

THE NATIONAL SCIENCE FOUNDATION AND THE IMPROVEMENT
OF SCIENCE TEACHING IN THE SECONDARY SCHOOLS

by

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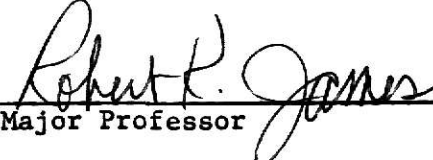
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Chapter 1

INTRODUCTION

Science education has been characterized in recent years by significant changes. Innovations in theory, curricula, and instructional materials have occurred regularly in an attempt to keep pace with the rapid expansion of science and technology. The resources for these innovations have not always been available.

After World War II a shortage of scientists and scientific research produced a reduced supply of scientific discoveries (27:1). This shortage of scientific manpower was caused by the interruption of the education of young scientists and engineers. This interruption plus the evaporation of research grant money limited the amount of research being done. As a result of these events the scientific and educational communities undertook a comprehensive reassessment of education in the sciences. One of the results of this reassessment was the formation of an organization to develop a national policy for the promotion of basic research and education in the sciences (8:2). This organization, created by act of Congress in 1950, was the National Science Foundation (NSF).

The formation of the National Science Foundation did not immediately make the resources available for producing the innovations which have characterized science education in the secondary schools of the United States. The initial concern of the National Science Foundation was with graduate education in the sciences at the university level. However, the National Science Foundation soon recognized,

"... that assuring an adequate future supply of scientists and engineers required adequate preparation at high school levels" (27:125). To provide adequate preparation for potential scientists and, therefore, increase the supply of young scientists and engineers the National Science Foundation set out to improve the teaching of science in the secondary schools. With this goal in mind the National Science Foundation began to provide the resources necessary to produce the innovations that have occurred in science education in recent years.

National Science Foundation support for the efforts that have produced the rapid educational change during the last two decades was based upon a two-part premise. First, in order to improve the teaching of science in the secondary schools, it is necessary to improve the subject matter competence of science teachers. Secondly, it is necessary to provide science teachers with modern materials and courses of study to increase the ability of science teachers to "inspire, as well as properly teach, potential scientists" (41:52). To improve the subject matter competence of secondary science teachers the National Science Foundation sponsored the development of a series of institute programs for teachers of science and mathematics, while it provided funds to support the efforts of a variety of committees in developing new materials and courses of study.

Have the efforts of the National Science Foundation improved the teaching of science in the secondary schools? In order to answer this question it is necessary to answer two other questions: 1) have National Science Foundation sponsored institutes improved the subject matter competence of science teachers? and 2) have the new materials and courses of study developed with National Science Foundation support increased

the ability of science teachers to instruct future scientists? In an attempt to answer these questions this report will outline the development of National Science Foundation programs for increasing the subject matter competence of science teachers and for providing new materials and courses of study, and will review evaluations of the effectiveness of these programs in achieving the goal of the National Science Foundation.

Chapter 2

NATIONAL SCIENCE FOUNDATION EFFORTS TO IMPROVE SECONDARY SCIENCE TEACHING

National Science Foundation support for the improvement of secondary science teaching has been directed toward several areas (11:381-382). This chapter will outline the efforts of the Institutes Section and the Cooperative College-School Science Program (CCSS) of the Special Projects in Science Education Section (SPISE) to improve the subject matter competence of science teachers, and the efforts of the Course Content Improvement Section to provide modern materials and courses of study.

IMPROVING SUBJECT MATTER COMPETENCE

The earliest effort to improve the subject matter competence of secondary science teachers was a National Science Foundation sponsored experimental conference for high school mathematics teachers held in 1954 (9:56). The purpose of the conference was to improve the subject matter competence of the participants by providing additional training. From this experimental conference the Summer Institutes Program evolved.

The National Science Foundation Summer Institute is, perhaps, the most widely known effort to improve science teaching supported by the National Science Foundation. A summer institute is similar to a regular summer session held on the campus of a college or university. All of the courses are generally held on the campus (field trips are an exception) and are taught by regular college faculty members. Activities

at summer institutes may include lectures, demonstrations, films, laboratory sessions field trips, discussions, and review sessions. These are designed to allow for instruction in the latest advances in the participants subject matter field, application and use of new procedures and equipment, and discussion and exchange of ideas with teachers from other parts of the country. All activities are to help update, upgrade, reorient, and provide advanced training for the participants (24,28, & 36).

