ABSTRACT

A HISTORICAL STUDY OF THE EVOLUTION OF THE OBJECTIVES OF THE NATIONAL SCIENCE FOUNDATION TEACHER TRAINING PROGRAMS, AS EXEMPLIFIED SPECIFICALLY BY THE ACADEMIC YEAR INSTITUTE PROGRAMS IN SCIENCE

By

Karl Chmelowitz Carter

This study investigated the circumstances and needs which culminated in establishment of the National Science Foundation and the subsequent creation and evolution of its teacher training programs, with particular emphasis on the Academic Year Institute Program.

Following the presentation and analysis of factors which led to creation of the National Science Foundation, results of the investigation of the rationale and incentives behind the Foundation's interest and involvement in the program of education in the sciences were presented. Of the several kinds of institutes sponsored by the Foundation as part of its program of education in the sciences, the one known as the Academic Year Institute program was selected and investigated in depth with respect to its origin, and to the subsequent growth and evolution of its objectives.

Data were collected from sources consisting primarily of government documents, NSF reports, AYI proposals and annual reports of directors, independent studies and published articles, and personal correspondence with government officials, Foundation officials, and

AYI directors. These sources provided materials for the following three different perspectives concerning the origin and evolution of objectives of the AYI program:

a. The federal perspective, which included perceptions of members of the legislative and executive branches of government. NSF officials were considered to be members of the executive branch;

b. The perspective of educators, which included views and perceptions of institute directors; and

c. The perspective of individuals who had conducted studies of various aspects of the AYI program.

These three perspectives were then evaluated and compared, and these served as the basis for the findings and conclusions reported in this study.

The pertinent findings of this study were:

1. The National Science Foundation was created in response to emerging and anticipated scientific and manpower needs following the close of World War II, and also in response to the challenge presented by Russia's intensified program for training manpower and carrying on scientific research.

2. The AYI program was initially established to provide supplementary subject matter training for secondary school teachers of science. The ultimate objective of the program was to increase the Nation's supply of trained and competent scientific manpower.

3. New and different objectives of the AYI program have evolved since its inception in 1956, and the importance of some of these objectives has not been perceived uniformly over time by all three groups

investigated in this study. Sufficiently consistent patterns across all three groups, concerning changes in perceived importance, were found for only five of the eighteen identified categories of AYI objectives. These were considered to be examples of evolution of objectives. Four of the five were perceived as being increasingly important AYI objectives over time. These categories of objectives were:

a. To provide teacher participants with supplementary education that would modernize and update their subject matter knowledge and to introduce them to new science curriculums.

b. To train the teacher participant so that he might better stimulate and assist in the reform of his high school curriculum through the introduction of course content improvement materials.

c. To train and prepare those with high potential for leadership for positions as college teachers, secondary supervisors, consultants, coordinators, teachers of teachers, and for leadership to bring about in-service training of their colleagues in the local school system.

d. To provide an opportunity for the teacher participant to earn an advanced degree.

The one category of objectives which was perceived as being of decreasing importance over time was:

e. To increase the numbers, competence, and supply of the Nation's scientists, researchers, mathematicians, engineers, and technical manpower.

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To My Family

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CHAPTER I

INTRODUCTION

The purpose of this study was to investigate the historical events leading to establishment of the National Science Foundation teacher training programs, and to trace the evolution of the objectives as exemplified specifically by the Academic Year Institute programs.

A historical study of the origin and evolution of teacher training program objectives facilitates evaluation of causative factors and thus aids in understanding the conditioning influence of the past upon the present. Since evaluation and modification of curriculums and methods used in training teachers are on-going processes, these understandings will have potential as positive elements in decisions concerning current as well as future revisions of teacher training programs.

Considerable amounts of both money and manpower are expended annually in training teachers. The efficiency of these training programs, and consequently the effectiveness of the expenditures, will be proportional to increases in our ability to match predictions or expectations with actual program results. The usefulness of the historical study in this respect is pointed out by Dovring:

> The old saying that by studying history we could predict the future, is probably for many people one of the most important reasons why they--consciously or unconsciously--regard historical studies as a useful and necessary part of our spiritual outfit and not merely as a nice thing to have.[1]

Researchers in natural science fields such as paleontology, geology, and astronomy have always made inferences and predictions on the basis of historical evidence, as have historians in disciplines such as philosophy, political science, and economics. In all of these areas of research, however, including that of the writer, one must bear in mind that predictions are valid only to the extent to which cause and effect phenomena of the past are comparable to those of the present. One must therefore remain cognizant, in interpreting historical studies, of changes in social, scientific-technological, economic, and education spheres.

The Academic Year Institute as a Program of the National Science Foundation

The National Science Foundation was created as a new federal agency in 1950 upon enactment of Public Law 507. Of its several statutory functions, those concerned with promotion and support of basic research and with education in the sciences have consistently received the major portion of budgeted operating funds.

The program of education in the sciences has encompassed a variety of activities over the years in response to changes in emphasis and in need, but the primary objective of the program continues to be the development of an adequate national supply of top quality scientific and technical manpower. Earliest efforts were concentrated on establishment and support of fellowships and scholarships at the graduate level which focused on the preparation of trained researchers in science. These were followed shortly by programs specifically designed to provide additional subject matter training for practising science teachers. This subject matter training has been implemented primarily through the institute programs, by which achievement of the desired effect on the science education of pre-college and undergraduate students was expected to be most direct and rapid.

Following National Science Foundation sponsorship of the first institute for the training of science teachers in 1953, enormous amounts of money and manpower have been expanded in developing and administering different kinds of training programs designed to increase the competence and effectiveness of teachers of science. Among those few which have had widespared effects on teachers and students at all grade levels is that program of particular concern to this study--the year-long training program called the Academic Year Institute.

Two pilot Academic Year Institutes were conducted in 1956, and rapid quantitative growth and expansion, as well as a profusion of qualitative variations, have characterized the program since that time. Academic Year Institute programs which have been sponsored by universities and colleges over the past fifteen years have offered training opportunities for science teachers which have drawn upon disciplines in the behavioral and social sciences as well as upon the natural sciences.

Changes in both the quantitative and the qualitative structure of the Academic Year Institute teacher training program which appeared over the years were largely in response to emerging needs and conditions, as well as to successes and failures of programs already in operation. Few of these later events and needs were, or indeed could have been, clearly discerned during the formative period of the

Academic Year Institute program. Consequently, it was neither feasible nor desirable for those designing and conducting the institute programs to establish and adhere to an initial set of clearly-defined and specific objectives.

Statement of the Problem

The problem was to conduct a historical study of the evolution of the objectives of the National Science Foundation teacher training programs, as exemplified specifically by the Academic Year Institute programs in science. This study includes the following major areas:

1. A collection and analysis of significant contributory factors which culminated in creation of the National Science Foundation.
2. An investigation of the rationale and incentives underlying the interest and involvement of the National Science Foundation in the program of education in the sciences, with particular emphasis on the Academic Year Institute Program.
3. A critical analysis, from a longitudinal perspective, of the assumptions made by college and university educators and by National Science Foundation officials as regards the purposes and objectives of the Academic Year Institute program and their means of achievement.
4. Tracing and evaluating the evolution of objectives of the Academic Year Institute program which have occurred since initiation of the program.

Need for the Study

Perhaps one of the more compelling reasons for a study of this nature--one which examines but a small segment of the overall sphere of National Science Foundation activities and programs and concerns--is that many of the same problems which originally prompted creation of the National Science Foundation, and origination of the teacher training programs which it sponsors, yet remain with us after nearly two decades of National Science Foundation operation.

In light of the persistence of some of these problems, such as the continuing shortage of qualified and competent science teachers and the undiminished rivalry in scientific and technological fields between the United States and the Soviet Union, it seems appropriate to systematically examine the purposes of the National Science Foundation's teacher training programs, and to ascertain how these purposes have changed.

The evolution of the purposes or objectives of the National Science Foundation Academic Year Institutes cannot be studied in isolation, for most additions, modifications, and deletions were in response to external circumstances or needs. This will be more clearly demonstrated in Chapter V.

The probability is considerable that events which have influenced teacher training programs in the past are continuing to do so currently and will persist to some degree in the future. Thus there exists an element of commonality over time which lends validity to inferences and predictions which might be generated by historical studies such as this one. Hayman concurred in this view when he stated:

> . . . today's events have meaning only in the context of past events which led to them.[2]

Several of the events which have significantly influenced the evolution of the Academic Year Institute program and which may well continue to do so in the future are:

1. The design and construction of new science and mathematics curriculums.
2. Revision and modernization of curriculums being used.
3. Ever-increasing numbers of students enrolling in the schools.
4. Influx into the profession of teachers with inadequate training in science and mathematics.
5. Migration of teachers with good subject matter training in science and mathematics away from classroom teaching.
6. Growth of the body of scientific knowledge.

Since the teacher continues to occupy the central role in the process of education, and since the above influences are likely to persist for some time, one senses the wisdom and urgency inherent in attempts to better evaluate programs whose objectives are primarily in the realm of teacher training. Numerous studies have been conducted on Academic Year Institute programs.* Nearly all of them were designed to evaluate the effectiveness of a single Academic Year Institute or of a group of institutes in achieving the stated objectives of the program. None were found to have been conducted whose objectives are even remotely comparable to those of this study.

This study concerns the evolution of the objectives of but one of the many teacher training programs which have emerged over the past

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*Data from these studies are used in Chapter V, and a complete listing of the studies appears in the Appendix of this study.

twenty years. It is the enhanced understanding of the causes and significance of this evolution, and the possible application and use of these understandings in subsequent evaluations of the Academic Year Institute program, and of others which may evolve, which justifies this study.

Footnotes

[1]Folke Dovring, History as a Social Science (The Hague: Martinus Nijhoff, 1960), p. 37.

[2]John L. Hayman Jr., Research in Education (Columbus, Ohio: Charles E. Merrill Publishing Company, 1968), p. 49.

CHAPTER II

THE CREATION, OBJECTIVES, AND EVOLUTION OF THE NATIONAL SCIENCE FOUNDATION

Developments Prior to 1950

Experiences and lessons derived from World War II, in conjunction with astute insight and foresight, prompted an action on the part of President Franklin Roosevelt which might be considered the initial precipitating incident in the evolution of the National Science Foundation. In November of 1944 President Roosevelt wrote a letter to Dr. Vannevar Bush, then director of the wartime Office of Scientific Research and Development, and requested from him a series of opinions and recommendations relative to postwar development of scientific research and manpower.[1]

The war had clearly shown how national health and survival were dependent upon the fruits of basic scientific research and upon an adequate supply of scientific manpower. The war had also brought about changed perspectives among leaders who began to sense the emergence of new postwar problems and the necessity for devising techniques and instruments to cope with them. The letter which President Roosevelt wrote to Vannevar Bush on November 17, 1944, reflected concern with the above problems. The President's letter succinctly delineated, and asked for recommendations on the following four points:

> FIRST: What can be done, consistent with military security, and with the prior approval of the military authorities, to

> make known to the world as soon as possible the contributions which have been made during our war effort to scientific knowledge?
>
> SECOND: With particular reference to the war of science against disease, what can be done now to organize a program for continuing in the future the work which has been done in medicine and related sciences?
>
> THIRD: What can the government do now and in the future to aid research activities by public and private organizations?
>
> FOURTH: Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war?[2]

It is of significance to this study that three of the four major points expressed by the President were concerned with aid to scientific research and with programs of science education. More particularly, the President's fourth point appears to have been specifically aimed at achieving goals very similar to those which were later incorporated into the Foundation's institute programs.

Following a six month period of investigation and consideration, during which he sought the aid and advice of scores of the Nation's most prominent scientists, Dr. Bush submitted to the President the accumulated facts, conclusions, and recommendations in his report titled <u>Science, the Endless Frontier</u>. A major recommendation of the Bush report was that:

> The Federal Government should accept new responsibilities for promoting the creation of new scientific knowledge and the development of scientific talent in our youth.[3]

To meet these responsibilities, Dr. Bush proposed that Congress establish an independent agency which would be devoted exclusively to the support of scientific research and advanced scientific education.

Concerning the more specific functions of this proposed new federal agency, Dr. Bush recommended:

> Such an agency should furnish the funds needed to support basic research in the colleges and universities, should coordinate where possible research programs on matters of utmost importance to the national welfare, should formulate a national policy for the Government toward science, should sponsor the interchange of scientific information among scientists and laboratories both in this country and abroad, and should ensure that the incentives to research in industry and the universities are maintained.[4]

For this new agency, Dr. Bush suggested the name "National Research Foundation."

With this report focusing on the need, and serving as a catalyst for action, a plethora of legislative bills and reports soon appeared in the United States Senate and House of Representatives. Most of them were similar in their broad objectives and purposes, but there were considerable differences in the organizational structures proposed. Among the earliest bills following the Bush Report, was one introduced by Senator Magnuson of Washington on July 19, 1945, a scant two weeks after Dr. Bush had submitted his report to the President. Senator Magnuson's Senate Bill 1285 would have created a National Research Foundation, which would be authorized under Section 2 to:

> a. develop and promote a national policy for scientific research and scientific education;
>
> . . . .
>
> d. discover and develop scientific talent, particularly in American youth;
>
> e. grant scholarships and fellowships in the mathematical, physical, and biological sciences;[5]
>
> . . . .

It was expected that the scholarships and fellowships would be granted to students working at the graduate level.

Less than a week later, on July 23, Senator Kilgore of West Virginia submitted Senate Bill 1297, designed to ". . . promote the progress of science and the useful arts, to secure the National Defense, to advance the national health and welfare, and for other purposes."[6] Provisions of the bill would have included the following objectives:

a. increased government support for scientific research and development;

b. coordination of government supported research activities;

c. stimulation of private research;

d. promotion of the interchange and flow of scientific information;

e. encourage the rapid use of new discoveries and techniques;

f. encourage the training of new scientific talent through a system of research fellowships and scholarships.

A third bill of significance to this study was the one introduced by Senator Elbert Thomas of Utah on July 26, 1945, which was directed at but one recommendation of the Bush Report. Senator Thomas' Senate Bill 1316 did not propose establishment of any sort of national agency, but instead was:

> A Bill to further promote the national strength, security, and welfare by assisting the States and Territories in extending and improving courses of instruction in the natural sciences through public secondary schools.[7]

It thus appears that Senator Thomas' Bill 1316 was among the earliest attempts at upgrading high school science instruction, far in advance of the programs instituted by the National Science Foundation in the summer of 1953. Senator Thomas' bill was sent to committee but for unknown reasons was never acted upon and consequently died there.

This appears ironic when one recognizes the enormous amounts of time, money, and manpower that were later expended by the Foundation in support of programs designed to accomplish essentially what Senator Thomas had proposed in his 1945 bill.

Numerous other bills were introduced over the next several years, including revised versions of the original Magnuson and Kilgore bills. Most of these were designed to achieve all or part of the recommended objectives set forth in Vannevar Bush's report to the President. In keeping with legislative procedures, committee hearings were held following introduction of each of these several bills. It was at these hearings that scientists, businessmen, government agencies, and other concerned groups and individuals could and did express their views, and thereby possibly have influence on the nature of the final bill.

Some appreciation of the recognized potential scope and impact of the legislation under consideration can be gained by examination of the wide variety of sources of testimony given before the committees hearing the bills. Those giving testimony included representatives from most of the major universities, the President's Cabinet, most of the major United States industries and some from abroad, numerous professional societies and scientific associations, and all of the military services. Each offered testimony, of course, in hopes of rectifying what he perceived to be faults or shortcomings in the bills, as well as to affect the bills in ways that could later be favorable to their own interests.

On a number of occasions certain bills neared completion and adoption, only to die with the adjournment of Congress. The 80th

Congress in 1947 passed Senate Bill S. 526, the National Science Foundation Act of 1947,[8] and it was sent to President Truman. The President vetoed this bill however, on the basis of what he considered to be unsound organizational structure, and also the lack of control over the program by the people.

Bills to establish a National Science Foundation, with modifications to meet the earlier objections of the President, were submitted and heard over the next two years with the final outcome being the evolution of Senate Bill S. 247. This bill was sent to the President and was signed by Mr. Truman on May 10, 1950, thereby authorizing establishment of the National Science Foundation.

Public Law 507, 81st Congress

The Eighty-First Congress, Second Session, approved and sent to the President Senate Bill S. 247 which was the end product of nearly five years of legislative activity. President Harry S. Truman then signed the bill on May 10, 1950, thereby enacting Public Law 507, now commonly known as The National Science Foundation Act of 1950.[9]

The Act authorized establishment of a federal agency whose purposes and organizational structure closely paralleled the recommendations of the Bush Report of 1945. The functions and purposes of the National Science Foundation were described in the first three sections of the original bill:

AN ACT

> To promote the progress of science, to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Science Foundation Act of 1950."

ESTABLISHMENT OF NATIONAL SCIENCE FOUNDATION

Section 2. There is hereby established in the executive branch of the Government an independent agency to be known as the National Science Foundation (hereinafter referred to as the "Foundation"). The Foundation shall consist of a National Science Board (hereinafter referred to as the "Board") and a Director.

FUNCTIONS OF THE FOUNDATION

Sec. 3. (a) The Foundation is authorized and directed - -

(1) to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences;

(2) to initiate and support basic scientific research in the mathematical, physical, medical, biological, engineering and other sciences, by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such basic scientific research and to appraise the impact of research upon industrial development and upon the general welfare;

(3) at the request of the Secretary of Defense, to initiate and support specific scientific research activities in connection with matters relating to the national defense by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such scientific research;

(4) to award, as provided in section 10, scholarships, and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences;

(5) to foster the interchange of scientific information among scientists in the United States and foreign countries;

(6) to evaluate scientific research programs undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups;

(7) to establish such special commissions as the Board may from time to time deem necessary for the purposes of this Act; and

(8) to maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all

> scientific and technical personnel in the United States, including its territories and possessions.
> (b) In exercising the authority and discharging the functions referred to in subsection (a) of this section, it shall be one of the objectives of the Foundation to strengthen basic research and education in the sciences, including independent research by individuals, throughout the United States, including its territories and possessions, and to avoid undue concentration of such research and education.
> (c) The Foundation shall render an annual report to the President for submission on or before the 15th day of January of each year to the Congress, summarizing the activities of the Foundation and making such recommendations as it may deem appropriate.

Recommendations which parallel those in the above enabling act can be found in the report which Vannevar Bush submitted to the President in 1945. In this report Dr. Bush recommended creation of an organization whose purposes and functions proved to be much like those which were later included in the 1950 National Science Foundation Act. Those broad purposes urged by Bush were ". . . the creation of new scientific knowledge and the development of scientific talent in our youth."[10]

Creation of the National Science Foundation thus involved the Federal government in not only policy-making and support of basic research, but promotion and support of education in the sciences as well. Additionally, the bill as finally passed contained compromises resulting from bureaucratic rivalries as well as special interest group pressures. Further investigation and more intensive examination of Foundation activities which focus on education in the sciences will be presented and discussed in a subsequent chapter of this study.

Initial Organization and Administrative Structure

Because the National Science Foundation was to have unique powers and responsibilities, great care was exercised throughout the five year evolutionary history of the enabling act to ensure inclusion in it of safeguards pertaining to administrative structure and authority. Numerous (and frequently stormy) hearings, debates, testimonies, and compromises ultimately produced the National Science Foundation Act of 1950. Included in the Act were built-in guarantees, summarized as follows, which would:

1. have the Director remain responsible to the President of the United States, and thus to the people;*
2. assure that appointees to the National Science Board would be representative of a reasonable cross-section of scientific disciplines;
3. preclude overlapping of, or infringement on, functions and authority of other government agencies, such as the Office of Scientific Research and Development, or the Atomic Energy Commission;
4. permit the Foundation to individually treat problems of patent rights related to inventions and discoveries resulting from Foundation-sponsored research;
5. establish proper and adequate security requirements and restrictions with respect to information, personnel, and property relating to the national defense; and,
6. sponsor and encourage basic research in institutions in such a manner that research activities would not be hindered by

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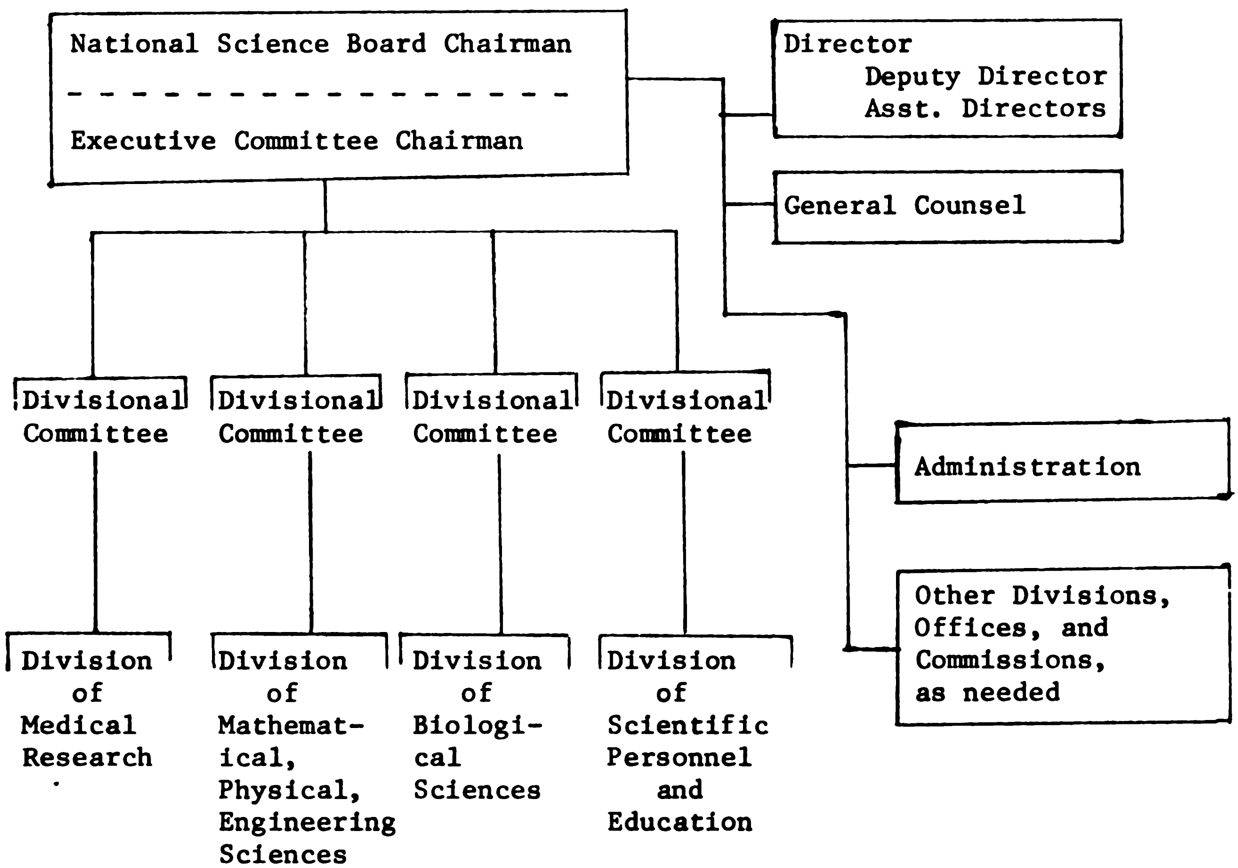
*In 1947 President Truman vetoed an earlier version of the National Science Foundation Act (S526), objecting to a provision in the bill under which the Director would be elected by a Board. President Truman felt that this method would be not sufficiently responsive to the will of the people.

political, governmental, or social pressures. This would include external as well as internal political interference, intervention, or control.

