, the changes in course of study, and new methods of instruction
developed as a result of participation in selected summer chemistry institutes held during 1964 at St. Thomas College and Iowa State University.

The following specific problems were investigated:

Problem 1. "Were the participants of these institutes motivated to expand their activities by encouraging students to attend summer science institutes for high school students, or completing science research projects under the direction of college science instructors?"

Table II illustrates the enrichment activities of the respondent.

<table>
<thead>
<tr>
<th>Type of Activity</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Response to This Item</td>
</tr>
<tr>
<td>Science fairs</td>
<td>11</td>
</tr>
<tr>
<td>science research projects</td>
<td>13</td>
</tr>
<tr>
<td>summer science institutes for high school students</td>
<td>13</td>
</tr>
<tr>
<td>Science projects sponsored by industry</td>
<td>13</td>
</tr>
<tr>
<td>Science symposiums</td>
<td>13</td>
</tr>
</tbody>
</table>
Problem 2. "Are the teacher-participants using instructional materials, including mimeographed materials and lecture notes, received at the institute?" Thirty-five participants responded to the question which attempted to gauge this: "Have you used the instructional material, such as mimeographed materials, lecture notes, or laboratory notes that you received at the Institute to make curriculum materials for teaching chemistry?" Twenty-six teachers, or 75 per cent of the respondents to this question, said they did use the institute material to teach chemistry.

The demonstrations observed at the institute were of considerable value since they proved many of the concepts that were being discussed. For this reason, the participants were asked to indicate what percentage of the demonstrations that they observed at the Institute were now being performed for their students. Thirty-three responded to this item with the following results: 00 per cent or more--two; 60 per cent to 10 per cent--three; 40 per cent to 60 per cent--six; under 40 per cent--twenty-two. One respondent stated that the demonstrations were too difficult for high school students.

To verify that the participants did observe demonstrations, so they could be repeated in his classroom the writer asked the following question: "How many demonstrations were performed for you at the Institute per week?" Twenty-eight
participants, or 60 per cent of the respondents, answered with these results: two institute members observed seven to ten demonstrations per week; four observed from four to seven demonstrations per week; nine members observed two to four demonstrations per week; and thirteen observed under two demonstrations per week. As these members attended one of two institutes, it seems the great variance to the above answers is due to some of the respondents' failure to recall the number of demonstrations performed.

Also included under this problem is a response to a question dealing with the amount of science reading which respondents were motivated to do by institute participation; the results of this survey are tabulated in Table III.

Problem 3. "Were the incidental experiences of the institute, such as films, guest speakers, and field trips of any value in the following year's instruction program?" The question for this problem somewhat modified the original concern, in that it restricted itself to participants' evaluation of the experiences themselves rather than their usefulness in later teaching situations. Results of this question are tabulated in Table IV.

Problem 4. "Have the institute members improved themselves professionally?" Responses in this area, including a
<table>
<thead>
<tr>
<th>Reasons</th>
<th>Number</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, because I have more science literature available to me</td>
<td>18</td>
<td>51</td>
</tr>
<tr>
<td>Yes, because I requested more from my administration</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Yes, because I am now more interested in some phases of science</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Yes, because I spent the institute allowance to get subscriptions</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Yes, because the students are supplying me</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Yes, because I make it a business to find out about science advances</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Yes, because I became aware of what was available by attending the institute</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>No change in the reading of scientific literature</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>No, because I do not have enough time</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
### TABLE IV

RESPONDENTS' OPINION OF THE VALUE OF ENRICHMENT ACTIVITIES PROVIDED AT THE ST. THOMAS COLLEGE AND IOWA STATE UNIVERSITY SUMMER CHEMISTRY INSTITUTE IN 1964

<table>
<thead>
<tr>
<th>Opinions</th>
<th>Films</th>
<th>Field Trips</th>
<th>Guest Speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number and percentage of respondents that considered this activity a valuable learning experience</td>
<td>16</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>33%</td>
<td>57%</td>
</tr>
<tr>
<td>Number and percentage of respondents that considered this activity to be of a supplemental nature</td>
<td>12</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>37%</td>
<td>43%</td>
<td>31%</td>
</tr>
<tr>
<td>Number and percentage of respondents that stated that this activity added little to the institute</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>12%</td>
<td>24%</td>
<td>19%</td>
</tr>
</tbody>
</table>
breakdown as to the specific types of professional improvement attained by the participants, are tabulated in Table V.