Through the years the format and activities of summer institutes have changed little. However, as time has passed additional objectives have been enumerated by the host institutions. Recent institutes include in their lists of objectives, in addition to the ones previously mentioned, assisting participants in gaining a greater understanding of the inquiry technique for teaching science and providing a greater background so that teachers might use the approach to teaching science suggested by the institute (PSSC, CHEMS, BSCS, etc.)

In fiscal 1956 the National Science Foundation announced support for a new program to help improve science teaching. This program, the Academic Year Institutes Program, was an extended program containing special courses of study planned cooperatively by members of science, mathematics, and education departments (39:68-69). These courses allowed teachers to upgrade training in their subject matter and to do research in their teaching field. Work completed could be used for partial fulfillment of the requirements for the master's degree. Work was done on a full-time basis with the support of a stipend from the National Science Foundation. This allowed potential master teachers the opportunity for intensive study and research in their subject

matter field without financial hardship.

The final program organized by the Institutes Section of the National Science Foundation was the In-Service Institutes Program. This program was designed to allow teachers of science to improve their subject matter competence by providing supplementary training while teaching (38:72). Classes were held once or twice a week in the evenings or on Saturdays in the school or at a nearby college or university facility (11:392). Support for this program was begun in fiscal 1957 and has continued until the present.

The Cooperative College-School Science Program (CCSS) of the Special Projects in Science Education Section of the National Science Foundation has provided the opportunity for colleges and universities to work closely with local school systems to improve science education. Cooperation may result in modernization and enrichment of existing courses or a more comprehensive introduction of a new instructional program. Training provided for the teachers of the school system by the colleges aids in the implementation of the new programs. In a small school system all teachers may be trained while in large school systems a group of teachers was trained to become resource teachers and instructors of other teachers in the school system (5:1-2, 42:101, 7:.8).

Although the National Science Foundation has continued support for all institute programs: Summer, Academic Year, and In-Service, the focus of these programs has changed as the educational background of science teachers attending institutes changed. In a study of the attributes of institute applicants in 1964 Berger (2) found an increase in the number of graduate credits of the accepted applicants in five science fields when compared with the graduate credits of acceptees

of previous applicant studies in 1957 and 1960. As the background of science teachers improved institute emphasis shifted to instruction in the effective use of new course content materials (methods), with nearly half of the In-Service Institutes committed to training for the teaching of the new curriculum materials in 1968 (6:177). Early institute programs were primarily for improving the subject matter competence of science teachers during a time when science teachers with less than the minimum requirements for certification were common and science often was not the primary field of science teachers. Referring to this situation Krieghbaum and Rawson noted, "Often the teacher trained in biology had to conduct classes in chemistry and physics, too" (21:11). As the science background of science teachers increased, new programs, including CCSS, were developed to introduce into classrooms new instructional programs developed by teams of scientists and educators.

PROVIDING MODERN MATERIALS AND COURSES OF STUDY

The shift of institute emphasis from content to include methods of science instruction was accompanied by the rapid increase in modern instructional materials available as a result of efforts supported by the National Science Foundation. The National Science Foundation deemed it necessary to provide modern materials and new courses of study to improve science teaching because, "...much of the science taught in the schools today (1957) does not reflect the current state of knowledge nor does it necessarily represent the best possible choice of materials for instructional purposes" (38:73). The National Science Foundation has not actually developed new materials and courses of study but has

supported the efforts of several groups composed of scientists, mathematicians, and educators in developing new materials and courses of study. Support has ranged from the development of entire courses to the writing of supplementary materials as aids for use by science instructors and students (11:370). New materials have been developed in all fields of science by various groups.