The organization scheme of the Foundation, based on the 1950 enabling act, was as follows:



Provisions were made in the original 1950 Bill to allow for necessary structural and administrative changes to the above scheme as needs might later appear, and indeed, numerous changes were made during the ensuing twenty years of Foundation activities.

The National Science Board has always consisted of twenty-four members appointed to six year terms by the President, by and with the advice and consent of the Senate, with appointees being selected from among those who have rendered distinguished service in the fields of the basic sciences, medical sciences, engineering, agriculture, education, or public affairs, with consideration given to recommendations for nominations submitted to him by the National Academy of Sciences, various associations of colleges and universities, and by other scientific and educational organizations. The Director serves as a non-voting ex-officio member of the National Science Board. The Executive Committee of the National Science Board was originally composed of nine members elected by the Board, but this number proved too unwieldy and was later reduced to five. The primary responsibility of the Board was to establish Foundation policies and to review and approve Foundation programs.

The Director is appointed to a six year term by the President of the United States, by and with the advice and consent of the Senate, and serves as the chief executive officer of the Foundation. He is responsible for development and coordination of the Foundation's programs and for administering the affairs of the Foundation.

Each of the original four Divisions within the Foundation was headed by an Assistant Director, with each Assistant Director being responsible for developing program plans and policies specific to his own Division, and also for administration of grant and contract awards in his area of responsibility. The activities of the four divisions were supplemented and aided by Divisional Committees, whose members were appointed by the National Science Board.

It was the Division of Scientific Personnel and Education, under authority granted it by the original charter, that early took the initiative in developing policies and programs that ultimately led to establishment of teacher-training programs such as Summer Institutes and Academic Year Institutes.

Early Stated Purposes of the National Science Foundation

Although the wording of the National Science Foundation Act of 1950 appears to adequately define the scope and purposes of that agency, examination of records of testimonies and arguments presented at hearings preceding adoption of the final form of the bill, as well as later comments and discussions concerning the activities and achievements of the agency since its inception, casts considerable doubt that there was unanimity of views held in various concerned quarters.

Under authority of the 1950 Act the Foundation was specifically charged to develop, encourage and support certain activities, which are summarized as follows (italics mine):

1. pursuit of a *national policy* for strengthening basic research and education in the sciences;
2. *basic scientific research* in the several areas;
3. *appraisal of the impact* of science research on other areas;
4. *coordination* of basic research activities and national defense needs;
5. programs granting *graduate fellowships and scholarships* in the sciences;
6. *international exchange* of scientific information;
7. *evaluation* of federal research programs;
8. *correlation* of the Foundation's research activities with those of private individuals and groups

9. establishment of a central clearinghouse for information on scientific and technical personnel.

These stated objectives are entirely consistent with objectives set forth by Dr. Bush in his 1945 report. In that report he recommended, under the section titled Purposes, that:

> The National Research Foundation should develop and promote a national policy for scientific research and scientific education, should support basic research in non-profit organizations, should develop scientific talent in American youth by means of scholarships and fellowships, and should by contract and otherwise support long-range research on military matters.[11]

Of the several Foundation objectives cited above, the ones concerning support for basic research and the training of scientists appear to have received greatest emphasis, while others having to do with coordination, national policy, military research, and exchange and clearinghouse activities, all received little attention or were later assumed by other agencies. This direction of emphasis is clearly pointed up in the following statements by experts from various fields, over a period of several years, which illustrate how strongly perceived and emphasized were the Foundation's purposes in supporting basic research and the training of scientists.

Soon after the Bush report was submitted to President Truman, Dr. Lee A. DuBridge, (currently President Nixon's science advisor) gave testimony before the Senate Military Affairs Committee which was intended to show the dependence of national security on basic research and on an adequate supply of scientists:

> Dr. DuBridge. I wish to emphasize that the greatest asset for national security is a broad program of research in all fields of science and a large number of trained active scientists.[12]

This was closely followed by testimony of Bernard M. Baruch several days later, in which he stated that major goals of a government program of science should be to:

> Greatly increase our scientific brainpower, using scholarships and other aids to develop new scientific talent in American youth, . . . and to . . . Stimulate basic scientific research to assure a continued flow of new, fundamental, scientific knowledge.[13]

While speaking on behalf of a Foundation bill submitted by himself, Mr. Wilbur Mills, Representative from Arkansas, stated at a 1946 House Subcommittee hearing:

> Both the Bush report and the hearings before the Senate subcommittee showed clearly the great need for support by the Federal Government of the basic scientific research work ordinarily performed in the universities.[14]

Speaking before his Senate colleagues a year later, Senator H. Alexander Smith of New Jersey stated:

> It is essential that we understand from the beginning that the proposed Foundation is not just another Government agency. It has been designed to fit a specific need and to accomplish a definite purpose. We in Congress are asking the eminent men and women of science to chart a program of basic research to insure our future.[15]

The necessity for establishing and giving direction to a government-supported science agency to meet the growing needs of national security and welfare was of greater than passing interest to President Truman, as evidenced by his public statement made shortly after the end of World War II:

> On several occasions, I have urged Congress to enact legislation to establish a National Science Foundation. Our national security and welfare require that we give direct support to basic scientific research and take steps to increase the number of trained scientists.[16]

Dr. Hugh Wolfe, representing the Federation of American Scientists, lent his personal support, as well as that of the Federation, to the

argument favoring the training of new scientific talent. Dr. Wolfe stated at a subcommittee hearing in 1948:

> We must discover and develop new scientific talent amongst our own people in order to increase the benefits from basic and applied scientific research.[17]

Certain interests and concerns were manifest in these positions which needed to be recognized for the immediate as well as the long range impact they might have on research efforts and the supply of trained scientists. The end product from the process of seeking out and preparing potential scientists could vary according to whether efforts were concentrated on high schools or universities; on older or younger people; on certain geographic areas of the country; on public schools or private; or on restricted economic or social segments of the population. Continued unbalanced emphasis on one or more of the above would be a violation of the democratic process, and thus to be guarded against.

By the end of the First Session, Eighty-First Congress in 1949, the form of the bill as it was finally passed was nearly complete, and any chances for major revisions were slight. Concerned individuals, however, continued to lend support to the provisions already quite well implanted in the legislative document being debated before House and Senate subcommittees. Dr. Karl Compton, Chairman of the Research and Development Board of the National Military Establishment, endorsed the bill by means of a letter in which he stated:

> We should not lose sight of the fact that the main purposes of the Foundation are to sponsor basic research and to provide scholarships and fellowships.[18]

Senator Elbert D. Thomas of Utah, in support of the bill that same year, cited the importance of support for not only basic research and the training of scientists, but also for establishment of programs to coordinate these efforts:

> These hearings and studies, in addition to establishing the grave need for more trained scientists in America, also establish the need for greatly stimulating American research in the basic sciences, as contrasted with applied science, as well as providing a responsible program of directing and coordinating such basic research.[19]

President Truman signed Senate Bill S. 247 in 1950, thereby creating the National Science Foundation. On this occasion, the President also suggested the great importance of the bill when he stated:

> The Nation's strength is being tested today on many fronts. The National Science Foundation faces a great challenge to advance basic scientific research and to develop a national research policy.[20]

Clearly, the overwhelming response to efforts ultimately leading to creation of this new federal agency was along lines concerned primarily with support for basic research and the training of scientists. Additional statements lending support to this perception of the purposes of the Foundation can be found in public papers and statements of Presidents Eisenhower, Kennedy, and Johnson. Scores of prominent scientists and other national leaders have, since 1950, publicly confirmed the need for those parts of the enabling act which authorized support for basic scientific research and for the training of scientists. The final version of the bill included, of course, those two objectives, as well as a number of others of lesser significance. Of these, some were later transferred to other agencies while the remainder appear to have been not vigorously pursued by the administration of the Foundation. Thus, the primary thrust of the Foundation's activities has remained that of strengthening basic research and education in the sciences.

Amendments to the National Science Foundation Act

Despite the lengthy, and presumably thorough, hearings and investigations preceding passage of the final form of the Senate bill, which established the National Science Foundation in 1950, the newly-created agency was soon to be altered in structure and modified in method and purpose. A number of these changes were effected internally by the agency's administrators under authority granted them under the original act, while some were brought about by Reorganization Plans and Executive Orders from the office of the President of the United States. Still other changes evolved and were implemented only after surviving the arduous route through normal legislative channels in the House and in the Senate; those surviving, of course, being far fewer in number than the total originally proposed.

As with any other document of considerable national influence and import, the National Science Foundation Act was seldom changed by amendments that were of a broad sweeping nature. Virtually all of the Foundation's original statutory functions were altered during the first fifteen years of operation, while structural changes were less frequent and generally of lesser significance.

The first year of operation of the Foundation was largely concerned with selecting necessary personnel and with interpreting objectives and goals, and charting the course of the organization. This period of self-analysis led to one of the earliest structural changes within the agency, as reported by Dr. Alan T. Waterman, the first Director of the Foundation:

> During fiscal 1952 the programs of the Division of Biological Sciences and the Division of Medical Research were combined on an experimental basis to permit an integrated program covering all of the life sciences.[21]

The functions of initiating and supporting basic scientific research were now to be accomplished through only three divisions: the Division of Mathematical, Physical, and Engineering Sciences; the Division of Biological and Medical Sciences; and the Division of Scientific personnel.

A 1953 amendment removed the original statutory limitation on appropriations, substituting for the $15 million maximum in Section 16.(a), the clause, ". . . such sums as may be necessary to carry out the provisions of this act."[22] This amendment was, of course, inevitable. No one could reasonably expect an agency with charges such as those given to the National Science Foundation to be at all effective on a national scale with a budget limitation of $15 million annually.

In the year following the appropriations amendment, President Eisenhower issued Executive Order 10521, which was intended to clarify and elaborate upon the responsibilities of the Foundation relative to conducting studies, making recommendations, and reviewing and coordinating programs of other federal agencies. Many of these responsibilities were later assumed by the Federal Council for Science and Technology which was created by President Eisenhower's Executive Order 10807, on March 17, 1959.

Reports of committee hearings on proposed amendments in 1958 indicate that there was continuing concern over the shortage of trained scientists and engineers. Consequently, bills were introduced to encourage the training of more engineers and engineering teachers, to provide incentive awards in science to high school students, and to provide fellowships for high school science teachers. These amendments, however, failed of passage.

The scope of different science disciplines in which the Foundation had been active was expanded still more by an amendment passed in July, 1958, which added paragraph 9 under Section 3.(a) as follows:

> (9) to initiate and support a program of study, research and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and Congress thereon.[23]

The amendment also spelled out details concerning authority for, and implementation of, the above new charge. In that same year the National Science Board also approved establishment of an Office of Social Sciences within the Foundation.

A 1959 amendment resulted in stronger emphasis being given to strengthening the Nation's scientific potential, by encouraging and providing additional opportunities for training more engineering and science students. This amendment also effected minor changes in the Foundation's organization, which included changes in National Science Board meeting times, election procedures, Executive Committee membership, property acquisition by the Foundation, international cooperation, and compensation for Board and Committee members.[24]

Still other minor changes were brought about by a 1960 amendment concerning the agency's use of certified mail and the inclusion of "nationals" as well as "citizens" among those eligible to receive Foundation grants.[25]

Reorganization Plan No. 2, issued by President Kennedy in 1962, established a new Office of Science and Technology, and transferred from the National Science Foundation to the new office the following:

> (1). So much of the functions conferred upon the Foundation as will enable the Director to advise and assist the President in achieving coordinated Federal policies for the promotion of basic research and education in the sciences;
>
> (2). The functions conferred upon the Foundation by that part of Section 3(a). 6 . . . which reads as follows: "to evaluate scientific research programs undertaken by agencies of the Federal Government."[26]

The same Reorganization Plan also reduced the size of the Executive Committee of the Foundation from nine members to five members, and directed that Divisional Advisory Committees need report only to the Director of the Foundation rather than to the National Science Board. A minor amendment later that year modified the required loyalty oath and required individuals seeking Foundation support to submit statements of criminal records. The amendment also prohibited members of subversive organizations from making application for fellowships or scholarships.[27]

In recognition of the greater complexity of the administrative structure of the Foundation, due to ever-increasing scientific activity, President Johnson issued Reorganization Plan No. 5 in May, 1965.[28] This instrument empowered the Director of the Foundation to delegate certain powers vested in him by the Act, but of greater importance to this study, the Plan abolished the Divisional Committees which were originally established under Section 3.(a) of the National Science Foundation Act of 1950. The number of Divisional Committees had already grown to an unwieldy eight, with at least three of them having overlapping responsibility and authority concerning matters of scientific personnel and education. Plan No. 5 also allowed the Director to make the necessary changes following abolition of the Divisional Committees.

The most recent changes occurred in July of 1968 when Congress approved legislation calling for revision of the National Science Foundation Act, as amended.[29] The origin and passage of this legislation was due primarily to the efforts of Representative Emilio Daddario of Connecticut, who has served as Chairman of the Subcommittee on Science, Research, and Development. Those changes of greatest significance are here summarized:

1. the addition of social sciences to the statutory functions listed under Section 3.(a) 2;

2. the addition of a paragraph authorizing the Foundation to

> ". . . foster and support development and use of computor and other scientific methods and techniques, primarily for research and education in the sciences.";

3. changes which had the net effect of considerably de-emphasizing that aspect of research described as "basic," while at the same time specifically permitting "applied" research for the first time. Minor changes in this same bill concerned responsibility for pursuit of national policies, duties and functions of the Deputy Director, restructuring of the Executive Committee, and the Director's authority to fix compensation of Foundation personnel.

Thus, although numerous changes have been made over the years, the original authority and broad functions of the National Science Foundation have suffered no severe limitations. More accurately, those functions of the Foundation coming under "education in the sciences" have been considerably expanded. This will be examined in the following chapter.

Footnotes

[1]Vannevar Bush, Science: The Endless Frontier (Washington, D.C.: National Science Foundation, 1945), pp. 3-4.

[2]*Ibid.*

[3]*Ibid.*, p. 31.

[4]*Ibid.*, p. 32.

[5]U.S. Congress, Senate, Legislative Proposals for the Promotion of Science, S. Doc. 92, 79th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1945), pp. 7-11.

[6]*Ibid.*, pp. 1-6.

[7]91, pt. 6, Cong. Rec. 8051 (1945).

[8]93, pt. 4, Cong. Rec. 5515 (1947).

[9]U.S. Congress, United States Statutes at Large: Public Laws and Reorganization Plans, Vol. LXIV, Pt. 1, (Washington, D.C.: Government Printing Office, 1950-1951), pp. 149-157.

[10]Bush, Science: The Endless Frontier (1945), *op. cit.*, p. 31.

[11]*Ibid.*, p. 34.

[12]U.S. Congress, Senate, Hearings on Science Legislation, Hearings Before a Subcommittee on Military Affairs on S. 1285, pts. 1-6, 79th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1945), p. 828.

[13]*Ibid.*, p. 909.

[14]U.S. Congress, House, National Science Foundation Act: Hearings Before a Subcommittee of the Committee on Interstate and Foreign Commerce, on H. R. 6448, 79th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1946), p. 16.

[15]Cong. Rec. 5251 (1947), *op. cit.*

[16]Public Papers of the Presidents of the United States: Harry S. Truman 1947 (Washington, D.C.: Government Printing Office, 1963), p. 368.

[17]U.S. Congress, House, National Science Foundation, Hearings Before a Subcommittee of the Committee on Interstate and Foreign Commerce, on H. R. 359, 81st Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1949), p. 91.

[18]*Ibid.*, p. 34.

[19]U.S. Congress, Senate, *Legislative Proposals Promoting the Progress of Science*: S. Doc. 90, 81st Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1949), p. 2.

[20]U.S. Congress, Senate, *Supplemental Appropriations for 1951*: Hearings Before the Committee on Appropriations, 81st Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1950), p. 881.

[21]National Science Foundation, *The Second Annual Report of the National Science Foundation* (Washington, D.C.: Government Printing Office, 1952), p. 18.

[22]U.S. Congress, *United States Statutes at Large: Public Laws and Reorganization Plans*, Vol. LXVII (Washington, D.C.: Government Printing Office, 1953), p. 488.

[23]U.S. Congress, *United States Statutes at Large: Public Laws and Reorganization Plan*, Vol. LXXII, pt. 1 (Washington, D.C.: Government Printing Office, 1958), pp. 353-354.

[24]U.S. Congress, *United States Statutes at Large: Laws and Concurrent Resolutions, and Proclamations and Proposed Amendments to the Constitution*, Vol. LXXIV (Washington, D.C.: Government Printing Office, 1960), p. 202.

[25]*Ibid.*, p. 256.

[26]*Public Papers of the Presidents of the United States: John F. Kennedy 1962* (Washington, D.C.: Government Printing Office, 1963), p. 282.

[27]U.S. Congress, *United States Statutes at Large: Laws and Concurrent Resolutions, and Reorganization Plan, Proposed Amendment to the Constitution, and Proclamations*, Vol. LXXVI (Washington, D.C.: Government Printing Office, 1962), p. 1069.

[28]*Public Papers of the Presidents of the United States: Lyndon B. Johnson 1965* (Washington, D.C.: Government Printing Office, 1966), p. 589.

[29]U.S. Congress, *United States Statutes at Large: Public Laws and Reorganization Plans*, Vol. LXXXII (Washington, D.C.: Government Printing Office, 1968), pp. 360-367.

CHAPTER III

THE INITIATION AND DEVELOPMENT OF NATIONAL SCIENCE FOUNDATION PROGRAMS FOR EDUCATION IN THE SCIENCES

Rationale and Incentives for the Programs

As World War II drew to a close in 1945, national leaders recognized that the health, strength, and welfare of this country would depend increasingly on sources of new knowledge. The preceding war years had necessarily been a period of intense technological application of the fruits of basic scientific research during which the unexploited pool of scientific knowledge, accumulated through basic research activity during the pre-war years by both American and European scientists, had been rapidly depleted. Thus, if the United States intended to remain a successfully competitive and effective world power, new scientific knowledge was an essential need of both industry and government. Technological progress depended on the flow of new knowledge. This new knowledge had to come from our own research laboratories, as urged by Dr. Vannevar Bush when he wrote:

> A nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill.[1]

In addition to domestic and international economic effects, a continuing flow of discoveries and new knowledge from the nation's basic research facilities was considered essential to national military security. In testimony given before the Senate Military Affairs Committee in 1945, Dr. Lee DuBridge confirmed the interdependence of war-time military technology and peace-time basic research as follows:

> The Chairman. I want to ask you a question at that point, Doctor. Isn't it a fact that in time of war there is never time to develop any new basic ideas? You utilize the peactime research in the application of basic things developed during peace?
>
> Dr. DuBridge. That is correct.
>
> The Chairman. So we have gone through a period of approximately 5 years that are barren of basic research?
>
> Dr. DuBridge. That is exactly right.
>
> The Chairman. And if there should be another war that war will have to rely on the interim period for all the basic research which can be utilized by the scientists?
>
> Dr. DuBridge. That is right.[2]

Basic research is carried on with little thought given to practical ends, and is intended to produce new knowledge. The bulk of this basic research has been carried on in college and university laboratories, with some being done in private as well as government research institutes. Adequate numbers of research scientists* and technicians trained to man these basic research laboratories were not available in immediate post-war years. The combined effects of several factors produced this post-war shortage of scientists and engineers, foremost among them being the disruption of the university education of potential scientists by wartime manpower draft needs. Others, who were adequately trained, chose to pursue post-war careers in areas of

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*Throughout this study, unless otherwise noted, the term "scientist" will mean those trained and practising in fields of science listed under Section 3.(a) 2, on p. 15 of this study.

applied research and technological applications of scientific knowledge, frequently with industrial or military organizations.