Twenty-three respondents, or 56 per cent of the forty-one teachers who replied, stated that they have been motivated to increase their education in the area of science since attending the 1964 summer chemistry institutes. They indicated that they have earned an average of thirteen semester-hours since completing the institute program.

Twenty-nine respondents said that they had improved the over-all science program in the schools where they are employed. Three teachers instructed an inservice program for their colleagues, while twenty-five provided other teachers in their schools with materials and information received at the institute. One teacher stated she was able to vitalize the chemistry course she was teaching.

One major goal of the summer institutes was an increased ability to teach difficult chemical concepts. More ability was to be attained through greater familiarity imparted at the institute session. The opinions of the respondents as to just how helpful the institute was in developing ability to explain chemical concepts are tabulated in Table VI.

**Problem 5.** "Have the instructors developed a new course of study which requires the discovery methods of learning?" This problem has been interpreted rather more literally than it reads, to include all curricular and text
**TABLE V**

GAINS IN PROFESSIONAL STATUS AS A RESULT OF ATTENDING A SUMMER CHEMISTRY INSTITUTE AT ST. THOMAS COLLEGE OR IOWA STATE UNIVERSITY IN 1964

<table>
<thead>
<tr>
<th>Professional Gains</th>
<th>Number</th>
<th>Per Cent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>More salary</td>
<td>15</td>
<td>36</td>
</tr>
<tr>
<td>A more ideal position</td>
<td>9</td>
<td>22</td>
</tr>
<tr>
<td>Better equipment and facilities</td>
<td>18</td>
<td>44</td>
</tr>
<tr>
<td>Secured employment in a high school with more than 250 pupils</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Depth of knowledge was increased</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>One may now use more flexibility in teaching</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>New ideas and techniques were gained</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>One is now more confident</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Better qualified teacher</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Opinions about chemistry are respected by others</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Type of Reply</td>
<td>Frequency</td>
<td>Percentage</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>This Institute was a major factor in contributing to my ability to explain chemical concepts</td>
<td>9</td>
<td>22</td>
</tr>
<tr>
<td>A considerable amount of my ability to explain chemical concepts was gained by attending this Institute</td>
<td>18</td>
<td>44</td>
</tr>
<tr>
<td>This Institute did contribute a minor amount to my ability to explain chemical concepts</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Contributed nothing to my ability to explain chemical concepts</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Did not answer the question: How much of your ability was to explain chemical concepts was gained by attending this Institute?</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>100</td>
</tr>
</tbody>
</table>
changes not covered in Problem 6. A general survey of such changes was tabulated in Table VII.

### TABLE VII

<table>
<thead>
<tr>
<th>Course</th>
<th>Total Responses</th>
<th>Exclusively</th>
<th>Mostly</th>
<th>Some Effect</th>
<th>Little Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>23</td>
<td>4</td>
<td>11</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Other science courses</td>
<td>12</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>35</strong></td>
<td><strong>5</strong></td>
<td><strong>17</strong></td>
<td><strong>3</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

| Percentage of Total    | 14              | 48          | 9      | 29          |

When asked, "What science topics have you deleted, minimized, or reorganized in the last two years?" the respondents provided the following information:

**Courses added**
- Earth Science-1
- Advanced Science-1
- Introduction to Chemistry-2
- Physical Science-1
- 2d Year Chemistry-2

**Courses deleted**
- Earth Science-1
- Physical Science-1
- General Science-1
Units Added

Geology-1
Cellular Chemistry-1
Organic Chemistry-1
Qualitative Analysis-1
Stoichiometry-1
Normality and Molality-1
Physical Properties and Theory-1
Solving Problems by the Mole Method-1

Units Deleted

Atomic energy-1

Table VIII reveals the respondents' answers to the following question: "Have any of the chemistry courses that you are teaching been reorganized, expanded, fused, or integrated?" Table VIII has been placed on the following page.