Support for the development of new materials for physics was begun in 1957. The Physical Science Study Committee (PSSC) with headquarters at the Massachusetts Institute of Technology was the first of the major curriculum reforms to get underway on a large scale. The prime aim of the committee was to present physics as a system of inquiry rather than a body of knowledge in order to make physics more interesting and attract top students to science (11:363 & 25:20). A textbook, teachers' manual, examinations, laboratory manual, laboratory exercises, inexpensive laboratory experiments were developed by the committee. These materials have been made available commercially as PSSC Physics with the aid of a non-profit organization, Educational Services, Incorporated. Another group at Harvard University has received support for the development of Harvard Project Physics. The goal of the project was to develop a humanistically oriented physics course that would attract a large number of students to study introductory physics and contribute to the knowledge of the factors that influence science learning (1:3). The project has also produced a textbook and associated materials for use in high school physics.

The most massive curriculum reform project to receive the support of the National Science Foundation was the Biological Science Curriculum Study (BSCS) Committee of the American Institute of Biological Sciences

which began receiving support in 1959 for the development of a new high school course in biology. The committee produced three versions of BSCS Biology (Yellow, Green, Blue) with textbooks, tests, films, and laboratory and field study guides, as well as teacher education materials and other aids for high school biology (11:365-366).

Two groups obtained National Science Foundation support for efforts to improve high school chemistry courses so as to reflect "contemporary scientific knowledge and points of view." The older of the chemistry curriculum reform projects, the Chemical Bond Approach Project (CBA), was formed in 1958 when the American Chemical Society suggested an organization to look into the problem of improving high school courses in chemistry. The Chemical Bond Approach Project developed a chemistry course stressing the fundamental principles of chemistry with chemical bonding as the central focus (11:366). The Chemical Education Materials Study (CHEMS) received its first support in 1960. The Study produced a high school chemistry course which heavily emphasized the experimental approach and the importance of laboratory work in developing major concepts (11:367). Each of these groups has published a textbook and produced associated materials for use in high school chemistry courses.

In 1964 the National Science Foundation began supporting the Earth Science Curriculum Project (ESCP of the American Geological Institute. This group was charged with the task of providing suitable materials for teaching in the earth sciences. New apparatus and a variety of references and supplementary materials, as well as a textbook, laboratory guide, and teachers' guide were produced through the Project's efforts.

Projects to produce materials and courses of study for improving science teaching at the junior high school level have not been neglected

by the National Science Foundation. The Introductory Physical Science Project (IPS), first funded in 1967, has produced a textbook, teachers' guide, and inexpensive laboratory apparatus for use as an inquiry course in the physical sciences at the junior high school level. The Intermediate Science Curriculum Study (ISCS) began receiving National Science Foundation shift of emphasis from scientific manpower to scientific literacy (46:69) ISCS produced an interdisciplinary science sequence recommended for use in the seventh, eighth, and ninth grades. This activity-oriented approach stresses the processes and concepts of science simultaneously while allowing the student to learn at a rate compatible with his background, interests, and ability (18:5).

Chapter 3

REVIEW OF EVALUATIONS OF NSF EFFORTS TO IMPROVE SCIENCE TEACHING

The objective of the programs outlined in the preceeding chapter, according to the National Science Foundation, has been to improve science teaching in two ways. The first way to improve science teaching was to improve the subject matter competence of science teachers through the use of Summer, Academic Year, and In-Service Institutes. The second way to improve science teaching was to provide science teachers with new, more effective materials and courses of study. This chapter will review evaluations of National Science Foundation supported activities in achieving improvement in science teaching.

NSF INSTITUTES

Have NSF-sponsored institutes improved the participants subject matter competence and, hence, their science teaching? To answer this question let's examine some of the studies of post-institute responses of participants of National Science Foundation sponsored institutes.

Slawson (40) surveyed 263 former academic year institute participants and received replies from 119 teachers. The responding teachers were asked to rate the contribution of the institute to the quality of their science teaching. Seventy-one percent replied that the institute's contribution to the quality of their science teaching was above average while 6.7% felt the institute's contribution was below average. Slawson then surveyed the principals of the responding teachers. Forty-nine

percent of the principals felt that the institute had an above average influence on the quality of the science teachers' teaching. Nineteen percent felt the institute of average influence and 9.5% of below average influence on the quality of science teachers' teaching. Twenty-three percent of the principals did not respond.