Stimuli for proposed National Science Foundation programs for education in the sciences, then, came from recognition of the need for nation-wide programs of basic research to replenish and enlarge the country's store of fundamental knowledge; from the lack of adequate numbers (due to attrition and non-replacement) of qualified basic research scientists to staff the growing numbers of basic research laboratories; and, to a lesser extent, increasingly pessimistic views concerning the availability of private funds for education in the sciences. Some idea of the extent of this post-war shortage of trained manpower is gained from Alfred Winslow Jones' lead article in Scientific American:

> Curtailment of education during the war cut the maturation of new scientists by half. The grievous loss may be estimated as some 20,000 graduates, including 3,000 doctors of science. Those who have been graduated are under an almost irresistible pull from industry.[3]

Clear recognition of this need for education in the sciences was manifest by Dr. Hugo Wolfe, speaking for the 3,000 member professional Federation of American Scientists before a House Committee hearing, when he stated:

> We must discover and develop new scientific talent amongst our own people in order to increase the benefits to our national life from basic and applied scientific research. Thus, funds allotted to the National Science Foundation can be expected to yield a handsome return to the national welfare.[4]

University scientists provided considerable support for the proposed science education activities of the emerging federal agency when they adopted a resolution proposed by the National Association of State Universities at its annual meeting in 1948. The Preamble to the resolution was as follows:

> Whereas it has long been evident and was never more evident than it is today that the national interest, welfare, and security are dependent upon the vigorous support and encouragement of basic scientific research and the training of specialized personnel for the adequate planning thereof; . . . .[5]

One would expect the military to be concerned less with pure research than with technological applications of the products of science to weaponry and defense systems. This outlook, however, was not prevalent during the formative period of the National Science Foundation objectives. Much to the contrary. As a representative of the National Military Establishment, testifying before a House Committee, Dr. Karl T. Compton indicated a profound respect for not only basic research, but also for the educational programs necessary to produce the scientists to carry on this research. In citing these interrelationships, Dr. Compton stated:

> Effective research, both basic and applied, obviously depends upon men and women soundly grounded in the accumulated learning of the past. . . . To equip human beings with this knowledge and these qualities is a long and expensive process. . . . Such individuals are truly a national resource, and it seems to me that increasing this resource is a proper function of government.[6]

Representatives of American industry were inclined to evaluate the programs of the Foundation from the standpoint of potential contributions to industrial progress and gain. Their testimonies and communications to legislative groups and individuals were most frequently addressed to matters of regulation and assignment of patent rights to any discoveries or inventions that might come out of basic research sponsored by the Foundation. One position which reflects greater awareness of fundamental necessities as well as increased concern for the best interests of the country was expressed by Edwin H. Land of the Polaroid Corporation. Mr. Land apparently took the minority position with respect to control of the scientific endeavor, when he stated:

> After several years of thinking about these bills, one thing stands out in my mind and that is the vital importance of the scholarship portions of both bills.* The wide dissemination of scholarships and fellowships for study and research at every level of our educational system seems to me perhaps the most important contribution these bills can make. . . . One of the great functions of the Foundation should, therefore, be to help educate and to create a large number of good scientists who are then helped economically but are left free to work in their own way.[7]

As with any meaningful piece of legislation, the Foundation bills contained provisions which were unacceptable to certain segments of the scientific community. Among the more significant objections to that section of the proposed Foundation bill authorizing the function of education in the sciences was one voiced by Dr. Frank B. Jewett, former president of the National Academy of Sciences. In his 1948 letter to the Chairman of the House Committee on Interstate and Foreign Commerce, which was holding hearings on proposed Foundation bills, Dr. Jewett included among a lengthy list of negative observations and opinions the following comment:

> Scientific education is but a part of general higher education and cannot be pushed ahead of it. It would, I think, be a serious mistake to single it out and entrust it to a foundation concerned primarily with entirely different matters. So far as Congress feels that Federal funds should be allocated to higher

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*Of the several versions of National Science Foundation bills being examined in the late 1940's, S1297 by Senator Harley Kilgore of West Virginia, and S1285 by Senator Warren Magnuson of Washington were most seriously considered.

> education, the interests of scientific education should, I am certain, be entrusted to a body concerned exclusively with education.[8]

Concern for the potential imbalance in the distribution of talent among the professions that could result from a program of intensive recruitment, education, and training of researchers for the physical and biological sciences was first expressed in the committee report to Dr. Bush by Dr. Henry Allen Moe, Chairman of the Committee on Discovery and Development of Scientific Talent. In his report, Dr. Moe included the caution that:

> When aided by selective devices for picking out scientifically talented youth, it is clear that large sums of money for scholarships and fellowships and monetary and other rewards in disproportionate amounts might draw into science too large a percentage of the Nation's high ability, with a result highly detrimental to the Nation and to science. Plans for the discovery and development of scientific talent must be related to the other needs of society for high ability; science, in the words of the man in the street, must not, and must not try to, hog it all.[9]

That recruiting zeal could be detrimental specifically to the social sciences was implied in a resolution passed by the American Educational Research Association in 1948 where it was urged:

> . . . that the National Science Foundation should contain provisions for research in the social sciences. Man has as much to learn about himself as about physical nature. . . . The Foundation will affect the distribution of talent; and if it emphasizes only the physical and biological sciences, it will in each oncoming generation drain off the most promising leadership from other essential fields, placing these fields in a more unfavorable position than they are at present, and thus progressively weaken the social leadership and fabric of our Nation.[10]

Eventually, as already cited in Chapter II, research in the social sciences became a statutory function of the Foundation with the amendment included in the 1968 charter revision. This amendment included provisions for programs to discover and train the necessary personnel for the social sciences.

In summary, the rationale and incentives for the programs of education in the sciences appear to have begun with recognition of the extent to which maintenance of a leadership position by our free society depended upon the continuous production of new scientific knowledge and its effective application. This, in turn, was dependent upon an adequate supply of able and trained scientists and engineers. The education required has always been lengthy and expensive, and these financial barriers, by preventing high ability students from going on to advanced work, have resulted in considerable waste of talent. One of the more promising measures by which this loss of talent might be avoided in the future was felt to be an effective Federally-sponsored program of education in the sciences that would serve to mitigate the financial burden.

Scholarships, Fellowships, and Traineeships

Two of the more important functions charged to the Foundation in its charter are found in Section 3.(b), which states:

> . . . it shall be one of the objectives of the Foundation to strengthen basic research and education in the sciences. . . .[11]

The administrative body established within the Foundation for carrying on that function of "education in the sciences" was the Division of Scientific Personnel and Education. That division, according to Section 7.(a) (4) of the National Science Foundation Act of 1950, was to:

> . . . be concerned with programs of the Foundation relating to the granting of scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences.[12] (Italics mine.)

Standard dictionaries indicate little or no difference between the terms "scholarship" and "fellowship," but for purposes of this study the differences between the terms becomes quite significant. Scholarships are usually awarded to undergraduate students and contain more restrictions than do fellowships, which are usually awarded to graduate and post-doctoral students.

Based on recommendations supplied by a study committee, Dr. Vannevar Bush included in his 1945 Report to President Truman a budget recommendation for the proposed National Research Foundation (later to be named the National Science Foundation) which would have provided funds for awarding 6,000 undergraduate scholarships and 300 graduate fellowships, to be administered during the first year of operation of the new agency. A 1947 poll taken by the Intersociety Committee on Science Foundation Legislation (representing over 75 scientific societies), reported that 84 percent of the societies polled felt that the Foundation should grant undergraduate scholarships.

In testimony before a House Committee, Dr. Charles MacQuigg, Director of the Engineering Experiment Station of The Ohio State University replied to a question by Representative Lea of California:

> Mr. Lea. Would the Federal aid that you recommend under this legislation if enacted extend to those who have not reached the graduate stage of education - undergraduates?
>
> Dr. MacQuigg. Yes, sir. That is intimated in the testimony which I referred to - the report of Dr. Moe's Committee. A scholarship, I believe, in educational practice is generally considered an undergraduate arrangement, whereas a fellowship means something on the graduate or post-graduate level.[13]

Numerous other scientists and educators advocated and urged that scholarships and fellowships be included in the Foundation Act. The importance attached to them by Dr. James Conant was clearly evident in his statement to the House Committee on Interstate and Foreign Commerce:

> . . . the provisions in these bills which empower the Foundation to grant scholarships and fellowships, . . . are by far the most important parts of the bills.[14]

The original enabling act included a section on Scholarships and Graduate Fellowships:

> Sec. 10. The Foundation is authorized to award, within the limits of funds made available specifically for such purpose pursuant to Section 16, scholarships and graduate fellowships for scientific study or scientific work in the mathematical, physical, medical, biological, engineering, and other sciences at accredited nonprofit American or nonprofit foreign institutions of higher education, selected by the recipient of such aid, for stated periods of time. Persons shall be selected for such scholarships and fellowships from among citizens of the United States, and such selections shall be made solely on the basis of ability; but in any case in which two or more applicants for scholarships or fellowships, as the case may be, are deemed by the Foundation to be possessed of substantially equal ability, and there are not sufficient scholarships or fellowships, as the case may be, available to grant one to each of said applicants, the available scholarship or scholarships or fellowship or fellowships shall be awarded to the applicants in such manner as will tend to result in a wide distribution of scholarships and fellowships among the States, Territories, possessions, and the District of Columbia.[15]

It is noteworthy here that the wording of the bill assures that the factor of residence or geographical distribution would remain subordinate to the ability of the applicant. Maintenance of high quality among students trained under these programs had been constantly emphasized. Noteworthy also is the exclusion of an earlier recommendation, made in the Bush Report, under which National Science Foundation Fellows would subsequently be enrolled in a National Science Reserve following their schooling. This was somewhat analagous to the Military Reserve, perhaps symbolizing an obligation of the Fellow to serve the country if war should again occur.

The use of scholarships and fellowships then, is authorized in several places in the National Science Foundation Act as originally passed; the Bush Report recommended their use; and distinguished scientists, legislators, and educators on numerous occasions cited them as desirable vehicles by which "education in the sciences" could be carried out. Implementation of the program of education in the sciences, however, did not begin until the 1952-53 academic year when 624 fellowships were first awarded--all of them restricted to graduate students. These awards were distributed so that 569 went to predoctoral graduate students, and the remaining 55 to postdoctoral applicants.

No undergraduate scholarships were awarded during the 1952-53 academic year, nor were any awarded in any succeeding year. A number of awards were made in 1959 which somewhat resembled undergraduate scholarships, called the Undergraduate Research Participation Program. Certainly the Foundation had adequate precedent on which to base decisions and actions concerning the scholarship and fellowship awards. Already in operation for varying numbers of years, and possibly with minor differences in objectives, were educational programs such as the G.I. Bill (Public Law 346, Seventy-Eighth Congress), the Naval Reserve Officers Training Corps, programs sponsored by the National Institute of Health and the Atomic Energy Commission, and training programs of the National Research Council (an arm of the National Academy of

Sciences). Data regarding the objectives and achievements of these programs were undoubtedly available to those in the National Science Foundation who were making decisions concerning scholarship and fellowship awards.

It is quite possible that the decision to place emphasis only on graduate fellowship programs was strongly influenced by Dr. Detlev Bronk, who was chairman of the National Research Council. This organization had long been sponsoring training programs in science exclusively for predoctoral graduate students and also for those who had already received their doctorate. Dr. Bronk was concurrently serving as Chairman of the Executive Committee of the National Science Board, which committee was instrumental in the policy decision cited in the First Annual Report of the National Science Foundation:

> Since the training of young scientists is of such crucial importance, the National Science Foundation has determined that a graduate fellowships program should be the first order of business. First emphasis will be given to fellowships rather than scholarships, because the completion of graduate work will have the most immediate effects upon the national supply of trained manpower.[16]

The reasoning behind the decision to not sponsor and support undergraduate scholarships in science appears to be expediential. Tangible results would surely be manifest sooner from a program supporting graduate education than from one supporting undergraduate education. There were several additional factors possibly bearing on this decision affecting the production of trained scientists. One was the interrelationship between graduate studies and basic research, in which dedicated graduate students would be not only studying, but actually participating and gaining experience in the processes of basic research, thus receiving the advanced training considered necessary for research scientists and engineers.

Still another factor was that cited by Dr. Randolf Major, representing the Merck Chemical Company, in testimony before a House Committee hearing where he stated:

> Very few collegiate undergraduates are sure of their future vocation, particularly in the first two years of college. Therefore, if scholarships are granted for scientific study, they may be given to those better qualified to enter other professions, and in other cases the recipients will decide after finishing college not to follow science as a career, thereby defeating the purpose of the grants.[17]

That this reasoning persisted over the years is brought out by Richard Bolt, writing for the National Science Foundation in 1961, in his statement:

> In the advanced training of scientists, for example, education and research are carried on together.[18]

The criteria for selecting the 624 Fellows in the first year of the program were consistent with statutory authority in that Fellows were selected solely on the basis of ability, but ability appeared to be concentrated in eight Northeastern states; and more particularly in New York State. Of the 624 Fellowships awarded for the 1952-53 academic year, 38 percent went to Northeast state applicants, and more than half of that 38 percent went to New York State applicants.

The National Research Council of the National Academy of Sciences carried out the preliminary selection process, and screened predoctoral applicants on the basis of examination scores, previous academic records, and letters of recommendation. Postdoctoral applicants took no examinations. A list of superior candidates was then submitted to the Foundation for final selection of Fellows.

The $1,532,971 allocated for the 1952-53 program was disbursed directly to the Fellows, who were then free to choose any accredited nonprofit institution of higher education in which to pursue their studies and research. Here also, a concentration occurred, in that the Fellows tended to seek training at a very limited number of select institutions.

These imbalances in geographic distribution of Fellows and in their selection of schools for their graduate studies and research occurred despite the safeguards built into the Foundation charter, and changes were later made in educational programs in attempts to remedy these minor faults. There were occasions when changes of this nature were prompted by members of Congress.

As is characteristic of any necessary and viable endeavor, the Fellowships program expanded over the next several years both in numbers of Fellows and in types of Fellowships. At the end of the 1964 fiscal year there were eight different graduate fellowship awards being made in the following numbers:[19]

Predoctoral:	Graduate Fellowships	1900
	Cooperative Graduate Fellowships	1326
	Summer Fellowships for Graduate Teaching Assistants	908
	Science Faculty Fellowships	325
	Summer Fellowships for Secondary School Teachers	292
Postdoctoral:	Senior Postdoctoral Fellowships	96
	Postdoctoral Fellowships	240
	Senior Foreign Scientists Fellowships	43

Because of an increasingly acute shortage of engineering manpower, the President's Science Advisory Committee in late 1962 urged that immediate remedial steps be taken. In response to this, the

Foundation established the Graduate Traineeship Program in fiscal year 1964, the emphasis of which was to be on producing trained engineers, rather than scientists or researchers. In addition, this program differed from most of the foregoing in that the institution applied for the number of traineeships it felt it needed, and trainees were selected by the institution from among graduate students within the school who had made application for traineeships. This differed from the Graduate Fellowships Program, where nation-wide competition produced qualified Fellows who were then permitted to use their Fellowship in a school of their own choosing. The Traineeships Program had the effect of giving the institution a better opportunity to attract and hold greater numbers of capable graduate students and thus help alleviate the geographical imbalance manifest in earlier years of graduate education programs.

Establishment of this program perhaps also reflects an attempt on the part of the Foundation to minimize or circumvent the risk of invidious comparisons between schools on the basis of how many Fellowships each had "collected." Additionally, the new program allowed increased control by the Foundation (and perhaps Congress also) over precisely where funds would go, as Graduate Traineeship monies could be geographically manipulated while little control could be exercised by the Foundation over those who had won Graduate Fellowships and entered schools of their own choosing. Further support for this is suggested when one examines the distribution of funds listed in Table 1, which shows that Graduate Traineeships received three times as much money as Graduate Fellowships during the 1967-68 academic year.

The Traineeship Program was expended over the next few years to include not only engineering, but also mathematical, physical, biological, and social sciences, and it eventually absorbed and replaced the programs of Cooperative Graduate Fellowships and Summer Fellowships for Graduate Teaching Assistants.

Thus at the end of the 1968 fiscal year the Foundation's program of education in the sciences, with respect to scholarships, fellowships, and traineeships, had no scholarships per se, and an existing program of fellowships and traineeships as follows:[20]

TABLE 1

FELLOWSHIPS AND TRAINEESHIPS OFFERED
FOR THE 1967-1968 ACADEMIC YEAR

Program	No. Offered	Net Obligations
Graduate Traineeships	5656	$30,229,305
Summer Traineeships for Graduate Teaching Assistants	965	1,063,102
Graduate Fellowships	2500	9,912,363
Postdoctoral Fellowships	120	663,500
Senior Postdoctoral Fellowships	55	537,901
Science Faculty Fellowships	223	2,864,768
Senior Foreign Scientist Fellowships	65	786,432
Total	9584	$46,057,371

There were additional graduate and advanced level educational activities sponsored by the Foundation which attempted to:

Improve and develop new courses and instructional materials in the sciences; and,

Provide opportunities for graduate departments and advanced graduate students to innovate and experiment with educational programs.

Institute Programs

The teacher training institutes considered relevant to this study, and which will be examined here, are group training activities that have been specially designed for science teachers with similar professional backgrounds. They are organized and conducted by colleges and universities and usually consist of supplementary training experiences which include remedial programs that emphasize basic subject matter and refresher programs that concentrate on new scientific knowledge. Guidelines established by the National Science Foundation for schools wishing to submit proposals for institutes specify that academic courses and experiences should be concentrated on science and mathematics subject matter, and not on methods of teaching these subjects.

Included in Chapter II of this study was an intensive review of the literature for the period prior to creation of the National Science Foundation. Sources yielded nothing to indicate that the Foundation intended, or was expected, to sponsor programs of education for teachers of science, although nothing in the original legislation specifically prohibited this particular function. As already pointed out in Chapter II, the primary emphasis of the Foundation was to be on encouraging and supporting basic scientific research and on the discovery and training of capable and talented scientific manpower. The authority under which these unique institute programs of direct Federal involvement in the training of science teachers was initiated most probably came from an expanded interpretation of that part of Section 3. (b) of the original Act which states:

> . . . it shall be one of the objectives of the Foundation to strengthen basic research and education in the sciences. . . .[21] (Italics mine.)

This position is further supported in the Eighteenth Annual Report, which contains the following statement:

> The National Science Foundation is charged by an act of Congress with specific responsibility for strengthening education in the sciences.[22]

Institutes are not the same as scholarships and fellowships, and thus are not authorized under Section 10, which authorizes the establishment and awarding of scholarships and fellowships. These, along with several other individual programs--each with its own design and objective--constitute the total Foundation program of education in the sciences, and thus are consistent with the interpretation of the Foundation act which emphasizes strengthening education in the sciences.

Institute programs are intended to increase the competence of science teachers and thus presumably improve the quality of classroom teaching. These intentions and assumptions are reflected consistently in statements made by various officials over the past fifteen years. During enactment hearings before a House Committee in 1948, Dr. Ralph McDonald of the NEA drew a cause-and-effect relationship between the quality of pre-college education and the Nation's success in scientific research efforts:

> It seems appropriate to point out in closing that a more adequately financed program of education at the elementary

> and secondary level seems absolutely essential to the success of a program of advanced study and research.[23]

Quality pre-college education affected not only the Nation's research efforts, but also the production of adequate numbers of competent scientists. Dr. Alan T. Waterman, first Director of the National Science Foundation, wrote in retrospect:

> It became apparent within the Foundation at an early date that the teaching of science and mathematics in the secondary schools would have to be improved if other measures being undertaken at the graduate and undergraduate levels were to be fully effective.[24]

Several years earlier the Foundation stated in its 1953 Annual Report:

> It is hoped that ways and means can be found through the secondary teachers at the secondary level to identify and motivate toward science those students who should become scientists.[25]

Testifying before a House Appropriations Committee hearing in 1960, the Foundation staff again emphasized the role of the teacher in influencing potential career scientists:

> The more a teacher knows about his field, the more he will be able to stimulate his capable students and to direct their interest toward intelligent consideration of careers in science and mathematics.[26]

Franklin Fisk, in reviewing National Science Foundation activities as part of his 1963 Doctoral dissertation, added support to the idea that the Foundation was created to produce more scientists:

> One would expect the Foundation to view the problem in this manner, that is, that the object of science instruction is mainly to produce scientists. This is one of the major reasons why the Foundation was created.[27]

In reporting on its major efforts at education in the sciences in the Annual Report for 1968, the Foundation cited its responsibility to provide training programs which would:

> Improve the competence of elementary school, secondary school, and college teachers through specially designed instructional programs . . . and, . . . Provide for the identification of high ability senior high school students, upper division college students and graduate students and appropriately support them in meaningful, enriched educational experiences in science.[28]

Institute training programs then, were expected to produce at least two significant effects:

1. They were to result in a better quality of science teaching, and,

2. They were to aid in the production of more and better-trained scientists.

The National Science Foundation has sponsored three different types of institutes:

1. Summer Institutes are group training experiences in subject matter for science teachers, held on college or university campuses during the summer, and vary in length from four to ten weeks.