Although the answers elicited by the following questions were of little relevance to the present study, the respondents were asked: "What textbook are you now using as a basic text?" Thirteen teachers replied that they were using Modern Chemistry, published by Holt, Rinehart and Company. Seven indicated that they were using CHEM Study, published by Freeman and Company. Two teachers were using a combination of the above two textbooks. One respondent was using CHEM Study and College Chemistry by Sienko and Plane. One chemistry teacher was using CHEM Study and Chemistry, by Garrett, Richardson, and Kiefer. Another was using CHEM Study and Chemistry of Lithography. The only other respondent to this question was using Chemistry: The Modern Approach, by Hose and Nicholson, published by Van Nostrand and Company.
TABLE VIII

SPECIFIC CHANGES IN CONTENT OF CHEMISTRY COURSES AS A RESULT OF ATTENDING A CHEMISTRY INSTITUTE IN THE SUMMER OF 1964 AT ST. THOMAS COLLEGE OR IOWA STATE UNIVERSITY

<table>
<thead>
<tr>
<th>Item Changed</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduced Emphasis on These Topics</td>
</tr>
<tr>
<td>Descriptive chemistry</td>
<td>4</td>
</tr>
<tr>
<td>Percentage uncertainty</td>
<td>1</td>
</tr>
<tr>
<td>Solving problems</td>
<td>1</td>
</tr>
<tr>
<td>CHEM Study</td>
<td></td>
</tr>
<tr>
<td>Significant figures</td>
<td>2</td>
</tr>
<tr>
<td>Periodicity of elements</td>
<td>1</td>
</tr>
<tr>
<td>Energy levels of electrons</td>
<td>5</td>
</tr>
<tr>
<td>Ionization</td>
<td>3</td>
</tr>
<tr>
<td>Atomic orbitals</td>
<td>6</td>
</tr>
<tr>
<td>Factor label method of solving problems</td>
<td>3</td>
</tr>
<tr>
<td>CHEM Study experiments</td>
<td>2</td>
</tr>
<tr>
<td>Organic units</td>
<td>1</td>
</tr>
</tbody>
</table>
Twenty-four of the twenty-six respondents that replied to this item said they were using chemistry laboratory manuals. Eleven teachers were using the CHEM Study Manual, and twelve teachers were using the Modern Chemistry textbook published by Holt, Rinehart and Company. One teacher was using the manual to Chemistry: the Modern Approach.

Twenty-two of the twenty-six chemistry teachers responding to this question said they had secured new textbooks for their courses since the institute. Of these, eleven stated that it was the institute which motivated them to select a new text.

Problem 6. "Are these instructors using more laboratory teaching in Chemistry?" Nineteen science teachers out of thirty-six who responded to this question indicated that they were allocating an average of sixty-six minutes more for laboratory work. They stated that their students are now conducting the following experiments because of the influence of institute training:

- Size of the molecule-6
- Radioactive Sources Experiment-1
- Qualitative Analysis Experiment-12
- Molecular structure-2
- Experiments with molecular models-2
- pH test experiments-1
- Paper Chromatography-4
- Polarity of molecules-1
- Redox experiments-2
- Other Science Projects-2
This last response is relevant to both this problem and to problem 5. Eight of the respondents wrote that they had initiated a CHEM Study program in their schools since they attended the 1964 summer science institute. Four other teachers were already teaching CHEM Study when the institute began. Of these fifteen teachers, fourteen felt that the new course content of CHEM Study more fully meets the needs of the students than did the old course content. Eight of the eleven teachers said they had initiated the CHEM Study program as a result of the institute's training.