Parker (31) conducted a similar survey of teachers participating in summer institutes. Of 162 teachers responding, 99.4% were, in their own opinion, better teachers as a result of their attendance at the institute. One hundred thirty-seven principals responded and 91.3% believed their teachers were more enthusiastic in their teaching and were better teachers because of their participation in the institute. Reasons cited for these opinions were increased knowledge in science and the ability to make better use of laboratory equipment. In a more recent study of institutes for BSCS Biology teachers, the data of Highway and Mertens (16) also supported the conclusion that the institute had succeeded in upgrading the subject matter competence of the participants.

The only empirical evidence that cognitive growth actually occurred as a result of attending a summer institute was provided by Welch and Walberg (48). Participants from four summer institutes for physics teachers showed significant gains on the Test on Selected Topics in Physics (TSTP). With this evidence Welch and Walberg concluded that the institutes had increased the subject matter competence of the participants. In answering the question, 'Do science institutes satisfy teacher objectives?' Sarner and Edmund concluded, "...it is evident that one purpose of the NSF is being accomplished by the institute programs, namely the increase of content course work" (35:31).

The conclusions of these investigators seem to leave little doubt that the subject matter competence of teachers is increased by participation in National Science Foundation sponsored institutes. Some investigators, on the other hand, have produced evidence which indicated that something other than the subject matter competence of science teachers affects student achievement in science. Tweeten (44), in a study correlating student achievement and certain evaluative measures, found that attendance at National Science Foundation sponsored institutes and a teachers academic preparation were not significantly related to a students achievement in science.

Perkes' (32) study of teacher preparation and behavior of junior high school science teachers related to student achievement also indicated that teachers would not teach science more effectively if they had more work in science. In this study, student achievement was reflected more in the teachers' behavior than in the number of credit hours of science. Results not too different from these were obtained by Rothman, et al., (34) in a study of the characteristics of physics teachers and student learning. The conclusion was that teachers' personalities and value systems (as evaluated in this study) are more strongly related to students' changes in physics achievement, attitude toward physics, and interest in science than are the extent of teachers' preparation in physics, math, the history and philosophy of science, their knowledge of physics, and their years of physics teaching experience.

These conclusions lead one to believe that National Science Foundation sponsored institutes, perhaps, have not done all the good attributed to them. However, by examining Perkes' research (32) more closely we find that teachers with a higher GPA, with course work completed more

recently, and with a greater number of credits in science education (methods) are more indirect in their teaching. There are more frequent teacher-student discussions, more frequent student participation in laboratory activities, more frequent use of equipment, greater use of questions of a hypothetical nature, and more lessons stressing principles of science, drawing on social and technological applications for classification purposes.

Attendance at a National Science Foundation sponsored institute will not insure any teacher of a higher GPA, but it does allow teachers to keep abreast of recent advances in science. Institute emphasis has shifted from subject matter orientation to orientation in the use of the new courses of study developed with National Science Foundation support. The use of the inquiry approach, stressed in the new courses of study, requires much more indirect teaching behaviors and, therefore, increases the probability that more laboratory and hypothetical exercises will be used in science teaching.

Krieghbaum and Rawson state that early institutes were, "conducted on a more sophisticated academic level than comparable institutes in the 1960's" (21:8). From the viewpoint of the science teacher and Perkes' findings, perhaps this was not a bad turn of events. The de-emphasis of academic rigor and the re-emphasis of methods in National Science Foundation sponsored institutes resulted in the preparation of more proficient science teachers who, in turn, prepared students with attitudes more favorable to science and with greater interest in science. These are the goals that the National Science Foundation set out to achieve by producing better prepared science teachers.

If this success is limited only to the science teachers who have

attended National Science Foundation sponsored institutes, how successful have the efforts of the National Science Foundation been at improving science teaching? Orr and Young (30), studying the characteristics of teachers attending National Science Foundation Institutes, found that 32% of an estimated 160,000 science teachers had attended a National Science Foundation Institute, while 13% had applied and were rejected. However, about 55% of the same group (160,000 science teachers) had never applied for participation in an institute sponsored by the National Science Foundation. This group of non-applicants was largely from non-public and junior high schools, and composed, to a large extent, of women. These non-applicants also had less extensive backgrounds in mathematics and science and often taught in at least one other subject matter field, causing a lack of identification with mathematics and science.