2. Academic Year Institutes are specially designed subject matter training programs held on campus for an entire academic year, and are usually restricted to experienced teachers of science at the secondary and college level.

3. In-Service Institutes also provide subject matter training for teachers of science, but are conducted on a part-time basis throughout the year. Participating teachers utilize the facilities of nearby colleges and universities during evening hours and weekends.

Summer Institutes for College Faculty

The first of the three types of institute programs to be considered is the summer institute. Two were conducted during the first year of operation in 1953, both being for college and university science faculty members. One was an eight week long training experience held at the University of Colorado for college teachers of mathematics, and the other was a five week institute for college teachers of physics held at the University of Minnesota.

Summer Institutes for Secondary Teachers

Summer institutes for high school teachers of science and mathematics had been recommended by numerous scientists and educators since the Foundation was created, and were also considered by the Foundation staff. At a meeting in March, 1952, however, the committee advising the Division of Scientific Personnel and Education formally resolved that:

> . . . the Foundation should not enter the field of secondary education at this time, but that the idea should be tabled for further consideration.[29]

One of the more important objectives of the Foundation was to increase the Nation's supply of scientists and engineers. Statistics from 1953 showed that nearly two-thirds of the academically eligible high school graduates never entered college. This heavy mortality was then reflected in smaller numbers of graduate students in several disciplines, including science and engineering. It seemed appropriate then, to attack the problem at an earlier stage in the educational sequence by remedying the poor standard of science teaching in high schools. Dr. Bowen Dees, then head of the Foundation's Fellowship Programs, recognized the problem in his comment:

> Even when you were working on fellowship business, if you talked to a professor for more than 30 minutes or so, the topic of the miserable state of teaching in the high schools would open up.[30]

Dr. Harry C. Kelly, head of the Division for Scientific Personnel and Education, described the thinking and action that led to the first Foundation-supported summer institute for high school teachers of science and mathematics in 1954:

> Our job was to improve the scientific competence of the Nation, and it was obvious that you don't do this with programs that affect only the graduate level . . . We knew that the teacher was the key . . . we finally concluded that we should establish some mechanism: (1) to help teachers, and (2) to encourage universities to set up special courses. This mechanism was the institutes.[31]

The first was a four week institute in mathematics held at the University of Washington in 1954, which had an enrollment of 53 high school teachers--only 27 of whom were given stipends. As expected, the summer institutes program expanded in both number and in kinds of subject matter offered. Part of this was due to rising concern over the rapidly-increasing numbers of trained scientific manpower in Russia. By 1956 the number of summer institutes being offered for high school teachers of science and mathematics was 18, and included fields such as astronomy, biology, radiation biology, physics, chemistry, mathematics, and multiple or general field offerings.

During the several years prior to 1956, selection procedures favored the better high school teacher, who would then attend the institute to be

> . . . brought up to date on recent developments or modern approaches in science and mathematics.[32]

Experiences with earlier institutes, however, showed that many teachers had weaknesses in their grasp of fundamentals, and in recognition of this need the Foundation, in the summer of 1956, offered the first institute expressly for teachers who had only a bare minimum of training in the sciences. Thus, an even broader population became eligible for summer institute participation, and by 1968 the number of summer institutes being sponsored by the Foundation had swelled to 450.

Summer Institutes for Elementary Teachers

Summer institutes for elementary school teachers and supervisors were developed on an experimental basis in 1959, and became an established part of the institute program the following year.

Over the entire fifteen year period of operation, estimates indicate that about four thousand summer institutes provided subject matter training for nearly 200,000 participating teachers of science and mathematics from elementary, secondary, and college levels. In looking back over these years of institutes, Kreighbaum and Rawson venture that:

> In the long view of history, it may well be that the greatest contribution of NSF institutes in general, and the summer institutes in particular, is that they helped focus an evolving philosophy of teacher training on a key concept: that subject matter courses should receive essential emphasis. The "workshops" that centered around "how-to" courses have been supplanted by subject-oriented training, such as given in institutes.[33]

Academic Year Institutes

The academic year institute was a new and extended science teacher training program, inaugurated in September, 1956, for high school teachers of science and mathematics. College teachers of science and mathematics first participated in the program in the fall of 1959. No academic year institutes have been conducted for teachers of elementary science. Previous summer institutes varying in length from four to ten weeks had been sponsored since 1953, and were considered

successful in acheiving their objectives of supplementing the subject matter training of selected science teachers. The academic year institute was intended to achieve the same objective, but in designing and proposing a year-long program of education in the sciences the Foundation apparently felt that a different segment of the science teacher population could be reached and also that subject matter could be treated in greater depth and scope than was possible in the limited time span available under summer institute programs.

Because the academic year institute program will be examined more intensively and extensively in the following chapter, treatment in this section will be limited to a descriptive overview of the academic year institute program which is intended to aid in rounding out the overall perspective of that portion of the Foundation's activities designated "education in the sciences."

An educational institution, usually a college or university that had adequate staff and physical faciltles, would submit a proposal to the National Science Foundation requesting authority and funds to conduct an academic year institute. The proposal listed, according to guidelines supplied by the Foundation, personnel, budget details, courses of study to be offered, institute objectives, criteria and procedures for selection of participants, and available educational and other facilities. Upon approval of the proposal and the implied promise of necessary funds, averaging about $6,000 per participant per year, the college or university would solicit applications from prospective participants. The application form used by participants was standard and in keeping with Foundation guidelines. Criteria and procedures for selection of participants were determined by the institution, these being consistent with broad guidelines established by the Foundation. Characteristic criteria of eligibility are those established and used at Michigan State University, listed in the proposal to the National Science Foundation for an academic year institute in general science for secondary teachers for the 1963-64 academic year. Criteria of eligibility stated were:

A. Be currently employed as a teacher of general science at any grade level 7 through 12 or be directly supervising general science instruction in these grades.

B. Plan to return to teaching general science at the conclusion of the institute.

C. Be available in East Lansing from September 16, 1963, to June 13, 1964.

D. Have had a minimum of three years teaching experience by September 1, 1963, and have at least five years of teaching time available prior to retirement.

E. Give evidence that participation in the Institute will contribute to the competence and effectiveness of his science and mathematics teaching.

F. Give evidence that he possesses an adequate introduction to the field of study and manifests interest and ability for future development. In order to satisfy this requirement, applicants must have one year of a laboratory science, and satisfactory letters of recommendation.

G. Not have been previously a participant in an Academic Year Institute.

The National Science Foundation guidelines, besides requiring each participant to have had a minimum of three years of teaching experience, suggested that participants should have several years of teaching eligibility left before their retirement date. A more general guideline is found in the "Fact Book," distributed to institute directors in 1957:

> Each institute will establish its own criteria for admission within the general Foundation policy that candidates shall be considered primarily on the basis of professional competence and promise as teachers of science and/or mathematics.[34]

Civil rights legislation and integration policies put into effect in the early 1960's brought about a revision of the Foundation's selection criteria statement, so that in 1963 it read:

> Candidates shall be selected, without regard to race, creed, or color, solely on the basis of their ability to benefit from the program and their capacity to develop as teachers of science and/or mathematics.[35]

Applications received by the institution undergo screening and final selection, and normally about fifty participants would be selected by the institute staff. Several alternates would also be designated. Those selected would then be notified and asked to confirm their intention of attending the institute. Upon attendance, the participant would receive a stipend of $3,000 for the academic year, plus allowances for dependents, fees, tuition, books, and travel. Most schools provided curricula leading to such degrees as Master of Science in Science Education, or Master of Arts in Teaching, and this emphasis on earning a degree soon produced a common pattern of a sequential summer institute following the AYI which enabled some participants to complete the degree requirements.

In-Service Institutes for Secondary Teachers

In-service institutes were first offered in fiscal 1957, and were designed to meet the needs of supplementary subject matter training for secondary school teachers of science and/or mathematics. Participation in this program did not require large blocks of time as did the summer and the academic year institutes. In-service institute participants met evenings and/or Saturdays throughout the school year, usually at the best available institution within a 50 mile radius. Course work offered during these institutes differed little from that offered at other kinds of institutes.

Following the first experimental year, twenty-three in-service institutes were offered during the 1957-58 school year in various sciences, in mathematics, and in combinations of these. Foundation grants for expenses for the first year of these institutes totaled $162,300.

In-Service Institutes for Elementary and College Teachers

The in-service institute program appeared to be popular and successful and was expanded to provide thirteen institutes for elementary teachers and supervisors of science during the 1959-60 academic year, and the first one for college teachers of science was offered in that same year. A number of in-service institutes centered their activities around helping teachers to prepare to teach the emerging new science and mathematics courses. The Foundation funded eighty-one in-service institutes during the 1958-59 academic year at a cost of more than half a million dollars. By the middle 1960's, numbers of in-service institutes had levelled off at around 300 each year and were financed by annual appropriations of Foundation funds in excess of $2 million. A far less expensive program for carrying on training of this sort was explored by Brandou, in his study to determine the feasibility of training secondary teachers of science to serve in helping increase the physical science background knowledge of in-service elementary classroom teachers.[36]

Institutes had been sponsored continuously for twelve years by the National Science Foundation. In assessing the institutes program, U.S. Commissioner of Education Francis Keppel implied in a 1965 statement that the fundamental objectives of the program had been met:

> Through these institutes, teachers have become familiar with recent advances in their special fields of knowledge. They have familiarized themselves with new courses of study. They have developed new approaches to learning and teaching - - - benefitting not only themselves and their students but inspiring their fellow teachers as well.[37]

Kreighbaum added that peripheral benefits may also have been realized, when he commented:

> National Science Foundation believes the institutes have had other less tangible, but nevertheless important, side effects such as helping to keep needed high school teachers in the profession by supplementing their incomes with stipends and enabling them to qualify for salary boosts on the basis of institute training.[38]

It appears at this point in time, however, that one of the two primary objectives of the Foundation--that of increasing the Nation's supply of trained scientists--had not been achieved by the institute programs. In his 1968 summary study Kreighbaum stated:

> . . . the original theory that institutes would result ultimately in an increase in the Nation's pool of scientists and engineers does not appear to be working out as intended. The rewards of science must compete with the attractions of other fields and, while the number of students majoring in college science and mathematics has increased in absolute terms, the percentage has not risen, and probably will not for the rest of this century. In other words, those increases that have occurred are due to population explosion.[39]

Table 2 shows the chronological development of the various institute programs of the National Science Foundation. It is not to be assumed that each program, once begun, would remain thereafter as a permanent part of the total spectrum of Foundation programs. For example, summer institutes for elementary teachers were discontinued in 1967.

TABLE 2

CHRONOLOGICAL DEVELOPMENT OF NATIONAL SCIENCE FOUNDATION INSTITUTE PROGRAMS

Academic Year	Type of Institute	Participant Level
1953-54	Summer	College
1954-55	Summer	Secondary
1956-57	Academic Year	Secondary
1957-58	In-Service	Secondary
1957-58	Academic Year	College
1959-60	Summer	Elementary
1959-60	In-Service	College
1959-60	In-Service	Elementary

Course Content Improvement

In any educational process there are three primary factors: the teacher, the subject matter, and the student. The student has been, and continues to be, of greatest concern to the National Science Foundation. More specifically, being able to recognize capable and talented students as potential scientists, as well as encouraging and training them, has been a paramount objective behind the programs and activities of the Foundation. Programs to aid in achievement of these objectives, such as scholarships and fellowships and those institutes which fall within the purview of "education in the sciences," have already been examined and their effects noted. Although the institute programs, in focusing on teacher improvement, were designed primarily to upgrade and update the subject matter competence of science and mathematics teachers, the effects of teacher improvement would inevitably manifest themselves in the classroom and in what is taught there. Thus in one sense, course content improvement is assumed to be a natural consequence of teacher improvement. In another sense, course content improvement depends upon teacher improvement. The interrelationships between the two are described by Kreighbaum and Rawson:

> In the United States, the most noticeable effect of the institutes has been the manner in which they have assisted the Nation's high schools to adopt new science and mathematics curriculums.[40]

More specifically, Dr. George C. Pimentel, Professor at the University of California at Berkeley, and Director of the CHEM Study, apparently thinks that institutes are a quite essential part of curriculum development projects:

> I believe that chemistry teachers with strong backgrounds in content can teach CHEMS without too much retraining but the average teacher probably would be well advised not to undertake this change without retraining. This is where the Summer Institutes play a vital role.[41]

From a still broader perspective, one might conclude that any program sponsored by the Foundation under "education in the sciences" would have an effect on course content, for none would deny that the content of a mathematics course would be altered by a teacher following his year-long training experience at an academic year institute. Continuing along this line of thought, an examination of Foundation activities with respect to "course content improvement" would necessarily begin far back in the history of the National Science Foundation. For example, one of the more obscure relationships is hinted at in the Second Annual Report in 1952, where the Foundation links basic research to science education:

> Finally, basic research in the sciences, largely carried on in educational institutions, is of vital importance in training scientific manpower. Analysis of technological components will of necessity include evaluation of the impact of research and development activities upon science education and the institutions for advanced training in the United States.[42]

An activity somewhat peripheral to the main thrust of later programs was one proposed by the American Society for Engineering Education in 1954, where:

> . . . conferees spent 3 days discussing such subjects as (a) the status of the basic science areas, (b) the most important areas to be included in the engineering curricula, and (c) how these added materials can be introduced into an overcrowded curriculum.[43]

In this study the meaning of course content improvement will be restricted to include only those activities designed to have clear-cut and immediate effects on the subject matter being taught in approved educational institutions, and will treat only a sample of representative programs sufficient to characterize them and thus place the activity of course content improvement in focus with regard to the overall activity of "education in the sciences."

The Seventh Annual Report of the National Science Foundation lists, under the category "Grants other than Research," a grant of $545,000 to Massachusetts Institute of Technology in 1957, for a one year project in "The Teaching of Physical Science in the Secondary Schools." The following year this same project was described in the Eighth Annual Report under a new section heading of "Course Content Improvement Studies as:

> One of the most encouraging activities in high school science instruction today is the development of an entirely new course in physics for high schools. The new course represents a drastic departure from traditional methods of instruction

> both in selection of subject matter and in the methods of presentation . . . Everything possible has been done to bring maximum appreciation and understanding of the science of physics to the high school student. The new course has been tested in a number of high school classes with most encouraging results.[44]

This Eighth Annual Report also listed an additional one year grant of $500,000 for the project, and total financial support for the project by the Foundation had exceeded five million dollars by 1964. The idea for the new physics course is generally acknowledged to have originated with Professor Jerrold Zacharias, of Massachusetts Institute of Technology, who remained a guiding force throughout the development period of the new course. Following development, trial, and evaluation of the textbook, laboratory guide, new laboratory apparatus, motion pictures, monographs, and teachers guide, the new Physical Science Study Committee course (called PSSC) was made available in 1960-61 to all who wished to use it. Subject matter for developing the PSSC course was selected to achieve the following:

(1) To stress major achievements of physics, such as the great conservation principles.

(2) To give insight into the way in which these powerful ideas were conceived, matured, and sometimes overthrown by even more powerful ideas.

(3) To present a unified story in which the interconnections within physics were brought to light.

(4) To show physics as a human activity comparable in significance with the humanities, the languages, and the other major studies of high school students.

Criteria for selecting and structuring laboratory experiences were:

(1) Experiments should indeed be experiments, and not routine accumulation of data to agree with (or be forced into agreement with) a result known well in advance by both teacher and student.

> (2) Experiments should be performed wherever possible with simple apparatus that could be made by the students from inexpensive materials.
>
> (3) The laboratory work should be open-ended in that each experiment should suggest or encourage further experiments along similar lines, and wherever possible lead to the consideration of theoretical ideas flowing from experiment.[45]

Initiation of the PSSC course development was soon followed by development of a mathematics course at Yale University in 1958 (called School Mathematics Study Group, or SMSG), in which strong emphasis would be put on making mathematics more meaningful, and to teach students mathematics rather than merely how to perform mathematical operations. A major goal was to provide the student with a sound basis for college courses in calculus and analytical geometry by the time he completed high school.

A chemistry course based on the nature of the chemical bond was developed at Earlham College in 1959. The essentials of this new Chemical Bond Approach course (hereafter called CBA) are best described by the Director, Dr. Laurence E. Strong, who wrote:

> The Chemical Bond Approach Project is an attempt to produce a study of chemistry that will reveal the importance of theory and experiment. . . . The goal is an integrated laboratory and concepts course. The integration for the course is based on logical structure and methods of the discipline. The concept of structure in particular is used as a major intellectual tool for the discussion of chemical systems. Our evidence suggests that high school students can respond effectively to this kind of presentation.[46]

Still another new chemistry course was being developed concurrently at Harvey Mudd College under the direction of Dr. J. A. Campbell, called the Chemical Education Materials Study (hereafter called CHEM Study). Some specific objectives listed in the CHEM Study <u>Newsletter</u> were:

> . . . to diminish the current separation between scientists and teachers in the understanding of science, to stimulate and prepare those high school students whose purpose it is to continue the study of chemistry in college as a profession, to encourage teachers to undertake further study of chemistry courses that are geared to keep pace with advancing scientific frontiers, and thereby improve their teaching methods, and to further in those students who will not continue the study of chemistry after high school an understanding of the importance of science in current and future human activities.[47]

The most far-reaching, and the most expensive, of the several new courses described here is the one begun at the University of Colorado in 1959, under the Directorship of Dr. Arnold Grobman, known as the Biological Sciences Curriculum Study (hereafter called BSCS). Those structuring the BSCS course felt that upon completion of the course a student should have:

> An understanding of his own place in the scheme of nature; that he is a living organism and has much in common with all living organisms.
>
> An understanding of his own body; its structure and function.
>
> An understanding of the diversity of life and of the interrelations of all creatures.
>
> An understanding of what man presently knows and believes regarding the basic biological problems of evolution, development, and inheritance.
>
> An understanding of the biological basis of many of the problems and procedures in medicine, public health, agriculture, and conservation.
>
> An appreciation of the beauty, drama, and tragedy of the living world.
>
> An understanding of the historical development of some of the concepts of biology to show that these are dependent on the contemporary techniques, technology, and the nature of society.
>
> An understanding of the nature of scientific inquiry; that science is an open-ended intellectual activity and that what is presently "known" or believed is subject to "change without notice"; that the scientist in his work strives to be honest,

> exact and a part of the community devoted to the pursuit of truth; that his methods are increasingly exact and the procedures themselves are increasingly self-correcting.[48]

These latter courses of study evolved via the normal process of conferences, committees, and writers, after which they underwent trial and evaluation periods and were then made available to schools and individuals that desired to use them. By 1963, new courses were available for the three major sciences in secondary schools--chemistry, biology, and physics--as well as improved courses in mathematics. At that time the combined cost of all of these programs was in excess of $40 million of Foundation funds, and more has since been spent on them.

Some of the impetus for course improvement, including recommendations on techniques and methods, was provided during this period of intense activity between 1959 and 1963 by a report of the President's Science Advisory Committee which stated in 1959 that:

> The quality and content of the curriculum is central in education. . . we recommend that present efforts be aggressively pursued and substantially expanded in bringing together leading scientists, scholars, and teachers in these various subject-matter fields to seek:
>
> 1. To bring the course content in each subject at each level into line with the most recent scholarly research in its field, consonant with the level of instruction.
>
> 2. To outline, write, publish, and revise the necessary textbooks and auxiliary reading materials to achieve the above objectives.
>
> . . . .
>
> 3. To develop and supply adequate teaching and learning aids of all appropriate kinds, including motion pictures, television, tape recordings, slides, and other audio-visual materials designed to aid the student in understanding the subject more thoroughly, . . .

> 4. To develop and supply laboratory equipment and materials to make the laboratory and field work a far more meaningful, useful and exciting aid to student and teacher.[49]

A plethora of project proposals followed the President's Science Advisory Committee's statement, with some being of small scale, others quite comprehensive. Nor were projects limited to secondary levels, as work was done at Stanford University on an elementary mathematics program, and science programs were undertaken at the University of California and the University of Illinois, for elementary schools; The American Geological Institute Earth Science Curriculum Project and the Princeton University Laboratory Program were both designed for use at the Junior High school level; already mentioned at the high school level were the programs of PSSC, CBA, CHEMS, SMSG, and BSCS; and there were several programs having to do with undergraduate and graduate science and mathematics courses of instruction. The National Science Foundation budget allocations for course content improvement projects, of course, reflected the increase in number and variety of curriculum innovations, and increased from $6 million in fiscal year 1959 to more than $20 million in 1968.

One of the first to publicly praise and support the course content improvement activities was John R. Mayor, Director of Educational Activities of the American Association for the Advancement of Science, who wrote in Science Education in 1961:

> In my opinion, as of this date, the most important single event in education, and in science education in particular, of the past quarter century, has been the development of these sample courses for use in high school science classes. . . . Two years ago, I would have said that the most important event was the development of the summer institutes of the National Science Foundation. While institutes continue to offer

> tremendous advantages to science teachers, they have not served as well in bringing about the open minded and the experimental point of view as the curriculum studies have.[50]

This was followed by the expression of confidence in the programs by Dr. Bowen Dees, Assistant Director of the Foundation's Division of Scientific Personnel and Education in a statement he made before a House Appropriations Committee in 1961:

> Your comment to the effect that this is one of our very important programs is quite correct. We feel this represents one of the breakthroughs in science instruction which has been made over the last 100 years, at least.[51]

A more recent study provides some idea of the nationwide effect of the Foundation's course content improvement activities. A 1967 North Central Association of Colleges and Secondary Schools study suggests that 72 percent of the accredited high schools throughout the fifty states that adopted new curriculum practices covered in the survey, were using those that had been developed by groups supported by National Science Foundation funds.