**Suggestions.** The respondents had an opportunity to make suggestions and give a general evaluation of the institute and its effect on each one as a teacher, without the restriction of highly specific questions. Some of these did not even adhere to this rather general question, but addressed themselves to topics remote from the institute. Among these received were the following:

1. My teaching is now more effective.
2. I have improved my background and so am more confident in my teaching.
3. A CHEM institute that I attended at a later date was more valuable to me in teaching high school chemistry than the institute attended in 1964.
4. Follow-up meetings should be held, if possible, during subsequent years.
5. More information should be taught that can be used directly in the high school classroom.
6. I could not use the material at the junior high level.

7. Professors of institutes should "cut down" on memorization "grind."

8. College instructors should provide outlines of what is expected of entering college freshmen who indicate a desire to major in chemistry.

9. More emphasis should be placed on the "use" of subject matter.

10. Too much material is presented in six weeks; the institute should be eight weeks in length.

Evidence that the participants have become more professional since the institute is provided by the remarks the respondents made as suggestions for the benefit of participants of future institutes:

1. Participants should restrict their training to the needs of their present positions.

2. Teachers should be active in such organizations as the Iowa Academy of Science.

3. Teachers should subscribe to professional journals, such as Chemistry and Science.

4. Participants should seek institutes that provide instruction in the subject areas in which the participant has little knowledge.

5. Participants should "pool" their ideas, effective techniques, and practices, and publish this for the benefit of other participants.

The most outstanding suggestion was received from a Sister of the Catholic Church, who attended the St. Thomas Institute.

Teachers could make better application of their science institute training by really digging down during the time of the institute, by sifting practical material from technical data, by using the technical material to make concepts
clear, by using the practical material for individual experimentation and interest, by being really enthusiastic in imparting love and knowledge of science, and by developing their own initiative and imparting it to their students.

V. SUMMARY OF THE FINDINGS OF THE QUESTIONNAIRE

The following is a list of items presented in a manner of summary.

1. One-third of the respondents stated their students have participated in science activities as a result of teacher instruction at the institute.

2. Twenty-six of the forty-one respondents stated that they did use the instructional materials received at the institute to make curriculum materials for teaching chemistry.

3. Twenty-five of the forty-one respondents stated that they had provided institute materials and information for other teachers.

4. After these instructors had spent two years back in the classroom following the institute, they stated the guest speakers had been of more value to them than films, and the films had been of more value to them than the field trips.

4. Forty-four per cent of the respondents felt that they had raised better laboratory equipment and facilities
as a result of institute attendance. Only 36 per cent said they had gained financially as a result of attending the institute.

Sixty-one per cent of the respondents stated that the institute caused them to change their course activities and the content that they are teaching to their high school students.

7. Eight of the forty-one respondents stated that they had initiated a QHBM study program as a result of the institute training they received.

The questionnaire revealed that participants in these two institutes are now emphasizing laboratory work by having students conduct more experiments.

Forty-six per cent of the respondents indicated their students were spending an average of sixty-six minutes more per week in the laboratory as a result of the institute.

10. These institutes caused the majority of the participants to read more scientific literature.

11. The respondents continued to increase their education since the institute.

12. Institute attendance caused participants to become more capable to lecture about chemical concepts.
CHAPTER IV

CONCLUSIONS

I. THE PROBLEM

Statement of the problem. The purpose of this investigation was to determine the effects of training upon the teacher, the changes in course of study, and new methods of instruction developed as a result of participation in selected summer chemistry institutes held during 1964 in Iowa and Minnesota colleges.

The following specific problems were investigated:

1. Were the participants of these institutes motivated to expand their activities by encouraging students to attend summer science institutes for high school students, or completing science research projects under the direction of college science professors?

2. Were the teacher-participants using the instructional materials, including mimeographed materials and lecture notes, received at the institute?

3. Were the incidental experiences of the institute, such as films, guest speakers, and field trips of value in the following year's instructional program?

4. Did the institute members improve themselves professionally?
5. Have the instructors developed a new course of study which required the discovery method of learning?
6. Were those instructors using more laboratory teaching in chemistry?