Other reports of large percentages of science teachers who had never attended a National Science Foundation Institute were present in the literature. Rogers (33), surveying the chemistry curriculum in Kansas had never attended an institute. Koelsche (20) enumerated the characteristics of applicants of a National Science Foundation sponsored institute at the University of Georgia. Of the 1667 surveyed 933 or 56% had never attended an institute sponsored by the National Science Foundation.

In contrast to the teachers of science who have never attended an institute are those who have attended more than one institute. Koelsche (20) found that 54% of the applicants for participation in a summer institute had attended one or more institutes; some applicants had attended as many as four institutes. Slawson felt that

the data collected in a survey of academic year institute participants suggested that participants "use this training in the teaching profession to further the improvement of the overall quality of science teaching in the nation's schools" (40:577).

The apparent success of National Science Foundation efforts to improve science teaching, characterized by an increase in the subject matter competence of science teachers, as evidenced by the witness of the teachers who have attended institutes and their principals, is overshadowed by the large percentage of science teachers who have never attended an institute. This fact, that over half of the nation's science teachers have never attended a National Science Foundation Institute (20 & 45: 97-99), indicated that the National Science Foundation had been only moderately successful in improving the quality of science teaching by increasing the subject matter competence of science teachers.

In addition to the high percentage of science teachers who have never attended a National Science Foundation sponsored institute there are those who have attended and have moved into educational positions in administration or in classrooms at levels above the secondary school. In Slawson's study (40) 119 teachers of 230 responding were still teaching at the secondary level, 35 had moved into college teaching and 25 had taken administrative positions in education. Only nine were no longer employed in education. Irby (17) also found a large upward shift in the employment status of academic year institute participants. Of 121 participants, 92% were still in teaching. However, 43% were teaching at the college level. Highwood and Mertens (16), in a more recent study evaluating summer institutes for biology teachers at Ball State University, found that 88% of the participants were still

teaching at the secondary level, while seven percent had moved upward into college classrooms. In another study of summer institute participants, Kastrinos (19) found that 85% of the participants were still teaching in some area of science, with 63% teaching in secondary classrooms and 22% were teaching at the college level. This upward mobility of institute participants into administrative and college teaching positions results in the loss of a large number of well trained and highly qualified secondary science teachers.

The efforts of the National Science Foundation to improve the quality of science teaching has been successful when viewing the entire spectrum of science education. However, success in improving science teaching at the secondary level has been limited by at least two factors. Too many science teachers do not apply for participation in National Science Foundation sponsored institutes and those highly motivated teachers attending institutes are more mobile. The teachers not attending are the teachers who could benefit most from institute participation, those who are poorly trained and, therefore, not highly motivated in science and mathematics (20 & 45: 97-99). The increasing mobility of science teachers attending institutes allow them to move upward into college classrooms and administrative positions. To be more successful in improving science teaching the National Science Foundation Institutes Program must make a greater effort to reach the science teachers with low motivation in the sciences.

NEW MATERIALS AND COURSES OF STUDY

The second part of the National Science Foundation's premise for improving science teaching was to provide science teachers with new

materials and courses of study. The support provided by the National Science Foundation for the efforts of various groups preparing new materials has made a wide range of modern materials available to science teachers.

What has been the effect of these materials on science teaching in the secondary schools? How do we determine whether these new materials and courses of study have improved science teaching? If science teaching has indeed improved students should obtain greater benefits from using the new materials and approaches than they do from using "traditional" materials and approaches and these benefits should be measurable (13: 98-88). A review of comparative studies of new courses of study and methods versus traditional patterns of learning should reveal the superiority of the new materials.

Montgomery (26) compared the effectiveness of BSCS teaching methods with traditional methods. The effectiveness of each method was measured by testing student achievement and retention of biology concepts. Both materials were taught using traditional (lecture) and inquiry methods. BSCS students taught by the inquiry method showed the greatest achievement, while all ASCS students showed greater retention than did the students using traditional materials. These results indicate that the new materials are more effective in producing measurable student gains.

George (12), using the Watson-Glaser Critical Thinking Appraisal (WGCTA) in a pre-instruction, post-instruction application, compared the effects of BSCS and conventional biology on the critical thinking ability of biology students. The study was designed to compare each BSCS Version (Blue, Green, and Yellow) with each other and with conventional biology. Only students using the BSCS Blue Version scored significantly better on

the post-test of critical thinking. George concluded that the implication of results was that the introduction of BSCS Biology will not always insure greater ability to do critical thinking.