More recently, the Foundation course content improvement programs have been diversified and more evenly distributed over the entire range of grade levels. Some representative science curriculum improvement activities supported by the Foundation during the 1968 fiscal year were as follows:

College: Production of fluid mechanics films
Application of computers to instructional problems in calculus
Development of laser techniques suitable for use in undergraduate instruction
Social science projects in group dynamics, political science, and psychology
Curriculum development in electronics technology

Pre-College: Completion of BSCS Study
The Anthropology Study Project
Social Studies Education Consortium
Studies on a biomedical technician curriculum
The Science Curriculum Improvement Study
The School Science Curriculum Project (grades 5-9)
The Earth Science Curriculum Project
The Engineering Concepts Curriculum Project
The High School Geography Project[52]

The relationships between course content improvement programs and the broader objective of the Foundation to produce more scientists can be seen in the preceding curriculum improvement projects. Scientists, and scientific societies, as ground-level participants are determiners of science curricula. This, in turn, permits then to structure and develop what they consider to be a proper foundation for students who are expected to pursue graduate work in the sciences and later qualify and join the ranks of practising scientists. That the National Science Foundation had this objective in mind is clearly shown in a Seventeenth Annual Report statement, in 1967, which read:

> As science and technology grow in importance, the necessity for the schools to provide sound instruction in science and mathematics increases. If children are to be properly motivated and prepared for careers in science, the Nation's schools need modern instructional materials, thoroughly competent teachers, and well-designed educational programs.[53]

Secondary Student Programs

Any viable agency that hopes to be effective must seek out and exploit every possible approach which will aid in achievement of its goal. The National Science Foundation, having as a primary goal the production of greater numbers of competent scientists, began by concentrating its early efforts on graduate students in science as well as on the university programs and faculties within which the graduate students were to grow and mature. Soon after, for reasons discussed earlier in this study, the Foundation established training programs for science teachers; first for college and later for secondary and elementary teachers. While these teacher training programs were undergoing an almost explosive increase in number and variety over the next several years, the high school student was not being overlooked. Science oriented programs which would directly involve the more talented and academically capable high school student, with the intent of getting and keeping them interested in science, were first launched in 1953 and have continued to thrive since that time. Thus, beginning with the 1953 addition of programs based on direct contact with secondary students, the total spectrum of National Science Foundation programs for "education in the sciences" was further broadened.

Following is a brief synopsis of several of the more significant Foundation sponsored programs aimed at secondary students.

The Foundation has awarded grants to Science Service, Inc., which supported and operated Science Clubs of America, and related activities. This program was the first of the Secondary School Student Training Programs, having been initially funded in 1953 with a $10,000 grant from the Foundation. Most of these funds were used to help organize and strengthen science clubs at the secondary level, and to sponsor local and regional science fairs for members of science clubs. Science Service, Inc. also compiled and published a pamphlet for secondary students titled <u>Thousands of Science Projects</u>.

The Traveling High School Science Library was a joint project with the American Association for the Advancement of Science to make available adequate library facilities to schools; particularly small schools in rural communities. The initial Foundation grant of $23,250 in 1955 was primarily for expenses of packaging and circulating, at the request of interested schools, sets of 200 science books selected by the AAAS. During summer months these books were made available to Foundation-sponsored summer institutes. The library program was discontinued after 1962.

The Traveling Science Demonstration Lecture Program was jointly sponsored by the Atomic Energy Commission and the National Science Foundation. The $115,800 budget for the first year of operation was administered by the Oak Ridge Institute of Nuclear Studies, where selected, experienced high school teachers received three months of intensive, specialized training. Upon request from an individual school, the trained teacher would go there and present programs of lectures with demonstrations, stressing the scientific principles involved in various subjects of scientific interest. The objectives of the program were:

> . . . to stimulate interest in science and in science teaching, to improve teaching methods, and to provide a greater number of secondary school students with a deeper appreciation of science and scientific careers.[54]

The program was considerably over-subscribed for the 1958-59 school year, and was awarded a $296,000 grant for the 1960-61 fiscal year. Despite this apparent success, the program was terminated in 1961.

The Visiting Scientists Program was initiated in 1954, in an attempt to have eminent scientists visit small college campuses for periods of several days in order to carry on discussions with students and faculty. Discussions usually centered around recent developments in the visiting scientist's discipline, as well as on career opportunities. The program was expanded to include high schools for the 1957-58 academic year. Beginning with an initial grant of $15,000 to the Mathematical Association of America in 1954, the program expanded in numbers of different disciplines, in scientists and schools involved, and in budget allocations. In 1966, forty-nine grants were made, costing a total of $457,000.

In 1957 a grant of $85,000 was made to the WGBH Educational Foundation in Massachusetts to finance the production of three films in a series designed to portray the activities of the International Geophysical Year. The I.G.Y. was a long-term study, undertaken by the Foundation, of the physical earth and its interrelationships with other celestial bodies.

A pilot program for the Secondary Student Training Program was funded by the Foundation for two summer institutes in 1958. The popularity of this program resulted in National Science Foundation sponsorship of 136 training programs for the summer of 1959, accommodating over 5,000 high-ability secondary students. A maximum was reached in 1964, when 185 programs were sponsored for 7,600 students. The program was designed to provide talented and academically capable secondary students with educational experiences beyond those normally available in the high school. Objectives cited by the Foundation were:

a. Identify high-ability secondary students who have excellent potential for becoming creative scientists--and to help these students identify their own interests, abilities, and limitations.

b. Accelerate their scholarly development by providing opportunity for instruction in scientific content and methods by scientists of recognized stature.

c. Develop cooperation between colleges and high schools in increasing the quality of education in the sciences.[55]

Program activities were conducted on the campus of the college or university and included lectures, quizzes, laboratory work, field trips, and research experience. In 1966 the program was altered so that selected students could participate during free time on Saturdays or evenings throughout the academic year, rather than only during summers. The program has been immensely successful and popular since its inception, and was conducted by schools in nearly every state as recently as the 1968-69 academic year.

The Cooperative College-School Science Program, first sponsored in 1958, is somewhat like the preceding Secondary Science Training Program as regards secondary student activities. A major difference between the two, however, is that considerable emphasis is placed on involvement and participation of the teacher as well as the secondary student in this program. By the latter half of the 1960 decade, the emphasis of this program had shifted to where a college or university would work cooperatively with a local school system to bring about improvement in the science education program of the entire school system, with secondary student participation being an adjunct.

State Academy of Science Programs were begun in 1959 with 43 grants being made to State Academies. These funds were used to support Visiting Scientists Programs and Junior Academies of Science. Activities of the latter included research studies and presentation of papers before the Senior Academy.

Of the dozen or so different secondary student science-incentive programs sponsored by the Foundation over the past fifteen years, some have been dropped, some have been absorbed by other agencies, and some are continuing and are successful.

The programs intended to improve the science education of secondary students can be arbitrarily placed into three categories as follows:

1. Participatory: The student is part of a program and does something. Example, - Summer Science Training Program.

2. Supplementary: Direct contact, but student somewhat passive. Example, - Traveling Scientists Demonstration.

3. Supplementary: Indirect, no contact with student during the program. Example, - Academic Year Institute for Teachers.

Reports of attempts to objectively evaluate the merits and effectiveness of programs in each of these categories are indeed rare. One study with rather encouraging results is reported in the Eighteenth Annual Report of the National Science Foundation which states:

> Systematic studies designed to evaluate aspects of the Student Science Training Program have been made and have shown that substantially all SSTP participants ultimately enter college, where a high percentage major in science and aim toward careers in science. A study completed in 1968 reports on the SSTP students of 1960 at the point of their college graduation. It shows that 73 percent of the young men were majoring in the physical sciences, engineering, mathematics, or biological sciences. An additional 12 percent were majoring in the social sciences or the health professions. Furthermore, "science" was a first occupational choice of 69 percent of the young men and 50 percent of the young women.[56]

No studies of significance were found which attempted to evaluate the effects of programs under category 2. above. Studies relating to the Academic Year Institute Programs will be reviewed in subsequent chapters.

Conferences and Seminars

Conferences and seminars represent two avenues by which "education in the sciences" has been successfully pursued over the entire span of the Foundation's history. According to current definitions, seminars are most commonly an activity engaged in by graduate students and are internal to a particular discipline within an institution. As such, their greatest educational effects would be manifest in the programs treated in an earlier section of this chapter under Scholarships, Fellowships, and Traineeships. Any further reference in this section to seminars then, will exclude those described above. Furthermore, no consistent distinctions are made by the Foundation between teacher-training activities listed variously as conferences, symposia, workshops, or seminars. Therefore, the terms will be used here interchangeably unless otherwise delineated.

Conferences and symposia have long been used by scientists, as well as by others, as a method for organizing and disseminating information about a field of study. The conferences draw together leading scientists from one or more countries to exchange information on recent research findings, to develop improvements in techniques, and to plan for future research. This kind of activity was one of the earliest to be sponsored by the Foundation, presumably under authority of that section of the charter charging the Foundation to "foster the exchange of scientific information," because the activity of "education in the sciences" had not yet been developed clearly as a part of the Foundation's operation.

Three conferences were supported as far back as 1952, with at least one of them being jointly sponsored with other Federal agencies. Eight more conferences were sponsored during fiscal year 1953, dealing with topics in the physical and biological sciences, as well as in mathematics. During this same year the program was expanded to include conferences for college teachers, along with workshops and advisory conferences. The significance of these first conferences for college teachers (they were called "institutes") was that the stated purposes were to improve education in science, and not to focus on reports and plans for research. The educational benefits were recognized by the Foundation in the Fourth Annual Report, which stated:

> The direct contact (of participating teachers) with active scientists has been beneficial in improving teaching and curricula, which in turn stimulates students at the undergraduate level, making them more aware of current scientific progress at an early stage in their training and encouraging them to undertake careers in research.[57] (Parentheses mine.)

This represents an expansion of Foundation interests, for conferences of both types have been supported during each year since 1953--those held exclusively for and with "leading scientists," and those involving teachers of science. Since the concern of this study is with "education in the sciences," only conferences and seminars which clearly fall within the latter category are here considered.

Two conferences for engineering education were added in 1954 to the four already scheduled to be held for college teachers of science and mathematics. The program of conferences slowly grew, and by the summer of 1960 the number of conferences, symposia, seminars and workshops concerned with science and mathematics education at all grade levels which were supported by the Foundation had reached 45, and were funded with slightly over $600,000 of Foundation money. No estimates of the number of participants for that year were available. Some idea of the range of topics treated can be gained from the following list of activities, which is representative of those conducted during the 1960-61 fiscal year:

Summer Conference in the Recent Developments in Nonaqueous Solvents for College Teachers of Undergraduate Chemistry, 14 days.
Conference on Interpreting Modern Science to the Public, 3 days.
Science News Writing Seminar, 6 days.
Symposium on the Educational use of Planetariums, 3 days.
Workshop in Microbiology for Secondary Teachers, 14 days.
Symposium on Educational Frontiers in Biomedical Engineering, 2 days.[58]

Reading over the entire list of these sponsored activities makes one aware of not only the growth of this phase of "education in the sciences," but also of the breadth of interests supported by the Foundation, and of the existence and availability of educational training opportunities for teachers at all grade levels.

By 1967 the popularity and/or effectiveness of the short two-to-six day conference appeared to decline to the point where only a handful were proposed and supported. In this same year there appeared a type of summer conference much resembling summer institutes, in that they focused on teacher training and extended over several consecutive weeks during the summer months. Twenty-two of those one-month summer conferences were sponsored in fiscal year 1967, primarily for high school teachers of science, but also included college teachers. They averaged about thirty teachers per conference, with Foundation financial support averaging about $20,000 per conference. By 1968 the nature of these summer conferences had apparently been altered, as they were listed by the Foundation as being ten-month grants. The significant factor, however, is that the purpose of conferences in 1968 continued to be that of teacher training--the same as it was in 1952.

In total perspective, that function designated "education in the sciences" experienced a meteoric rise with the growth of the National

Science Foundation. Earliest efforts of the Foundation were intensely concentrated on support of graduate students in science through the fellowships program, and later included traineeships. This was soon followed by programs, first to train college teachers, then secondary and elementary teachers of science and mathematics. Peripherally, numerous other programs evolved, under Foundation sponsorship, to include nearly every conceivable aspect of education in science at every grade level from pre-school to post-doctoral. However, the primary emphasis of the Foundation on education, reflected by the approval of proposals and awarding of grants, has continued to be the fellowships and institutes. These two areas have consistently commanded the lion's share of the budget allocated for "education in the sciences," as shown in Table 3.

TABLE 3

DISTRIBUTION OF BUDGET ALLOCATIONS FOR EDUCATION IN THE SCIENCES FOR THREE SELECTED YEARS

Year	Total for Education in Science[a]	Fellowships	Institutes
1955	$ 2,099,496	$ 1,783,706	$ 315,790[b]
1960	66,883,695	13,391,316	33,775,040[c]
1968	124,832,567	46,057,371	38,327,747[d]

[a]The figures under Education in Science for the 1955 and 1960 years were reported in the Annual Reports under Support of Scientific Manpower.

[b]National Science Foundation, Fifth Annual Report for the Fiscal Year 1955 (Washington, D.C.: Government Printing Office, 1955), p. 156.

[c]National Science Foundation, Tenth Annual Report for the Fiscal Year Ended June 30, 1960 (1961), op. cit., p. 169.

[d]National Science Foundation, Eighteenth Annual Report for the Fiscal Year Ended June 30, 1968 (1968), op. cit., pp. 254-255.

Also to be noted in the preceding Table is the enormous increase, between 1955 and 1960, of money available for institutes. The increase in appropriations for institutes was undoubtedly due to recognition of the need for increased training of practising teachers of science, with the 100-fold increase between 1955 and 1960 being at least partly due to the Sputnik phenomenon. The relative "levelling-off" of increases in institute appropriations since 1960 may be a consequence of the combined effects of improved teacher training programs at the undergraduate and graduate levels, and of what might best be described as depletion of the supply of experienced teachers in need of this training.

Another factor not to be overlooked is that a considerable portion of the 1968 total, allocated to education in the sciences, is used to support programs ancillary to teacher training institutes, such as course content improvement and secondary student programs.

Because the National Science Foundation has been continuously supporting academic year institute programs since 1956, and to further explore factors discussed in Chapter II of this study, the writer will in the next chapter intensively and extensively examine that portion of the Foundation's institute program called the academic year institute.

Footnotes

[1]Vannevar Bush, Science: The Endless Frontier (Washington, D.C.: National Science Foundation, 1945), p. 19.

[2]U.S. Congress, Senate, Hearings on Science Legislation, Hearings before a Subcommittee of the Committee on Military Affairs, 79th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1945), pt. 1-6, p. 829.

[3]Alfred Winslow Jones, "The National Science Foundation--its Momentous Responsibility will be to Assist the Fundamental Research which is Essential to Human Progress." Scientific American, Vol. CLXXVIII (June, 1948), p. 7.

[4]U.S. Congress, House, National Science Foundation, Hearings Before the Committee on Interstate and Foreign Commerce, 80th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1948), p. 81.

[5]Ibid., p. 127.

[6]U.S. Congress, House, National Science Foundation, Hearings Before a Subcommittee of the Committee on Interstate and Foreign Commerce, 81st Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1949), p. 115.

[7]Ibid., p. 146.

[8]U.S. Congress, House, National Science Foundation (1948), op. cit., p. 120.

[9]Bush, Science: The Endless Frontier (1945), op. cit., p. 143.

[10]U.S. Congress, House, National Science Foundation (1948), op. cit., p. 106.

[11]U.S. Congress, United States Statutes at Large: Public Laws and Reorganization Plans, Vol. LXIV, pt. 1 (Washington, D.C.: Government Printing Office, 1950-1951), p. 149.

[12]Ibid., p. 152.

[13]U.S. Congress, House, National Science Foundation, Hearings Before the Committee on Interstate and Foreign Commerce, 80th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1947), p. 71.

[14]Ibid., p. 147.

[15]U.S. Congress, United States Statutes at Large: Public Laws and Reorganization Plans (1950-1951), op. cit., p. 150.

[16]National Science Foundation, The First Annual Report of the National Science Foundation, Year Ending June 30, 1951 (Washington, D.C.: Government Printing Office, 1951), p. 17.

[17]U.S. Congress, House, National Science Foundation (1947), *op. cit.*, p. 179.

[18]National Science Foundation, Investing in Scientific Progress, NSF 68-28 (Washington, D.C.: National Science Foundation, 1961), p. 4.

[19]National Science Foundation, Grants and Awards for the Fiscal Year Ended June 30, 1964 (Washington, D.C.: Government Printing Office, 1964), p. 207.

[20]National Science Foundation, Eighteenth Annual Report for the Fiscal Year Ended June 30, 1968 (Washington, D.C.: Government Printing Office, 1968), p. 154.

[21]U.S. Congress, United States Statutes at Large: Public Laws and Reorganization Plans (1950-1951), *op. cit.*, p. 150.

[22]National Science Foundation, Eighteenth Annual Report for the Fiscal Year Ended June 30, 1968 (1968), *op. cit.*, p. 149.

[23]U.S. Congress, House, National Science Foundation (1948), *op. cit.*, p. 114.

[24]Alan T. Waterman, "The National Science Foundation Program for High School Teachers." California Journal of Secondary Education, Vol. XXXII (March, 1957), p. 172.

[25]National Science Foundation, The Third Annual Report of the National Science Foundation, Year Ending June 30, 1953 (Washington, D.C.: Government Printing Office, 1953), p. 54.

[26]U.S. Congress, House, Independent Offices Appropriations for 1961: Hearings Before the Subcommittee of the Committee on Appropriations, 86th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1960), pt. 3, p. 117.

[27]Franklin G. Fisk, "Is the National Science Foundation Becoming a New Federal Education Agency?" (Unpublished Doctoral dissertation, University of Kansas, 1963), p. 166.

[28]National Science Foundation, Eighteenth Annual Report for the Fiscal Year Ended June 30, 1968 (1968), *op. cit.*, p. 149.

[29]Hillier Kriegbaum and Hugh Rawson, To Improve Secondary School Science and Mathematics Teaching (Washington, D.C.: Government Printing Office, 1968), p. 5.

[30] Ibid., p. 11.

[31] Ibid.

[32] Ibid., p. 17.

[33] Ibid., p. 41.

[34] Ibid., p. 24.

[35] Ibid., p. 34.

[36] Julian R. Brandon, "A Study of an Experimental Program for the In-Service Science Education of Elementary School Teachers." (Unpublished Doctoral dissertation, Michigan State University, 1963).

[37] Kriegbaum and Rawson, To Improve Secondary School Sciences and Mathematics Teaching (1968), op. cit., p. 37.

[38] Ibid., p. 39.

[39] Ibid., p. 40.

[40] Ibid., p. 36.

[41] Ibid., p. 37.

[42] National Science Foundation, The Second Annual Report of the National Science Foundation 1952 (Washington, D.C.: Government Printing Office, 1952), p. 12.

[43] National Science Foundation, Fourth Annual Report for the Fiscal Year Ended June 30, 1954 (Washington, D.C.: Government Printing Office, 1954), p. 55.

[44] National Science Foundation, Eighth Annual Report for the Fiscal Year Ended June 30, 1958 (Washington, D.C.: Government Printing Office, 1959), p. 65.

[45] Fisk, "Is the National Science Foundation Becoming a New Federal Education Agency?" (1963), op. cit., p. 84.

[46] Laurence E. Strong, "Chemistry as a Science in the High School." The School Review, Vol. LXX (Spring, 1962), p. 50.

[47] Chemical Education Material Study Newsletter, I (November, 1960), p. 1.

[48] BSCS Newsletter, 111 (May, 1960), p. 2.

[49] President's Science Advisory Committee, Education for the Age of Science (Washington, D.C.: Government Printing Office, 1959), pp. 30-32.

[50] John R. Mayor, "Approaching the Draft of a Policy for Science Teacher Education." Science Education (April, 1961), p. 194.

[51] U.S. Congress, House, Independent Offices Appropriations: Hearings Before the Subcommittee of the Committee on Appropriations, 87th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1961), pt. 2, p. 520.

[52] National Science Foundation, Eighteenth Annual Report for the Fiscal Year Ended June 30, 1968 (1968), op. cit., p. 165.

[53] National Science Foundation, Seventeenth Annual Report for the Fiscal Year Ended June 30, 1967 (Washington, D.C.: Government Printing Office, 1968), p. 131.

[54] National Science Foundation, Sixth Annual Report for the Fiscal Year Ended June 30, 1956 (Washington, D.C.: Government Printing Office, 1956), p. 69.

[55] National Science Foundation, Eleventh Annual Report for the Fiscal Year Ended June 30, 1961 (Washington, D.C.: Government Printing Office, 1962), p. 97.

[56] National Science Foundation, Eighteenth Annual Report for the Fiscal Year Ended June 30, 1968 (1968), op. cit., p. 173.

[57] National Science Foundation, Fourth Annual Report for the Fiscal Year Ended June 30, 1954 (1954), op. cit., p. 54.

[58] National Science Foundation, Tenth Annual Report for the Fiscal Year Ended June 30, 1960 (Washington, D.C.: Government Printing Office, 1961), p. 228.