Procedure. Forty-five science teachers who attended chemistry institutes at either Iowa State University or St. Thomas College in the summer of 1964 were selected for this study. A questionnaire that was designed to measure the changes that resulted from the institute was used to gather the data. A tabulation chart was constructed to organize the data received. This data was then organized into eight tables for this report.

II. COMPARISON OF STUDIES

The following is a comparison of conclusions of earlier studies of chemistry institutes and the conclusions of individual problems of this study.

Problem 1. Were the participants of these institutes inspired to expand their activities by encouraging students to attend summer science institutes for high school students, or did the science research projects under the direction of college science professors?

According to Parker and Adams, teachers that attended institutes did cause their students to become more active in
science clubs and science fairs, as well as in the use of
demonstrations and research for students.¹

One-third of the respondents stated that their stu-
dents have participated in science activities as a result
of the teachers' instruction at the institute. Many of the
participants indicated that they employed various motivating
activities before they attended an institute. A one-third
increase in the use of activities as a result of institute
attendance does concur with the findings of Parker and Adams.

Problem 2. Were the teacher participants using the
instructional materials, including mimeographed materials and
lecture notes, received at the Institute?

Samuel Schenberg wrote in his dissertation that teachers
that had attended institutes, "made their lecture notes and
other mimeographed materials available to other teachers in
their schools."²

This writer found that 63 per cent of the respondents
did use the instructional materials received at the Institute.
The conclusion of this study does indicate concurrence with
the conclusions of Samuel Schenberg that participants did make
institute materials available to other teachers.

Problem 3. Were the incidental experiences of the
Institute, such as films, guest speakers, and field trips,

¹Parker and Adams, op. cit., pp. 13-14.
²Schenberg, op. cit., pp. 11-12.
of value in the following year's instructional program?

Sarner and Edmund found that 23 per cent of the institute participants were satisfied with the value of field trips.¹

In this study 33 per cent of the respondents indicate that field trips were of value. This report agrees with the conclusion of Sarner and Edmund that field trips of institutes are not effective.

**Problem 4.** Did the institute members improve themselves professionally?

John F. Yon reported in his dissertation that institute participants did advance in professional status.²

This writer found that less than 50 per cent of the institute members gained better laboratory equipment and facilities, or gained financially as a result of the institute. These findings are in contrast to the conclusions of Yon. This reporter concludes that participants of these two institutes did not gain professionally as a result of the institute.

**Problem 5.** Have the instructors developed a new course of study which required the discovery method of learning?

Paul Blackwood wrote that students should develop

²*op. cit., * p. 15.
skills of inquiry to understand the methods of scientists.1

From the findings of this study one may conclude only an insignificant portion of the participants developed a new course of study that required the discovery method of learning because only 19 per cent of the participants indicated a change to this type of a course of study. Other participants indicated that they were already using a course of study that required the discovery method of learning.

Problem 6. Were these instructors using more laboratory teaching in chemistry?

R. G. Heiderman wrote that institute participants had an "increased effectiveness in laboratory techniques."2 Parker and Adams also reported that institute participants had improved their laboratory instruction.3

This writer concludes that students of participants are conducting more experiments. Forty-six per cent of the respondents reported their students were spending an average of sixty-six minutes more per week in the laboratory as a result of the institute. The conclusions of this report concur with the conclusions of Heiderman, Parker, and Adams that participants do improve their laboratory instruction by attending institutes.

1Blackwood, op. cit., p. 24.
2Heiderman, op. cit., p. 10.
3Parker, op. cit., p. 13.
III. CONCLUSIONS

Findings indicate that the participants were affected by the instruction offered at the Institute because:

1. A majority of the respondents did change their course of study. Findings range from 14 per cent of the respondents changing their content taught exclusively because of the Institute and 46 per cent mostly as a result of the Institute.

2. A majority of the respondents did change their method of instruction by allowing more time for laboratory instruction, and by conducting more experiments. Respondents indicate an average of sixty-six minutes more per week was spent in the laboratory as a result of the Institute. Eight respondents indicated they had initiated a CMI Study program as a result of the Institute.