A more extensive analysis of the instructional outcomes of students involved with three courses in high school chemistry was performed by Troxel (43). Using four instruments: ACS Cooperative Examination--General Chemistry (ACS), Test on Understanding Science (TOUS), Watson-Glaser Critical Thinking Appraisal (WGCTA), and Prouse Subject Preference Survey (Prouse) on a pretest, posttest basis, Troxel attempted to determine if there was any difference in the attainment of the common objectives of three chemistry courses; CBA, CHEMS, and Modern Chemistry. One thousand three hundred and thirty-three chemistry students in Iowa and Illinois were compared on the basis of: 1) the total group without regard to grade level or ability, 2) each grade level without respect to ability level, and 3) each grade level divided into three ability groups as determined by the WGCTA pretest.

Students in the total group, regardless of their grade level, who were enrolled in CHEMS and CBA courses performed significantly better on the ACS, TOUS, and WGCTA examinations than did students enrolled in Modern Chemistry courses. Significant differences in development of critical thinking ability were noted for some ability group(s) in each grade level, with CHEMS or CBA students generally developing into significantly better critical thinkers than Modern Chemistry students. Some ability levels of grade eleven students enrolled in CHEMS and CBA courses developed a significantly better understanding of science than did students in Modern Chemistry courses, as measured by the TOUS.

A comparison of CHEMS with a conventional chemistry course in terms of cognitive ability was done by Herron (15) using a test he

constructed himself and the Watson-Glaser Critical Thinking Appraisal (WGCTA). All CHEMS students scored higher on application and analysis (as described by Bloom's taxonomy) items on Herron's test. Students of conventional chemistry courses categorized as average (80th to 89th centiles on the Iowa Test of Educational Development) and low (below the 80th centile) scored significantly higher on the WGCTA sub-test Recognizing Assumptions than did comparable CHEMS students, otherwise on significant differences in critical thinking ability were noted between students of CHEMS and conventional chemistry courses.

Brakken and Wasik, in separate studies, compared the effects on students of PSSC Physics and conventional high school physics courses. A greater gain in critical thinking and numerical ability for PSSC students was noted by Brakken (4). Wasik, on the other hand, found no significant differences in correlations of academic aptitude and cognitive measures in PSSC and non-PSSC students (47).

Friend (10) investigated whether the pupil-inquiry method of teaching was superior to a teacher-directed method of teaching the same new curriculum; Time, Space, and Matter, to eighth graders. In both cases the objectives of the instruction were to improve the critical thinking of the students, improve the students understanding of the methods of science, and increase the students knowledge of specific subject matter content. Friend found the pupil-inquiry method more effective in developing eighth graders understanding of the methods of science. Neither technique was superior in developing critical thinking ability or teaching of science facts and principles. This indicated that the new materials and methods were only partially more successful at producing desired student change than were the traditional methods and materials.

The conclusion that the new materials and courses of study are only partially more successful than the traditional forms of instruction is the most cautious conclusion which can be drawn from often contradictory results. The evidence of the studies just cited allows the conclusion that the new curricula improve some measurable student abilities more than conventional curricula. One of these abilities is critical thinking which was evaluated in several of the studies previously cited. These studies show either no significant difference in the development of critical thinking ability or greater development of critical thinking ability by students in the new curricula. None of the studies indicated greater development of critical thinking for students enrolled in conventional courses. Before any conclusions about other measurable student abilities can be drawn more evidence must be accumulated.

Other research has been initiated to compare the preparedness of students of new and traditional curricula for future science courses. Williams (49) investigated whether students who had taken Introductory Physical Science (IPS) had an advantage when entering BSCS Biology. Williams found that IPS students do not perform better academically or demonstrate higher qualities of cooperation, leadership, initiative, helpfulness, or self-reliance than do non-IPS students. The broadest possible conclusion from Williams' data is that IPS students do not have any advantage upon entering BSCS Biology.