CHAPTER IV

ORIGIN AND GROWTH OF THE ACADEMIC YEAR INSTITUTE PROGRAM

Authority

Explicit authorization for the National Science Foundation program of academic year institutes (hereafter called AYI) cannot be found in the original legislation as passed in 1950, nor in any of the amendments made to it since that time. Only by interpretation of a collection of several references from the original legislation that pertain to scholarships, fellowships, and education in the sciences does one perceive the source of authority for Foundation sponsorship of the AYI programs for secondary and college teachers.

Under Sec. 3. (a) of the original National Science Foundation Act, titled Functions of the Foundation, Part 4 states that the Foundation is authorized and directed:

> (4) to award, as provided in Section 10, scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences; . . .[1]

The germane portion of section 10 referred to above authorizes the Foundation to award scholarships and graduate fellowships for scientific studies in the various disciplines. A similar reference is found in Sec. 7. of the original act, titled Divisions Within the Foundation, which authorizes establishment of the original four Divisions. The one of concern to this study is found under Part 4:

> (4) A Division of Scientific Personnel and Education, which shall be concerned with programs of the Foundation relating to the granting of scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences.[2]

As indicated earlier in this study, institute awards are neither scholarships nor fellowships and thus are not specifically authorized under any of the immediately preceding citations. The Division of Scientific Personnel and Education, however, seemed to be the most appropriate unit within the Foundation to serve in administration of the institute programs, and has effectively performed that function since institutes were first established in 1953.

The remaining possible source of authority for establishing the AYI program is found under Sec. 3.(a), where the Foundation is authorized and directed:

> (1) to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences;[3]

and in Sec. 3.(b):

> . . . it shall be one of the objectives of the Foundation to strengthen basic research and education in the sciences, . . .[4]

Academic Year Institutes were initially sponsored then, by interpretation of that part of the act which authorizes the Foundation to strengthen basic research and education in the sciences. The absence of clear-cut authority for this in the original act indicates that the need for a teacher-training program of the duration and magnitude of the institutes program was obviously not clearly foreseen by those responsible for authoring and passing the original National Science Foundation bill. Records of testimony at hearings prior to passage of the bill, which have been cited earlier in this study, clearly indicate that the intent was for the Foundation to focus on training in science subject matter and not on education or pedagogy or methodology. Since that time the authorization was subject to considerable interpretation and has permitted establishment of not only the institute programs, but also a wide variety of different kinds of educational activities under the rubric of "education in the sciences."

Need for the Institutes

Examination of perceptions of authorities in government and in education of the purposes of the AYI program and the need for it will be restricted in this section to those several years preceding establishment of the program and the earliest period of its operation. The broader longitudinal perspective will be examined more thoroughly in the following chapter.

A number of conditions which prevailed during the several years prior to the actual launching of the AYI program were of significance in determining both its structure and its purpose. Primary among these was the recognition of the effects of a stepped-up program of training that was producing large numbers of scientists and engineers in Russia. Data from several sources indicated that because of results of the intensive training program that had been instituted in Russia following the end of World War II, the estimated numbers of scientists and engineers trained annually in Russia would surpass that of the United States by 1953.

Several years later, in 1955, the Foundation accumulated the data presented in Table 4, showing the accuracy of the above predictions.

TABLE 4

COMPARISON OF SCIENCE PERSONNEL IN THE SOVIET UNION AND THE UNITED STATES[a]

Trained Personnel	Soviet Union	United States
1955 graduates in all sciences	126,000	59,000
Engineers (included above)	59,000	22,589

[a]U.S. Congress, Joint Committee on Atomic Energy, Development of Scientific, Engineering, and Other Professional Manpower, by Charles A. Quattlebaum. Joint Committee Print (Washington, D.C.: Government Printing Office, 1957), p. 59.

Of even greater concern was the fact that projections based on these estimates indicated that by 1960, because of the shortage of scientists and engineers, the United States would lose the technological superiority which it had held over Russia for so many years. Allen W. Dulles, then Director of the C.I.A., predicted that during the 1950-1960 decade the Soviets would graduate 300,000 more in the sciences than would the United States.[5] It appears that no solace was to be found in speculating that the Russians would be sacrificing quality for quantity, for Charles Quattlebaum in the comprehensive study on professional manpower which he did for the Joint Committee on Atomic Energy in 1957 stated the following:

> The training given Soviet engineers and scientists compares favorably with the best in the United States and Europe.[6]

The rapid increase in population numbers in this country created greater demands for the products of technology, which resulted in ever-greater demands for trained manpower. In addition, the burgeoning activities stemming from scientific break-throughs in the atomic energy and other fields further intensified the competition for skilled and talented scientists and engineers. The Korean war had also taken its toll of potential and practising scientists in terms of both draftees and casualties. The effects of the diminished birth rate during the 1930-1940 decade were manifest in fewer numbers of college-age students, causing enrollments in courses in science and mathematics to decline, thus yielding fewer graduates.

A contributing factor to the worsening manpower shortage which occurred near the middle of the 1950's was the unfortunate misinterpretation of the nature of the college population in the 1950-1951 school year. Those compiling statistics for predictions noted that graduating classes of scientists and engineers were of larger-than-average size and thus assumed that within the next few years, at such a continued rate, the supply of scientists and engineers would surpass the demand. This, of course, influenced career counselors in high schools and colleges to advise students against pursuing careers in science or engineering. What the statisticians failed to notice was that the bumper crop of graduates was due to the large number of World War II veterans then graduating, and that the freshman enrollment of that year was at an all-time low. The urgency was reflected several years later in a 1955 estimate by the Foundation that:

> . . . in relation to the number in 1955, by 1970 the need for highly trained scientific and technical personnel will (1) nearly double for high school teaching, (2) increase from 169,000 to 495,000 for college and university teaching, grow from 700,000 to 1,550,000 for engineering jobs, and markedly increase for research and development.[7]

Unlike things mechanical and inanimate, students could not be overnight transformed into trained and competent scientists and engineers.

From the time of entry into high school, an accelerated program might produce a Ph.D. in eight or nine years, with ten or more years being the average. The Foundation estimated a much longer period of preparation:

> It takes approximately 25 years of study to become reasonably proficient in the sciences - - 12 years of elementary and secondary school education, 4 years of undergraduate college study, 4 years of graduate study (although some students earn a doctorate in 3 post-baccalaureate years, others take 6 or more) and about 5 years of post-doctoral study, research, and experience.[8]

And even these programs are subject to delaying factors, as pointed out by Maynard Boring, President of the American Society for Engineering Education:

> The length of the typical 4-year engineering and undergraduate training program has increased to 4.7 years because of attempts to make up deficiencies in high school studies.[9]

As perceived by government, educators, and scientists, the above factors in combination presented a crisis situation with regard to the professional manpower supply. And it was this impending consequence that provided impetus for the establishment of the Foundation programs to cope with the emergency. The AYI was one of the later programs to evolve, having been preceded by the graduate fellowships program and the summer institutes programs for secondary and for college teachers, among others.

Objectives of the Institutes

Although nowhere to be found as a clear and succinct policy statement, myriad comments and testimonies are found in the literature which support the conclusion that the AYI program had as one of its most important objectives the increase of the Nation's supply of trained and competent scientists and engineers. Of course, this end result might be achieved in several different ways, and programs designed explicitly to achieve other objectives could nonetheless be contributory to this one in varying degrees. For example, revised and modernized curriculums in elementary science are designed more to round out the elementary experience than to prepare future scientists. And yet it is entirely possible that a child might therein be motivated and ultimately pursue a career in science as a result of his elementary experience.

At the other extreme the graduate fellowships program was specifically designed to bolster the Nation's supply of trained professional manpower. But here too, even though the effect is of far greater significance in contributing to the trained manpower pool, not all who were awarded fellowships continued on as practising scientists or engineers following completion of their fellowships.

It appears to the writer that the AYI experience would more resemble the fellowships than any other, and thus one would expect the ultimate AYI objectives and effects to be similar to those of the fellowships program, this being the production of trained, competent scientists. Support for the above position is copious. Recognition of the importance of the secondary school in this endeavor appeared as early as 1953, when the first Director of the Foundation, Alan T. Waterman, reported:

> If the Nation's scientific and technical manpower is to be maintained in adequate numbers and proficiency, there must be an adequate flow of students with aptitudes in these fields up through the secondary schools and colleges.[10]

In his statement of support for Foundation activities early in 1955, Hubert Humphrey, then Senator from Minnesota, cited the fellowship and research programs as contributing significantly in increasing our scientific manpower supply. He then drew a parallel between the effects of the fellowships program and the institutes program:

> This third program (institutes) has only been in its experimental stage during the past 3 years, but the Foundation is now ready to embark on a full, long-range program (the AYI) to insure an increased and improved supply of science teachers and scientists in the future.[11] (Parentheses mine.)

At a House appropriations hearing for 1957, the Foundation Director, Alan T. Waterman, continued to link the competence and supply of high school teachers with the demand for more trained scientists:

> Waterman. The demand for scientists is known to be great. This means that we must look around to see how we can train more able scientists, both more scientists and more able ones. There is a short-range and a long-range view.[12]

Waterman then described the graduate student programs, and continued:

> Waterman. In the long-range, the problem is far more serious. We must trace this back to the origin of the scientists which is in our high schools. This is where the interest in science starts.[13]
>
> . . . .
>
> Now, we find this is part of a general problem which is more acute in science, namely, the numbers and competence of the secondary school teachers. . . . We need to train more scientists to teach in the schools. . . .[14]

Dr. Waterman's belief that interest in science begins in the high school is supported by some studies, and contradicted by others. Evidence for a later period of career interest and decision is supplied by Chester Barnard, the second Chairman of the National Science Board:

> The histories of holders of Ph.D's in chemistry, physics, and biology, show that interest in the branch of science in which these men later specialized began most often in the junior year of college.[15]

While serving as Chairman of the House Subcommittee before which Dr. Waterman testified in 1956, Mr. Albert Thomas of Texas cited the proposed AYI program as one being extremely worthwhile, which would be of considerable value to the entire Nation. As the following quotation demonstrates, cost was no obstacle at that point in time, although in later years the Foundation has sometimes had difficulty in securing necessary funds for programs and operations. Mr. Thomas, responding to a comment by Dr. Detlev Bronk, stated:

> Mr. Thomas. This little book, Soviet Professional Manpower, I read word for word, including most of the tables, and after reading it I completely reversed my thinking, too, just like you said you reversed your thinking. . . . This is the most alarming situation that I can imagine. . . . Lord help us if they ever reach the point where they are ahead of us, and they are too close to us now. . . .
>
> Certainly you ought to pursue this new program that you started for the training - - I think the word "refresher" is not a very accurate word - - courses for your high school instructors which is estimated to cost $3 million this year. If you can use $9 million or $10 million, we are certainly prepared to give it to you. You are really striking at something worthwhile. . . . You are striking out on something new now. You are going right at the fundamental thing, this shortage that is created by a lack of high school teachers, when you start doing work like that, you are really striking something that is of value to the whole Nation.[16]

Later during the same subcommittee meeting, Mr. Thomas added:

> Mr. Thomas. This money will give training to the tune of about 300 high school teachers. That is certainly a small number. If you could increase that to 1,000 or 1,200 teachers, and get your money's worth, we would certainly entertain a suggestion on your part that this $3 million be increased to $9 or $10 million.[17]

Perhaps this was an over-simplification, for even if the AYI program had been expanded to provide training for as many as 1,000 or 1,200 students as suggested by Mr. Thomas, this would have amounted to little more than a scratch on the surface of a much broader and deeper problem. The National Science Teachers Association, early in 1956, spoke of 60,000 secondary teachers of science in the Nation. Estimates concerning how many of these were in need of supplementary training varied from less than 10 percent to nearly 100 percent. Thus, even if as many as 1,500 annually were to receive supplementary training through the AYI program, it would take forty years to accomplish the task--and this would not be taking into account replacements and additions to the original number.

When Dr. Waterman presented his 1958 budget request for funds with which to carry on the second year of operation of the AYI program, and to expand from two to a total of ten institutes, the Director of the Foundation again described the interdependence of teacher training, student careers, and the supply of competent scientific manpower:

> Waterman: The Foundation's program of education in the sciences is concerned with the problem of providing the necessary supply of competent scientific manpower which will be so urgently needed in the years ahead. . . .
>
> Basic experimental programs in this area are focused at the problems of strengthening present science teaching, improving science curricula and teacher training, and early identification, motivation, and counseling of able students with scientific aptitudes to pursue careers in science and science teaching. . . .
>
> Of the amount requested, $3 million is aimed at strengthening present high school science teachers by means of an experimental supplementary training program, which contemplates the support of specially designed year-long courses of study at selected Universities for high school teachers of science.[18]

Several months later Dr. Waterman reinforced the above position in a letter to Senator Warren Magnuson, Chairman of the Senate Subcommittee on Appropriations for the Foundation:

> Waterman. In the long run, for the maintenance of an adequate level of research, and for the training of a sufficient number of skilled scientists to fill our technological needs, we must depend upon a full supply of competent teachers in our high schools and colleges.[19]

In other testimony given before committee hearings on appropriations that same year, Dr. Waterman left little doubt of his conviction that the high school teacher in his classroom could make significant contributions in alleviating the manpower shortage. This was to come about largely by the teacher stimulating his students to select science as a career and by helping them to prepare adequately for that career.

It appears that a similar view prevailed at other levels of the Foundation administration with regard to the effects which a classroom teacher might have on student careers. Dr. Harry C. Kelly, an Assistant Director for Scientific Personnel and Education, in testimony before a subcommittee on Research and Development early in 1956 pointed out that although the primary objectives of programs in education in the sciences (which includes the AYI) were directed toward increasing the subject matter knowledge of the teacher, there was recognition of the importance of the quality of the high school teacher in the process of stimulating and motivating students:

> Dr. Kelly. Experience shows that we can count heavily on the well-qualified science teacher to capture the imagination of our talented young people, to formulate and teach stimulating courses, and to guide the professional development of able students according to their abilities.[20]

Dr. Kelly's position appears to be consistent with the one expressed previously by the Director of the Foundation, and the Director's outlook apparently had not changed appreciably over the preceding three years, for he included in the Foundation's <u>Third Annual Report</u> expression of the hope that:

> . . . ways and means can be found through the science teachers at the secondary level to identify and motivate toward science those students who should become scientists.[21]

Expression of the same hope is again found in the Fourth Annual Report, where Dr. Waterman stated:

> Many organizations, both private and public, have studied the problem and generally agree that the high school teacher of science has a unique opportunity to recognize talent early and to stimulate students toward more intensive science training at college and postgraduate levels.[22]

That quality was not to be sacrificed in the implementation of the program was implied in 1957 by the Foundation Director in drawing connections between teachers and their part in the motivation of students:

> Mr. Waterman. We think if we aim high and try to get high quality students by aiming at the teacher is the thing to do. The teacher is the best motivator and I cannot imagine anything duller for a bright boy than to get a dull teacher.[23]

Although Dr. Waterman referred above specifically to boys, it should be pointed out that data collected in the year following his 1957 comment showed that girls constituted slightly more than one-third of the total number of science and mathematics majors enrolled as junior-year students throughout the Nation.

Thus the conclusion appears reasonably well supported that early Foundation policy, at least, included a deliberate attempt to motivate high school students toward careers in science by exposing them to competent and well-trained teachers. It seems probable, also, that staffing our high school classrooms with trained competent teachers could well have had the effect of helping to minimize the needless waste of other talents as well, as pointed out by Charles Quattlebaum in a 1960 study of educational programs:

> Each year some 200,000 of the Nation's able students drop out of high school or end their formal education with a high school diploma. This represents a tragic waste of our human resources, particularly because of our national need for men and women broadly educated for professional service in the fields of science, teaching, and other professions.[24]

There are other factors which may also have considerable influence on student motivation, his entrance into college, his choice of career, and his success in that career. Besides the high school teacher, these would include parental influence, financial resources, exposure to TV and other news media, and career information and counseling from his high school.

Efforts to attain several other objectives which the AYI program was expected to achieve were cited by various scientists and educators. One that seems to pervade and support most other objectives is the concerted effort at designing courses of instruction to provide supplemental subject matter training. Increasing the subject matter knowledge of institute participants had been the function of summer institutes for the three years preceding the initiation of the AYI program, and this was to continue as a goal in the new experimental program, according to Dael Wolfle, Executive Officer of the AAAS:

> In 1956-57 the Foundation tried out the idea of year-long institutes for high school teachers. Emphasis, as in the summer institutes, was on science and mathematics rather than on pedagogy, and the Universities and Colleges that give institutes of both types developed, in many cases, special courses to meet the teacher's special needs.[25]

To some extent, the success of the summer institute program served as a stimulus for creation of the AYI program. This is suggested by Stevenson, who described the new program as being "for a few selected individuals" to take "a concentrated dose of subject-matter course work."[26] A somewhat different aspect was brought out by

Dr. Bowen Dees, formerly Assistant Director in the Division of Scientific Personnel and Education, and now President of the Franklin Institute in Philadelphia. In addition to his concurrence that evaluations of summer institutes pointed up the need for a program that would permit an in-service teacher to get a concentrated, uninterrupted "dose" of subject matter, Dr. Dees also indicated that failure to achieve desired results from the graduate fellowships program probably contributed to the establishment of the academic year institute program. By 1956 the Foundation had been in operation for six years and the graduate fellowships program was in its fourth year, but the number of graduating scientists continued to decline. Dr. Dees indicated that the Foundation expected, also, that at least a small percentage of these science graduates would take positions as secondary teachers of science, but instead they were going into higher education, government, and industry. The problem concerning quantity and quality of secondary teachers thus remained, and Dr. Dees considered the AYI program to be one possible means of coping with the problem.[27]

It appears that some had expectations that yet another peripheral benefit would accrue to the Nation upon establishment of the AYI program. Dr. Detlev Bronk, former Chairman of the National Science Board, and Dr. Harry C. Kelly of the Foundation staff, both expressed optimism that the program would serve as an incentive and provide a pattern that would induce universities to design and implement similar teacher-training courses as part of their own regular program of courses--independent of Foundation supervision and financial support. It was the lack of proper and adequate teacher training programs in the early 1950's which served as one of the factors on which the Foundation based its original decision to not grant fellowships to high school teachers of science. Dr. Bronk likened the AYI program to seed corn, expecting others to begin similar programs when the achievements of the AYI program became known, and implied that indeed perhaps two schools in Pennsylvania were planning to have training programs of their own for high school science teachers. How much of this has occurred, and why, appears to be a topic worthy of additional study.

In addition to providing subject matter training for teachers of science with the expectation that this would eventually augment the Nation's supply of trained and competent scientists, several other purposes were to be served by the program. Since only a small proportion of the population has both the interest and the ability to become scientists, and since the public interest is presumably better served as more and more of this limited talent is utilized, the matter of incentives for the pursuit of scientific careers can be perceived, as was pointed out by Dr. Chester Barnard in 1954 when he was Chairman of the National Science Board, to be an important social problem. Two years later, when he succeeded Dr. Barnard as Chairman, Dr. Detlev Bronk emphasized the relationship between education for science and effective citizenship when he stated:

> We recognize a responsibility for the teaching of science which goes far beyond the training of scientists alone. We would further the better teaching of science so that all the citizens of our country may understand science more adequately in order that they can more effectively fulfill their responsibilities as citizens of our democracy.[28]

Low teachers' salaries further aggrevated the problem of inadequate numbers of trained personnel, as Quattlebaum concluded in his study on the supply of professional manpower:

> . . . the shortage of technical and professional training in this country is largely due to the shortage of qualified teachers, which in turn is largely due to the low salaries of teachers.[29]

Teachers frequently left the profession for better paying positions in industry. This affected the quality as well as the quantity of teachers remaining in the profession, as the better trained teacher, who had most to gain, would be the first to leave and accept a job in industry. This would additionally produce the result of increasing the proportion of teachers in need of supplementary training. The Foundation undoubtedly was aware of this problem when they determined the size of the stipend to be awarded to those accepted as AYI participants. Quattlebaum cited a 1956 report which listed the average salary for classroom teachers as $4,420. Some, of course, were paid much less. Dr. Robert Carlston, then Executive Secretary of the National Science Teachers Association, in testimony before a subcommittee hearing, told of working with a science teacher from Tennessee who held a Master's Degree and was being paid $3,000 annually. By comparison, a stipend awarded to an AYI participant who had four dependents would be as follows:[30]

Base	$3,000
Four dependents (maximum)	1,800
Travel (maximum)	160
Book allowance (maximum)	50
Total	$5,010

This award of $5,010 tax-free dollars compares <u>very</u> favorably with the $4,420 average teacher salary being paid in 1956, and thus in itself constituted a considerable incentive for teachers to participate in the program. Since many universities had designed special programs of study that made it possible for participants to complete the Master's

Degree during the nine or ten month academic year (sometimes including the following summer institute), teachers frequently realized substantial salary increases upon returning to classroom teaching. This also, then, increased the probability of the AYI participant remaining in the teaching profession.