3. Thirty-six per cent of the respondents increased student participation in science activities as a result of the Institute. Findings range from seven respondents having students participate in science projects sponsored by industry to fifteen respondents that were having students compete in science fairs as a result of the Institute.
4. Seventy-five per cent of the respondents indicate that they were using instructional materials received at the institute.

5. Fifty-seven per cent of the respondents indicate that guest speakers were of value to the instructional program during the year following the institute. Other findings range from 33 per cent of the respondents indicating that field trips were of value during the year following the institute, and 50 per cent of the respondents indicating that films were valuable to the instructional program during the year following the institute.

6. A majority of the respondents did provide institute materials and information to other teachers.

7. More than 50 per cent of the respondents are reading more scientific literature as a result of the institute.

8. Fifty-six per cent of the respondents have increased their formal education since the institute.

9. Respondents did gain professionally as a result of the institute. Thirty-six per cent gained more salary, and 44 per cent gained better equipment and facilities as a result of the institute.

10. As a result of institute attendance, a majority of respondents indicate they are more capable of lecture about chemical concepts.
The purpose of this study was to investigate certain effects of the institute on the participants. If a significant amount of change can be determined this may demonstrate that summer institutes are an efficient method for providing core training for teachers.

From the findings of this study conclusions may be drawn that because participants did develop new or revised courses of study, and demonstrations and laboratory activities were increased. The participants did change their instructional program significantly.

IV. RECOMMENDATION FOR FURTHER STUDY

There is a need for follow-up studies of NSF science institutes. Some specific recommendations for further study are as follows:

1. A study could be made of the effectiveness of a summer institute in comparison to an academic year institute.

2. A study could be made to reveal whether the instructors of institutes use the methods that they possess should be used to teach chemistry, while instructing the institute.

3. A study could be made to evaluate the effectiveness of teachers who use the discovery method of learning and have had formal instruction at an institute, in contrast to those teachers who use the new methods, but have not received institute training.
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BIBLIOGRAPHY

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APPENDIXES
APPENDIX A

THE QUESTIONNAIRE

The National Science Foundation has supported institutes all over the nation to increase educational opportunities for our youth. This questionnaire is being sent to participants in selected 1964 summer chemistry institutes held in Iowa and Minnesota. The purpose of the study is to determine the effects of training upon the teacher, the changes in course of study, and new methods of instruction developed as a result of participation in the institute.

Would you please complete the following basic data about yourself.

Name

Are you presently employed in the teaching profession? ___ Yes ___ No.

Is the teaching of chemistry one of your assigned duties? ___ Yes ___ No.

How many students were enrolled in your chemistry classes last year? students.

How many secondary teachers are employed in your school? teachers.
How many chemistry classes did you teach last year?  
______ classes.

Please write short answers to the following questions.

I. Course activities and content

A. What science topics have you deleted, minimized, or reorganized in the last two years?^1

B. Have any of the chemistry courses that you are teaching been reorganized, expanded, fused, or integrated? For example, maybe you are offering two years of chemistry, or maybe you are placing more emphasis on cancellation of units. Please name the course changes and write a few aspects of the new course.

C. Are you allocating more hours for the laboratory activities since your 10th summer chemistry institute?  ____ Yes  ____ No.
   (1) If you answered yes, how many more minutes per week are you spending in the laboratory?  ____ minutes
   (2) Could you identify a few of the new experiments that your students are now conducting because of the influence of the institute trainings? For example, paper chromatography, the size of a molecule, or a laboratory unit in qualitative analysis.

^1Lee E. Buchring, "Senior High School," National Schools, LV (February, 1960), 69-75.
Science fairs

Science research projects

Summer science institutes for high school students

Science projects sponsored by Industry

Science symposiums

E. If your course activities and content taught has changed is this a result of Institute training? Please check one blank

_____ Exclusively

_____ Mostly

_____ Little effect

II. Curriculum Materials

A. What textbook are you now using as a basic text? ____________________________

Are you using a laboratory manual? ____ Yes ____ No. If you answered yes, would you please name the manual ____________________________

Is this textbook new since the institute? ____ Yes ____ No.