Studies have also been conducted to compare the effect of the new and traditional curricula on the success of students in college science courses. Bertran (3) failed to find any difference in college grades between students who had been through CHEMS chemistry and students who

had been through CHEMS chemistry and students who had taken a more conventional chemistry course in high school. Granger and Yager (14) determined that students of BSCS Biology did not achieve any better in college level biology courses than did students with backgrounds in traditional high school biology. However, they did conclude that BSCS students had a more favorable attitude toward biology and their total high school biology experience than did non-BSCS students. Kruglak (22 & 23) studied the physics background of freshmen entering college and concluded that the method of physics instruction in high school (traditional versus PSSC) had no effect on the high school physics scores of entering freshmen.

The conclusions of these studies do not point to any improvement in the achievement of students, present or future, resulting from instruction with the new curricula developed with National Science Foundation Support. Granger and Yager (14) did note that BSCS students had a more favorable attitude toward biology than did non-BSCS students. Friends (10) indicated that eighth graders developed a better understanding of the methods of science using the inquiry approach to learning.

Generalization from this small amount of positive evidence is, perhaps, unwise. Therefore, based on these studies, it would be most accurate to say that the modern materials and new courses of study provided to science teachers have not benefited students to any considerable degree. With the evidence available it is very difficult to conclude that the materials and courses of study provided by the efforts supported by the National Science Foundation have improved the teaching of science in the secondary schools of the United

States.

This evidence, coupled with the fact that over half of the science teachers in the United States have not attended a National Science Foundation Institute, does not mean that the National Science Foundation has failed in its efforts to improve science teaching. It only indicates that more evidence is necessary before a definite statement of the accomplishments of the National Science Foundation can be made.

Chapter 4

SUMMARY

The National Science Foundation began seeking ways to improve science education in the United States shortly after it was organized in 1950. Efforts to improve secondary science teaching were organized along two lines. One has been to improve the subject matter competence of science teachers by means of institute programs. These have been conducted on college and university campuses and also in the local schools themselves. The other was to provide modern materials and new courses of study by supporting the efforts of outstanding scientists, mathematicians, and science educators to produce such materials.

Teachers have praised the institutes and new curriculum materials for improving their teaching. Principals have noted the improvement of science instruction after teachers have participated in institutes. Researchers, however, are still working to produce additional evidence that the new approaches to science education are producing measurable improvement. Brakken described this state of affairs accurately: "Although the new curricula have been affirmed intuitively, evaluators are hard pressed to point to specific areas of improvement" (4: 19).

Science teaching has changed greatly in the two decades since the formation of the National Science Foundation. New knowledge and instructional innovations have emerged. The incorporation of these into the secondary science curriculum has been promoted by the support of the National Science Foundation. The effectiveness of National Science

Foundation support in improving the quality of secondary science teaching will continue to be debated until investigators provide more convincing empirical evidence of such effectiveness.

In order to provide this evidence research is needed in several areas. A study of the selection procedures for National Science Foundation supported programs should be undertaken to determine how a greater number of teachers who are not highly motivated in the sciences may be included in these programs. In order to determine how effective National Science Foundation sponsored institutes have been at improving science teaching, studies comparing the teaching of institute participants and non-participants are needed. Evidence from these studies will allow a more definite conclusion concerning the effectiveness of National Science Foundation support in improving secondary science teaching.

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THE NATIONAL SCIENCE FOUNDATION AND THE IMPROVEMENT
OF SCIENCE TEACHING IN THE SECONDARY SCHOOLS

by

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AN ABSTRACT OF A MASTER'S REPORT

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MASTER OF SCIENCE

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This report examines the role of the National Science Foundation in the improvement of science teaching in the secondary schools. Two aspects of the improvement in science teaching are considered; the improvement of the subject matter competence of science teachers and providing modern materials and courses of study. A description of the institutes program and curriculum revision efforts is followed by a review of surveys and evaluations of the institutes program and new curriculum materials. The evidence of the surveys of institute participants indicates that NSF institutes do improve the subject matter competence of teachers attending the institutes. Too many teachers not attending institutes and the upward mobility of a segment of those teachers attending has limited the success of the institutes program in improving secondary science teaching. The research concerning the new curriculum materials has produced contradictory evidence. This evidence points to the need for more extensive research before any definite conclusions are drawn concerning National Science Foundation efforts to improve science teaching by providing teachers with new materials and courses of study.