Eligibility and Selection of Participants

Each college or university, upon being awarded the funds necessary to conduct its proposed AYI program would undertake to solicit applicants. Broad minimum requirements were imposed by the Foundation, and each school would then establish additional specific criteria and procedures for selection of its participants. The broad guidelines proposed by the Foundation in 1956 for its initial institute were as follows:

> Each University receiving a grant will select the high school teacher participants for its program. Only teachers with a minimum of 3 years teaching experience and who can be expected to continue teaching for a reasonable period will be considered. The principal selection criteria will be: the general scholastic aptitude of the candidate as judged by a complete transcript of college-grade records and any other evidence available, the degree to which the applicant's proposed plan of study could be expected to supplement training as a high school teacher, and recommendations by the applicant's principal and superintendent.[31]

For purposes of comparison, the eligibility requirements set by the Foundation for 1969 are listed below:

> To be eligible to attend an Academic Year Institute for Secondary School Teachers an individual:
>
> 1. Must be presently employed as a teacher or supervisor of science or mathematics in grades 7-12 with three years of teaching experience;
>
> 2. Must ordinarily have received a bachelor's degree;
>
> 3. Must not have attended a previous NSF-supported Academic Year Institute or two or more NSF-sponsored summer institutes. (This requirement may be waived in exceptional circumstances.)

In addition, individual institutes establish specific academic prerequisites for admission; their brochures should be consulted for details.[32]

Academic Year Institutes for College Teachers - Eligibility:

1. Must be a United States College teacher of one of the sciences, mathematics or engineering. Teachers at junior or community colleges or technical schools are eligible.

2. Must have three years of college teaching experience.

Literature distributed by the Foundation during the 1960's has usually also included under "eligibility requirements" the statement that candidates will be selected without regard to race, creed, or color.

Eligibility requirements in effect at Michigan State University during the 1963-64 academic year have already been listed on page 55 of this study, and are representative of others, although some variation has existed from one school to another and from one year to the next within a single school. This is to be expected as a consequence of changes in needs and perspectives of the school and the teachers to be trained. In general, however, primary consideration was given to the participant's potential for future development as a science teacher.

A number of assumptions were made by the universities conducting AYI programs. The brochure describing the program for the 1960-61 year at the University of Texas lists among its chief objectives "to provide participant teachers with the opportunity to increase their knowledge in the fields of science and mathematics," while the brochure distributed by Stanford University for that same year lists ". . . opportunities to refresh and increase their knowledge of chemistry. . . ." Implicit in both of these is the assumption that each participant will have had the requisite minimum amount of subject matter training in his field. Some idea of the degree of validity in these assumptions is supplied by the results of a study by Victor Greulach, in which he found the average number of courses in biology listed by applicants to the University of North Carolina for the AYI in biology to be 7.7, but the study did not distinguish between quarter and semester credits.[34]

The individual school, of course, determined the minimum assumed to be necessary for the applicant to profit from the institute experience. One would expect that screening and evaluation procedures used on applications would result in acceptance by the school of at least some of those with the least amount of training, and presumably the greatest need. This appears to have been the expectation of Harlan Koch, the editor of the North Central Association Quarterly, who commented in 1956:

> Thus teachers with weak, and others with strong, preparation will be accepted for the Program at cooperating institutions. . . . Three years of teaching experience will be required to qualify.[35]

This was inconsistent with findings which Milliken reported in his study of institute programs at Kansas State College, however, for in his Doctoral dissertation Milliken stated: "Until 1959, proposals for institutes for the 'less able' teachers were not approved by the NSF."[36] If indeed Milliken's claim was true, it would have been a distinct violation of not only eligibility criteria and selection procedures of individual schools, but also of the guidelines proposed by the Foundation itself. Furthermore, achievement of the basic objectives of upgrading the quality of secondary school teachers of science would have been hampered through implementation of this policy because it would have excluded a considerable portion of needy teachers.

The Pilot Institutes

Two schools were selected by the National Science Foundation in 1955, each to prepare and conduct its own High School Science Teacher Supplementary Training Program for the 1956-57 academic year. One was the Oklahoma Agricultural and Mechanical College at Stillwater, Oklahoma, where Professor James H. Zant of the Department of Mathematics served as Director for the first training program offered; the other was the University of Wisconsin at Madison, Wisconsin, where Professor C. Harvey Sorum of the Department of Chemistry served as Director for the first training program offered there. Since that time the Oklahoma College has become the Oklahoma State University, and the Supplementary Training Program, after the first year, became the Academic Year Institute Program.

In playing the role of pioneers in this venture, these two schools were in a position to establish patterns for the structure and operation of future institute programs. They would also significantly affect the attitudes and philosophies of the Foundation, and consequently those of other schools contemplating offering training programs of their own. Subsequent proliferation and diversification of the AYI programs over the next fifteen years gives testimony, it would seem, to the appropriateness of the basic patterns and directions established by the Directors of the very first programs.

The Oklahoma Agricultural and Mechanical College Program

Selection of the participants for the first training program was made by the Director of the institute and his staff from among the abundance of applicants who learned of the program through personal contact, the press, various educational and scientific journals, and the general brochure prepared and sent out by the Washington, D.C. office of the Foundation.

Eligibility requirements were consistent with those earlier established by the Foundation (pp. 99-100, this study), except that not all of those selected for participation in the first program had the minimum of three years teaching experience recommended by the Foundation. In discussing the nature of the participant population making up the first institute, Ostlund pointed out: "Furthermore, the range in teaching experience was from 2 to 25 years, with a mean of 6.1 years."[37] Additionally, participants were selected by the same standards as were any other students in the Graduate School working for a degree. Selection of the participants was based on evaluation of the following:

1. Academic record
2. Success as a science teacher
3. Success as a citizen in the community
4. Strength in scientific background
5. Age (less than 40)
6. Experience[38]

College transcripts, letters of recommendation, and the candidate's application supplied nearly all of these data. In his 1958 Director's Report to the Foundation, Dr. Zant indicated that of the several factors considered in the selection process, those concerning the applicant's academic ability and scientific background were best as predictors of the applicant's potential as an effective teacher of science.

Fifty participants were originally selected and began the program, but only 48 completed the entire academic year. Eighteen participants came from school systems within the state of Oklahoma, with the remainder being scattered among eleven other states from as far away as Georgia and Tennessee. Selection procedures apparently were designed to yield a group of participants who were above average teachers, as indicated by the required letters of recommendation, for McIntosh in his study of that first AYI refers to ". . . a group of top notch teachers."[39] McIntosh was himself selected as a participant for the first institute program and thus had an opportunity for first-hand observations.[39]

This positive selection effect, which resulted in the preponderance of superior teachers found in the first training program at Oklahoma, appears to be consistent with Foundation policy as pointed out by Milliken (p. 101, this study). Further support for this view is found in McIntosh's study, for his interview data indicate that the majority of teachers in the first training program felt their subject matter backgrounds to be adequate. In each case, the participants indicated they felt that, prior to participation in the program at Oklahoma, their backgrounds were adequate in mathematics, physics, biology, chemistry, general science, and education courses.[40] One wonders if designing and offering special basic courses to this group of top notch teachers was appropriate in light of the extensive training and experience which the participants had.

Advisement was to be done on the basis of evaluation of transcripts and of the results of a battery of tests administered shortly before the academic year began. Each participant was to confer with an academic advisor and plan a program of studies and activities that would be best suited to his own needs. There appeared to be rather widespread dissatisfaction with this aspect of the training experience, as many of the participants felt that, contrary to brochure statements, little opportunity was provided for individual counseling and course planning. For example, in the first semester most of the participants were placed in a single class in mathematics and biology. Of the 48 responses reported by McIntosh in his study, 33 participants rated advisement as below average, and only four rated it above average.[41]

As would be expected, some of the courses taken were designed specifically for this training program and others were from among those regularly offered by the science departments of the Graduate School. Likewise, some were required of participants, others were selected from the wide range that was available. The nine special courses provided by the AYI were as follows:

Chemistry 443	Advanced General Chemistry (3 semester hours, including laboratory)
Chemistry 5T3	Advanced General Chemistry (continued) (3 semester hours, including laboratory)
Mathematics 5S5	Calculus for High School Science Teachers (5 semester hours)
Mathematics 5Z3	Modern Mathematics for High School Science Teachers (3 semester hours)
Physics 4X3	Physics Since 1900 (3 semester hours, without laboratory)

Physics 5X3	<u>Physics Since 1900</u> (continued) (3 semester hours, without laboratory)
Engineering 403	<u>General Engineering for Science Teachers</u> (3 semester hours, including laboratory)
Education 510	<u>Seminar</u> (1 semester hour each semester)
Biology 5X4	<u>Biological Principles and Concepts</u> (4 semester hours, including laboratories and field trips)[42]

At the conclusion of the year's program the special courses were rated according to the number of favorable and unfavorable comments made by the participants on factors such as attitude of the professor, laboratory, text, and practical value. Based on the data supplied by the participants, the courses were ranked from best to worst as follows:

1. <u>Calculus for High School Science Teachers</u>
2. <u>Physics Since 1900</u> (5X3)
3. <u>Physics Since 1900</u> (4X3)
4. <u>Seminar</u> (Education)
5. <u>Biological Principles and Concepts</u>
6. <u>Modern Mathematics for High School Science Teachers</u>
7. <u>Advanced General Chemistry</u> (5T3)
8. <u>General Engineering for Science Teachers</u>
9. <u>Advanced General Chemistry</u> (443)[43]

To round out their courses of studies the participants selected regular Graduate School courses in a wide variety of fields, including astronomy, geology, education, and zoology.

From the perspective of the Director of the training program, the basic objective of the supplementary training was:

> . . . to provide for the participants a broad understanding and competence in the content of science and mathematics from a modern and basic point of view.[44]

A successful program would, of course, achieve this objective. From the perspective of the participant, however, the objectives of the program were more specific but not incompatible with those of the University and the Director. McIntosh found that getting a Master's degree was reported to be of great importance to two-thirds of the participants and of no importance to only one-tenth of them. Exclusive of desires concerning acquiring of the degree, participants overwhelmingly listed "broader background of subject matter," "advanced work in own field," and "bring weak areas up to par" as expectations of the program. When asked if the program had been a disappointment to them, 14 said "yes," 25 said "no," and 9 said "partially." The cases of disappointment appear to have had their origin chiefly in mishandling of the advisement program and in one thoroughly-disliked chemistry course, which negative experiences were in no way reflected in the fact that the grade point averages were 3.44 for the first semester and 3.71 for the second semester. Even more significantly, 47 of the 48 participants who attended over the entire year qualified for and received their Master's degree. Later evaluations, which will be discussed more thoroughly in Chapter V, indicate that this first training program at the Oklahoma A & M College should indeed be considered a success.

The University of Wisconsin Program

The second of the two schools which pioneered in designing and offering AYI programs was the University of Wisconsin at Madison, Wisconsin. Under the directorship of Dr. C. Harvey Sorum, Professor of Chemistry, the first Supplementary Training Program for High School Teachers of Science and Mathematics at the University of Wisconsin was initiated in the Fall of 1956.

The primary purpose of the institute was to make the participant teachers better teachers by giving each the opportunity to learn, in depth, the subject that he was teaching or planned to teach. At Wisconsin, as at Oklahoma, a number of courses were made-to-order for the participants, based on survey results from summer institute participants which indicated that they were unable to successfully participate in regularly offered graduate courses in science and mathematics. The objectives of the program, as cited in a study by Heideman, were:

1. To upgrade the teachers presently trained in science and mathematics in their fields of competency.
2. To remove academic deficiencies due to inadequate or insufficient training.[45]

During the first year of the program, major emphasis was given to the latter of the two objectives. Subordinate to these was an additional objective of the program, not formally stated in the literature, ". . . to allow for maximal development of modern teaching methods."[46] The inclusion of teaching methods in the program objectives at Wisconsin appears to have been inconsistent with original Foundation statements of purpose, but the practice became more common after the AYI program had been in operation for several years.

Forty-seven secondary teachers were selected for this first Supplementary Training Program; twenty from the state of Wisconsin, and the other 27 from eleven other states and the District of Columbia.

By the end of the summer following this first program, all but one of the participants had qualified for and received the degree of Master of Science in Science Education.

A number of rather specific eligibility requirements were established by the University of Wisconsin, which were consistent with the broader requirements earlier established by the Foundation. The University required that participants:

1. Have a Bachelor's degree;
2. Presently be employed as a High School Teacher of Science and/or Mathematics;
3. Have taught in High School at least three years;
4. Have adequate scholastic ability as indicated by an undergraduate grade point average of 2.75 or better;
5. Have high potential ability as a teacher and high character as evidenced by letters of recommendation;
6. Be under forty-six years of age.[47]

Further favorable selection was sought by choosing, on the basis of grade transcripts, only the upper 25 percent of the teachers who made application to the University. Heideman considers that the above procedures resulted in selection of a group of teachers who would rank among the best qualified science and mathematics teachers. His only evidence for this claim, however, is enforcement of the minimum grade point requirement, which is a poor indicator at best. Contradictory data exist concerning this select group. The average of undergraduate grades for the participants was 3.24, which is indeed superior, but yet in personal interviews it was observed that a majority of the participants revealed a lack of confidence in their profession and in themselves as teachers, characteristics which are not generally indicative of superior and experienced teachers. The average number of semester hours in science and mathematics for the participants prior to their year-long AYI experience was impressive:

Mathematics	21.37	Physics	15.38
Biology	17.40	Seminars	12.55
Chemistry	15.86	Earth Sci.	7.80[48]

Nevertheless, with that degree of experience practically all summer institute participants, it was pointed out by the Director, had withdrawn at some time from one or more regular graduate courses in the sciences. To accommodate the needs of this special group, the University instituted specially-designed basic courses in chemistry, physics, biology and mathematics, in addition to a seminar. All participants were required to take a minimum of ten credits each semester from the basics, and could take additional courses from the regular University offerings. Apparently the specially-designed courses satisfactorily met the needs of the participants, for they all received favorable ratings at the conclusion of the training program. This uniformly favorable evaluation suggests, at first glance, a degree of success greater than that experienced at the first AYI at Oklahoma A & M College. Data which became available at a later date, however, showed that eleven of the original forty-seven, or 24 percent, of the first Wisconsin participants had left the profession as classroom teachers.

Some effects of the training experience as perceived by the participants were reported by Heideman in his 1962 study. All participants were asked to respond to three separate questions, using a 1 to 5 value rating scale, prior to their AYI experience and again near the end of the institute. Pre-AYI value ratings were combined and averaged for each question, as were post-AYI ratings. Comparison of these pre- and post- group averages for each of the three questions showed:

1. A 30 percent gain in ability to originate new ideas.
2. A 25 percent gain in desire to try new teaching methods.
3. A 20 percent gain in ability to inspire students toward scientific careers.[49]

The latter two gains cited by the participants and attributed by them to the Supplementary Training Program experience would suggest that they were somehow positively injected into the overall objectives of the program, although neither the Foundation nor the institute Director specifically indicated that these were intended to be program objectives.

In common with participants in the first training program held at Oklahoma A & M College that same year, those at Wisconsin had numerous complaints concerning the quality of educational counseling. They consistently praised the Foundation and the schools for their part in providing the opportunities they had to upgrade their academic backgrounds and to learn new concepts. In his study, Heideman cited a number of reports of changes in teaching methodology and attitude changes which the participants attributed to the training experience. Although the absence of a valid pre-test and the possible existence of a "halo-effect" lend a degree of subjectivity to the above conclusion, there is convincing evidence throughout his study that the Supplementary Training Program did indeed, according to the participants, achieve its primary objective of making better teachers of the participants.

Results of an even more thorough study of the intents and effects of early AYI programs, including numerous evaluations of them, are presented in the following chapter.

Proliferation and Diversification

Few who are familiar with the hierarchy of tax-supported educational programs will be surprised to learn of the rapid increase in size and in variety of the AYI program during the first ten years of its operation. A succinct example of the evidence on enlargement and proliferation in the program is to be seen in the annual announcements of institutes to be sponsored by the Foundation. The 1958-59 institutes were publicized via a one-page flyer. The 1963-64 announcements required a twenty-page pamphlet. The purely quantitative aspects of this growth are presented in Table 5.

TABLE 5

NUMBER AND COST OF ACADEMIC YEAR INSTITUTES AND PARTICIPANTS SPONSORED ANNUALLY BY THE NATIONAL SCIENCE FOUNDATION

Year	Number of Institutes	Number of Participants[a]	Cost
1956-57	2	95	$ 504,700
1957-58	16	782	4,250,885
1958-59	19	932	5,080,000
1959-60	33	1533	9,061,580
1960-61	33	1526	9,173,700
1961-62	43	1557	9,849,700
1962-63	56	1786	11,566,090
1963-64	58	1865	11,425,608
1964-65	66	2030	12,553,839
1965-66	73	1990	12,299,331
1966-67	73	1850	11,378,510
1967-68	76	1740	10,841,695
1968-69	72	1670	10,074,686
		Totals	
13	620	19,376	$118,060,324

[a]Because actual numbers of participants for the last five years were not available, numbers of participants were estimated on the basis of cost of the program.

The average number of participants per institute decreased from nearly 50 in the early institutes to less than 30 in the second half of the 1960 decade. This accounts for 56 institutes accommodating 1786 participants in 1962-63, and 76 institutes accommodating only 1740 participants in 1967-68.

With increasing numbers of participants attending the institutes over the first ten years, changes had to be made in the program to accommodate the greater diversity in training backgrounds and interests of the participants. This is most clearly shown in the data presented in Table 6, which contains the range of disciplines in which institutes were offered for two selected years.

TABLE 6

COMPARISON OF GROWTH OF SUBJECT MATTER FIELDS OFFERED IN ACADEMIC YEARS 1956-57 AND IN 1967-68

1956-57	1967-68	
Biology	Anthropology	Geology
Chemistry	Astronomy	History & Philosophy of Science
Mathematics	Biology	Isotope Technology
Physics	Chemistry	Machine Design
	Earth Sciences	Mathematics
	Economic Analysis	Nuclear Science
	Electronics	Oceanography
	Electrical Technology	Physics
	Engineering	Radiation Biology
	General Science	Sociology
		Statistics

Further changes in the AYI program were implemented as part of the Foundation's attempts to attract and recruit participants from a broader area of occupational categories. The magnitude and the direction of these changes, presented in Table 7, reflect continued concern on the part of the Foundation with the shortage of competent teachers and with increasing numbers of secondary students. Of particular interest is the Foundation's sponsorship, in 1965, of institutes designed for the retraining of professionals from non-science fields.

A number of factors may have contributed to the evolution of the changes shown in these tables, foremost among them being the tardy but finally decisive recognition, on the part of our Nation's leaders, that our security, world leadership, and prestige were being threatened. Reports considered generally reliable indicated that current and predicted increases in the numbers of trained scientists and engineers in the USSR would soon make it possible for them to challenge our technological leadership.

Additionally, the fact that teacher-training programs held promise for upgrading the quality of our Nation's schools and would thus contribute positively to the general welfare of the country, served to considerably mitigate the arguments opposing the growth of the program. Some small degree of proliferation is possibly attributible to attempts to establish geographical balance in the distribution of sponsored institutes. But if this was so, initially, it later disappeared as a significant factor. This can be inferred from examination of Table 8, which shows intense concentration of academic year institutes (and the money to support them) in a few states over the past 13

TABLE 7

GROWTH OF CATEGORIES OF ELIGIBLE PARTICIPANTS

Year	Academic Year Institutes Offered For:
1957-58	Practising secondary teachers of science and/or mathematics
1959-60	High School teachers of science and mathematics High School and College teachers of science and mathematics
1961-62	High School Teachers of science and mathematics High School and College teachers of science and mathematics Junior College teachers College teachers
1963-64	Secondary teachers of science and mathematics Secondary and College teachers of science and mathematics Secondary and Junior College teachers of science and mathematics College teachers
1964-65	Secondary School teachers College teachers Secondary and College teachers Technical Institute and Junior College teachers
1965-66	Secondary School teachers College teachers Junior College and Technical Institute teachers Secondary and College teachers Secondary, College, and Pre-Service teachers Training teachers to Instruct Engineering Technicians Re-education of Women in Science Retraining Retired Armed Service Officers Secondary School teachers and Retired Military Officers

TABLE 8

NUMBER OF ACADEMIC YEAR INSTITUTES AWARDED TO EACH STATE, 1956-57 THROUGH 1968-69

State	No. of Institutes	Total Amount of Awards
More than 30 Institutes		
Illinois	34	$6,210,931
Michigan	36	7,150,038
New York	31	5,653,603
Pennsylvania	38	6,831,824
20-29 Institutes		
California	22	$4,083,634
Georgia	20	5,191,257
Massachusetts	26	5,374,136
North Carolina	25	4,239,372
Oklahoma	25	4,120,594
Oregon	25	4,708,043
Texas	25	5,203,488
10-19 Institutes		
Arizona	12	$2,394,640
Indiana	17	3,017,730
Iowa	11	3,053,003
Louisiana	10	2,536,468
Minnesota	10	1,336,700
Missouri	10	2,515,570
New Mexico	10	2,655,200

TABLE 8--Continued

State	No. of Institutes	Total Amount of Awards
10-19 Institutes		
Ohio	16	$4,218,708
Rhode Island	10	2,822,000
South Dakota	12	3,141,210
Tennessee	13	1,938,405
Utah	13	3,650,755
Virginia	16	3,072,453
Washington	14	1,106,371
Wisconsin	16	2,769,855
1-9 Institutes		
Alabama	8	$1,169,700
Arkansas	6	610,800
Colorado	9	2,270,215
Connecticut	7	601,100
Florida	7	838,500
Hawaii	9	1,147,500
Kansas	9	1,787,604
Maine	7	490,900
Maryland	6	409,790
Mississippi	8	1,580,257
Montana	4	272,000
Nebraska	2	146,075

TABLE 8--Continued

State	No. of Institutes	Total Amount of Awards
	1-9 Institutes	
New Jersey	8	$1,637,168
North Dakota	9	2,293,215
South Carolina	8	1,475,100
West Virginia	4	694,600
Wyoming	4	556,475
Puerto Rico	8	1,084,337
	No Institutes	
Alaska	0	0
Delaware	0	0
Idaho	0	0
Kentucky	0	0
Nevada	0	0
New Hampshire	0	0
Vermont	0	0
Dist. of Columbia	0	0
	TOTALS	
52[a]	620	$118,060,324

[a]Includes District of Columbia and Puerto Rico.

years. The four states of Illinois, Michigan, New York, and Pennsylvania received 24 percent of all academic year institutes sponsored by the Foundation, while none were awarded to the District of Columbia or to the states of Alaska, Delaware, Idaho, Kentucky, Nevada, New Hampshire, or Vermont. Thus in awarding academic year institutes over the years, either the Foundation seems to have preferred certain states over others, or certain states consistently chose not to make application for institutes. Numerous factors had to be considered in making these awards, however, such as location of population centers, and the facilities of the schools which submitted proposals for institutes. In many cases it was undoubtedly a matter of the Foundation going along with the prepared, competent, successful school, rather than attempting to upgrade one of lesser quality with the institute grant.