In your opinion, did the institute training motivate you to secure a new basic textbook? ____ Yes ____ No.

Please name two or three of your favorite reference manuals or textbooks.
III. Teaching Methods

A. Have you initiated a CEA, CEEMS, or another learning by discovery curriculum since you have attended the Institute?  ___ Yes ___ No.

If you answered yes to the last question, do you feel this new course content meets the needs of chemistry students more fully than the old course content?  ___ Yes ___ No.

Did you initiate this program as a result of the Institute training?  ___ Yes ___ No.

IV. Knowledge Gained and Applied

A. How much of your ability to explain chemical concepts was gained by attending this Institute?

(1) This Institute was a major factor ______

(2) A considerable amount of ability was gained ______

(3) This Institute contributed some of my ability to explain chemical concepts. ______

(4) Contributed nothing ______

In your opinion, have you caused the total science program in your school to be improved by any of the following actions as a member of the school staff since the summer of 1964? Please check.

(1) When you returned from the institute did you instruct an in-service instructional program for teachers? ______
(2) Did you provide materials or information received from the Institute to other teachers in your school?

(3) Other improvements

V. Demonstrations and activities

A. What approximate per cent of the demonstrations that you observed at the Institute have been performed by you for your students?

20% or better ____, 30 to 60%, 40 to 60%, less than 40% ___.

In relation to the above question, about how many demonstrations were performed for you at the Institute per week?

10 or more ___, 7-10 ___, 4 to 7 ___, 2 to 4 ___, less than 2 ___.

B. Have you used the instructional material such as micrographed materials, lecture notes, or laboratory notes that you received at the Institute to make curriculum materials for teaching chemistry?

7. Please place an A, B, or C beside the following enrichment activities, A, if you think the activity was a valuable learning experience, B, if the activity was only of a supplemental nature, use a C, if the activity added little to the Institute.

A. ___ B. Field trips ___. C. Guest speakers ___
VI. Professional Advancement

A. Have you gained professionally because of the Institute by any of the following factors? Please check more than one, if each statement applies to your position.

(1) More salary

(2) A more ideal position

(3) Better equipment and facilities

(4) I secured employment in a high school with more than 250 students.

(5) Other, please state.

VII. Continued education

A. Were you motivated by the Institute to increase your education in the science area? ___ Yes ___ No.

(1) If you answered yes to the above question, how many more semester hours of science courses have you completed since the Institute? ___ semester hours.

B. Are you now reading more scientific literature than before you attended the Institute?

(1) Yes, because I have more science literature available to me.

(2) Yes, because:

(3) No change.
VIII. General Remarks

Please write a few statements describing how you think Institute participants could make better application of their science Institute training.
APPENDIX B

Latimer, Iowa
September 1, 1966

Dear 1964 Summer Chemistry Institute Participant,

Would you please complete the attached questionnaire concerning the effects of participation in a 1964 summer chemistry institute at St. Thomas College or Iowa State University.

I have been a participant at institutes at both of the above schools, so I recognize many of your names as old friends or associates.

The questionnaire is being used to secure data for completing a thesis, which is required for a Master's degree at Drake University. I hope you will spend a few minutes completing this questionnaire because the data received may aid in planning future institutes, and also your aid will help me to complete my graduate studies.

Please return the questionnaire to me at Latimer, Iowa in the enclosed stamped and addressed envelope.

Sincerely yours,
Dear 1964 Summer Science Institute Participant:

About two weeks ago I mailed you a questionnaire concerning a follow-up study of your 1964 summer science institute. I have not received the questionnaire that I mailed to you. Would you please complete and return the questionnaire in the stamped envelope at your earliest convenience.

As of today, I have about a 50 per cent return of the questionnaire. If this study is to be completed I need at least a 75 per cent return of the questionnaire. A Master of Science degree may be offered if I may have your cooperation in completing this study.

Sincerely yours,