A much earlier incentive for expansion of the AYI program could well have been provided by Mr. Thomas' offer of $10 million for teacher training institutes, rather than the $3 million which Dr. Waterman had included in his budget request for the 1957-58 fiscal year. The $3 million which Dr. Waterman requested was intended to be used to continue the two pilot programs at Oklahoma and Wisconsin, and to initiate eight more for the 1957-58 academic year. The Foundation had already invited 25 institutions of higher education to submit proposals for institutes for the 1957-58 academic year. As it turned out not eight, but sixteen, institutes were sponsored and funded during the second year of operation of the AYI program.

Reaction to the Russian technological achievements which culminated in their launching Sputnik in 1957 was probably a significant additional factor in the growth of the AYI program. There were only 19 AYI programs sponsored for the 1958-59 academic year, but this number was nearly doubled for the following year. Since legislative procedures and budget proposals must be initiated far in advance of actual spending of the monies, the nearly-doubled number of institutes for the 1959-60 academic year is the more accurate reflection of the effects of Sputnik I.

Finally, not to be overlooked is the universal inclination for bureaucratic organizations, once established, to seek perpetual security, if not immortality, through constant growth.

Data presented in the preceding tables show the growth and variety of institutes sponsored by the Foundation over the past thirteen years. The Director of the Foundation recognized the hazards inherent in an overly-rapid expansion of the program, and seemed to favor initial restriction of the maximum number of institutes to approximately twenty. In his statement to a subcommittee hearing on appropriations for 1958 Dr. Waterman said:

> This Fall a total of 16 academic year institutes will begin full-year courses to train about 850 high school science teachers. About the same number are contemplated in fiscal year 1958. These year-long institutes will train only about one-half of one percent of our high school science and mathematics teachers each year. Despite the enthusiastic endorsement by both teacher and school officials, we believe this program should not be expanded beyond the present level lest too many active teachers be withdrawn from their classrooms.[50]

In the light of up-to-date statistics then available to the Director showing expected increases in numbers of secondary school students over the next fifteen years, and being fully cognizant of increasing competition for the services of those trained in science and engineering (which included many secondary school teachers), the writer tends to question the rationale behind such a committment to restriction as made by the Director. In any case, the Foundation soon found itself the sponsor of numbers and varieties of institutes far in excess of the less-than-twenty originally proposed by Dr. Waterman at the 1958 budget hearing.

Footnotes

[1]U.S. Congress, United States Statutes at Large: Public Laws and Reorganization Plans, Vol. LXIV, pt. 1 (Washington, D.C.: Government Printing Office, 1950-51), p. 149.

[2]Ibid., p. 152.

[3]Ibid., p. 149.

[4]Ibid., p. 150.

[5]U.S. Congress, Joint Committee on Atomic Energy, Development of Scientific, Engineering, and Other Professional Manpower, by Charles A. Quattlebaum. Joint Committee Print (Washington, D.C.: Government Printing Office, 1957), p. 58.

[6]Ibid.

[7]Ibid., p. 11.

[8]U.S. Congress, House, Independent Offices Appropriations for 1963: Hearing Before a Subcommittee of the Committee on Appropriations, 87th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1962), p. 125.

[9]Maynard M. Boring, "The Manpower Situation, 1956" General Electric Review (March 1956), pp. 26-27.

[10]National Science Foundation, The Third Annual Report of the National Science Foundation (Washington, D.C.: Government Printing Office, 1953), p. 51.

[11]U.S. Congress, Senate, Independent Offices Appropriations for 1956: Hearing Before a Subcommittee of the Committee on Appropriations, 84th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1955), pp. 408-409.

[12]U.S. Congress, House, Independent Offices Appropriations for 1957, Hearings Before the Subcommittee of the Committee on Appropriations, 84th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1956), p. 573.

[13]Ibid.

[14]Ibid.

[15]National Science Foundation, The Second Annual Report of the National Science Foundation (Washington, D.C.: Government Printing Office, 1952), p. 29.

[16]U.S. Congress, House, Independent Offices Appropriations for 1957 (1956) op. cit., pp. 522-523.

[17]Ibid., p. 551.

[18]U.S. Congress, House, Independent Offices Appropriations for 1957 (1956) op. cit., p. 530.

[19]U.S. Congress, Senate, Independent Offices Appropriations, 1957, Hearings Before the Subcommittee of the Committee on Appropriations, 84th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1956), p. 376.

[20]U.S. Congress, Joint Committee on Atomic Energy, Hearing before a Subcommittee on Research and Development of the Joint Committee on Atomic Energy, 84th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1956), pp. 50-51.

[21]National Science Foundation, The Third Annual Report of the National Science Foundation (1953) op. cit., p. 54.

[22]National Science Foundation, Fourth Annual Report for the Fiscal Year Ending June 30, 1954 (Washington, D.C.: Government Printing Office, 1954), p. 56.

[23]U.S. Congress, House, Independent Offices Appropriations for 1957 (1956), op. cit., p. 618.

[24]Charles A. Quattlebaum, Federal Educational Policies, Programs and Proposals, pt. 1 (Washington, D.C.: Government Printing Office, 1960), p. 35.

[25]Dael Wolfle, "N.S.F.: The First Six Years," Science, CXXVI No. 3269 (1957), pp. 338-339.

[26]Everett Earl Stevenson, "A Follow-Up Study of the Participants of the Academic Year Institutes Held at the Ohio State University, 1957-1961" (Unpublished Doctoral dissertation, The Ohio State University, 1961), pp. 22-23.

[27]Bowen C. Dees, personal correspondence.

[28]National Science Foundation, Sixth Annual Report for the Fiscal Year Ended June 30, 1956 (Washington, D.C.: Government Printing Office, 1956), p. ix.

[29]U.S. Congress, Joint Committee on Atomic Energy, Development of Scientific, Engineering, and Other Professional Manpower, by Charles A. Quattlebaum . (1957) op. cit., p. 11.

[30]Based on the writer's own experience as an AYI participant at Stanford University during academic year 1960-61.

[31]U.S. Congress, House, Independent Offices Appropriations for 1957 (1956) *op. cit.*, p. 595.

[32]National Science Foundation, Guide to Programs, NSF 69-13 (Washington, D.C.: Government Printing Office, June, 1969), p. 43.

[33]*Ibid.*, p. 30.

[34]Victor A. Greulach, "Some Information About the Biology Applicants for NSF Institutes at the University of North Carolina," The American Biology Teacher, XX, No. 8 (1958), p. 301.

[35]Harlan C. Koch, ed., North Central Association Quarterly, XXXI, No. 2 (1956), p. 177.

[36]Don Quentin Milliken, "An Evaluation of National Science Foundation Institutes by the Participants" (unpublished Doctoral dissertation, The Oklahoma State University, 1964), p. 13.

[37]Leonard A. Ostlund, "The Evaluation Report of the 1956-57 Academic Year Institute for High School Science and Mathematics Teachers Sponsored by the National Science Foundation at the Oklahoma State University, Stillwater" (unpublished report, Oklahoma State University, Stillwater, 1957), p. 7.

[38]James H. Zant, "A Report On Academic Year Institute for High School Science and Mathematics Teachers" (unpublished report, The Oklahoma State University, 1958), p. 5.

[39]J. Paul McIntosh, "Opinions and Attitudes of National Science Foundation Participants" (unpublished Master's thesis, Oklahoma Agricultural and Mechanical College, 1957), p. 2.

[40]*Ibid.*, p. 25.

[41]*Ibid.*, p. 23.

[42]Zant, "A Report on Academic Year Institute for High School Science and Mathematics Teachers" (1958), *op. cit.*, pp. 9-10.

[43]*Ibid.*, p. 48.

[44]*Ibid.*, p. 3.

[45]Robert G. Heideman, "National Science Foundation Academic Year Institutes for Secondary School Teachers of Science and Mathematics Held at the University of Wisconsin 1956-57 through 1958-59" (unpublished Doctoral dissertation, University of Wisconsin, 1962), p. 3.

[46] _Ibid._, p. 3.

[47] _Ibid._, p. 12.

[48] _Ibid._, p. 27.

[49] _Ibid._, p. 111.

[50] U.S. Congress, House, _Independent Offices Appropriations, 1958_, Hearings Before the Subcommittee of the Committee on Appropriations, 88th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1957), pp. 1273-1274.

CHAPTER V

THE OBJECTIVES OF THE ACADEMIC YEAR INSTITUTE PROGRAMS

Proliferation of numbers and diversity of subject matter offerings described in the previous chapter represented changes reflecting quantitative growth of the AYI program during the first fifteen years of its operation.

As with any viable program designed to serve the public need, the AYI program would be expected to remain sensitive and responsive to not only temporal shifts of emphasis, but also to emergence of new areas of need due to cumulative effects of previous events and their anticipated effects on future needs. Variations of existing needs and the emergence and consequent perception of new ones would necessitate not only quantitative, but also qualitative changes in the program. Thus, the AYI program could not be expected to maintain and pursue over its fifteen year history the same specific program objectives which originally served as the basis for its creation.

In this chapter the writer will identify, describe, and trace the evolution of some of the more significant purposes or objectives of the AYI program. It must be recognized, however, that these evolutionary phenomena cannot be meaningfully studied in isolation. Their effects on the students, the school systems, the teaching profession, the universities, and the AYI program itself, must all be considered and explored in order to maximize elucidation of the total, complex development of this new program for training science teachers.

Perceptions of the purposes of the AYI program will, understandably, vary amongst concerned parties. The degree of congruity of these perceptions will vary with time and events, demand for the product, success of the program, and personal views and priorities. As one example, members of a House Appropriations Committee examining a budget request submitted by the Foundation may decide to severely cut back on funds for the program in light of limited finances and other higher priorities as seen from their own perspective of national needs, whereas those preparing and submitting the budget request for the AYI program would, on the basis of deeper and more intimate knowledge, be more acutely aware of the urgency of their own program in terms of overall Foundation objectives.

These perceptions, their changes over time, some of the underlying causes, and some of the immediate and long range effects will be explored from three different vantage points which will provide divergent perspectives. These three areas of exploration will be:

A. <u>The federal perspective</u>, which will include perceptions of members of Congress, representing the legislative branch, and of officials of the National Science Foundation, representing the executive branch.

B. <u>The institutional perspective</u>, which will include perceptions of AYI Directors primarily, and to a lesser extent those of other educators.

C. <u>The perspective reflected in independent studies</u>, such as theses, journal reports, and other independent studies.

Studies initiated and/or contracted by the Foundation will be included under category A, The federal perspective.

The Federal Perspective

I. Perceptions of members of the legislative branch

The severest critic and culling factor concerning the Foundation's annual budget request has most frequently been a Subcommittee on Independent Offices of the House Committee on Appropriations. These Subcommittee hearings were chaired for many years by Mr. Albert Thomas, Representative from Texas, and since 1966 by Mr. Joseph Evins, Representative from Tennessee. The role of this Subcommittee was predominantly that of close scrutiny of budget items and interrogation of Foundation officials. This produced a perhaps not unhealthy situation in that the Foundation had to remain prepared to explain, justify, and defend whichever budget item the Subcommittee chose to bring forth for questioning. Following this ordeal before the House Subcommittee the Foundation budget was next subjected to a less rigorous, general review before a Subcommittee of the Senate Committee on Appropriations. For fourteen years Senator Warren Magnuson of Washington served as Chairman of this Subcommittee, until 1969 when Senator Joseph Pastore of Rhode Island was named Chairman. Practically the entire annual budget of the Foundation in the past has depended, and continues to depend, upon decisions of these two Subcommittees.

The Foundation's budget item requests for "education in the sciences" have usually received favorable treatment at these hearings, and none so much as those intended for programs aimed at secondary teachers of science and mathematics. The budget for fiscal year 1957-58 was being reviewed by the House Subcommittee in January, 1956, and contained a modest request for $3 million to support eight additional AYI programs for 1957-58. Funds for the two pilot AYI programs at Oklahoma A & M College and the University of Wisconsin had been allocated during the previous year, and thus the Subcommittee was already familiar with the new AYI program. The strength of Chairman Thomas' conviction of the worth and value of the innovatory AYI program is nowhere so clearly manifest as in the offer he made to Foundation Director Alan T. Waterman at that hearing. Mr. Thomas suggested that rather than the $3 million which the Foundation was requesting for the AYI, the Subcommittee would respond favorably to a request for $9 million or $10 million to train even more teachers.[1] During a budget hearing in January of the following year Representative Charles Jonas of North Carolina also lent his support to the program. Mr. Jones, however, was willing to support the increased funding of the AYI program only at the expense of other existing Foundation programs.

> Mr. Jonas. I think you could devote far more attention to the improvement of the teaching at the high school levels in this country. I would like to see more emphasis placed on that and less placed on giving grants for fellowships in areas which may be fine and good for the country in the long run but which have a questionable relationship to the development of science as I see it.[2]

At that same hearing, Representative Edward Boland of Massachusetts expressed concern over the decreasing desire of students to study long and hard, and felt that the Foundation should be responsible for ". . . developing some sort of salesmanship in our teachers and in our schools."[3] This "salesmanship" expectation is completely compatible with the frequently-stated objective of the Foundation to have teachers in high schools inspire and motivate students toward careers in science and mathematics.

By observing which budget items the Subcommittee members chose to question, as well as the kinds of questions asked, one can better understand the positions and concerns of the legislators, and perhaps the concerns of their constituents as well. Representative Jonas of North Carolina seems to have sensed a potential weakness in the AYI program concerning the assumptions that the benefits of AYI participation realized by the selected teachers would indeed accrue to the high school student, and thus contribute positively to the broader Foundation objective of increasing and improving the Nation's scientific manpower supply. This, of course, was related ultimately to the Nation's security. This concern prompted Mr. Jonas to ask of Dr. Waterman at a budget hearing in March, 1960:

> Mr. Jonas. Do you have any assurances that the people who enjoy these fellowships and benefits from the institutes will continue in the teaching field, and what assurance do you have that you are not just educating people to leave teaching and go and get high-paying jobs in industry?[4]

Dr. Waterman then expressed his opinion that ". . . practically all go right back to the school for teaching purposes."[5] This was further supported by comments from other Foundation staff members present at the hearing who indicated that they had data showing that the rate of loss of teachers due to added training at institutes was less than the normal rate of loss of teachers, since it was of the order of 10 percent or less. It appears that estimates made by the Foundation were unrealistically optimistic, according to data gathered by the writer.

Based on available figures collected from annual final reports of institute Directors, 14 percent of 1958-59 AYI participants did not return to secondary science teaching. At the end of the 1962-63 academic year, this percentage had risen to twenty-six. Determination of how much of this attrition was the result of attendance at an AYI would require further study. Nevertheless, several years later the House Subcommittee appeared to be quite well satisfied with the AYI program in 1965, after nearly ten years of operation. Mr. Thomas felt that it was one of the best programs the Foundation had, while Mr. Jonas was impressed with its grass-roots effect, prompting him to observe:

> I have always favored it. I felt it was starting at the place where we ought to start. That is, upgrade the quality of teaching in our primary and secondary schools.[6]

Throughout the entire history of Foundation operations, leaders of the House Subcommittee on Independent Offices favored and retained in the Foundation budget a restriction specifying that a certain fraction of the funds budgeted for science education programs, averaging near 40 percent, must be spent on programs of supplementary education for secondary school teachers. Consequently, a good portion of those restricted funds have been used in the past for AYI programs. Differences between Foundation officials and the Subcommittee concerning their judgement of the relative worth of this program and the need for the budget restriction appeared in records of testimony for nearly every year. Apparently the Foundation felt that other programs and activities, such as institutes for college teachers, might better be funded with some of the restricted money, thus perhaps indicating some degree of dissatisfaction on the part of the Foundation with the secondary school AYI program.

Continued efforts on the part of the Foundation to have the restrictive clause removed and thereby permit reassignment of part of these funds to other training programs evoked a comment from Mr. Talcott, Representative from California, during a 1967 hearing at which he reminded the Foundation officers of the many instances in the past when they, themselves, had indicated that institutes were among the most successful part of the education program. Mr. Talcott also indicated his own concurrance with that view. We may conclude, then, that the perceptions of members of the legislative branch of the federal government, as evidenced by their comments and their continued support, have remained consistent throughout the history of the AYI program in perceiving the program as being worthwhile and highly successful in providing supplementary training for high school science and mathematics teachers and thereby contributing to improvement of the Nation's supply of competent scientific manpower.

II. Perceptions of members of the executive branch

An in-depth examination was made in Chapter IV of factors and events leading to the origin of the AYI program and its early growth. In this section an attempt will be made to ascertain whether there have been any changes in the ways in which members of the executive branch of the federal government have perceived the purposes of the AYI program, and if so to identify, describe, and trace their evolution. Since the Foundation is an independent agency within the executive branch of the government, the Director and his staff are considered to be members of the executive branch for purposes of this study. Data presented and examined in this section concerning perceptions of members of the executive branch were gathered from several sources, which included Annual Reports made by the Foundation, appropriations hearings of House Committees and Senate Committees, pamphlets and brochures and other literature distributed by the Foundation, reports in papers and journals, studies authorized and/or conducted by the Foundation, and personal communications with present and former officials of the Foundation.

Early in 1956, at a budget hearing, the Foundation Director justified the budget item requesting more funds for increased numbers of AYI programs in succeeding years as follows:

> Potentially one of the most valuable programs the Foundation has is the one for the supplementary education of high school science and mathematics teachers, where a grant is awarded to the teacher to enable him to obtain further education in the field of science in which he is interested. It is planned that the teachers will attend certain universities to be selected and take refresher courses for approximately one academic year.[7]

Farther along in that same budget presentation the Foundation acknowledged the need for development of specially designed programs at the selected universities:

> These courses are specifically designed to: provide opportunities for teachers to pursue a course of study for approximately 1 academic year in order to increase and/or renew their knowledge and understanding of their respective fields of science; to afford opportunities for "refresher" training to certain individuals not now teaching and so facilitate their return to the classroom at an effective level of competence; and to afford opportunities for science training to teachers now of necessity teaching an occasional science course but whose training and primary teaching responsibilities are in fields in which there is relatively ample supply of teachers.
>
> In addition, this program is expected to encourage universities to develop and offer as part of their regular programs more effective plans for training in-service and potential science

> teachers as well as encouraging secondary school administrators to provide their science teachers with opportunities for obtaining additional training which will make them more effective in presenting science to high school students.[8]

The program is thus identified by the Foundation Director as being one of supplementary education and "potentially one of the most valuable." Also appearing in the above testimony are hints of long-range Foundation expectations concerning the role universities ought to play in restructuring teacher-training programs and establishment of working relationships with school administrators. These objectives became more salient and significant in later years. Closely following the above testimony in time, Dr. Waterman told a Senate Subcommittee on Appropriations:

> Undeniably, the high school teachers can do a great deal to stimulate students to enter science as a career and to prepare adequately for careers in science.[9]

This objective is entirely consistent with a statement Dr. Waterman included in a letter to Senator Warren Magnuson in March of that year, in which Waterman pointed out that improvement of the quality of science teaching through the AYI program was directed to solving the long-range problem of increasing our scientific and technological manpower supply, both in numbers and in competence. In a speech given later that year Dr. Waterman emphasized the critical and difficult problem of maintaining an adequate supply of capable scientists and engineers. In addition, the high school population was showing continued growth and the present and future supply of competent high school science and mathematics teachers appeared to be inadequate to provide quality education for those increasing numbers of high school science students. In his 1956 Annual Report Dr. Waterman again linked the activities of the program to the supply of trained scientific manpower when he said:

> Programs designed to improve science teaching are directed toward the essential objective of increasing the numbers of well-trained scientists and engineers.[10]

In a brochure produced and distributed by the Foundation in 1957 announcing AYI programs, there was included among objectives to be achieved by those teacher-training institutes "better knowledge of their subjects," "improving teaching capabilities," "specially designed courses," and "increase the teacher's capacity to motivate students to consider careers in science, mathematics, and engineering."[11] This last objective was further emphasized by the Director in his comment at a Senate appropriations hearing, where Dr. Waterman stated:

> . . . improvement of teaching at the high school level will result in motivating more students of high ability to pursue careers in science.[12]

Comments made later by the Director and other Foundation officials at House and Senate appropriations hearings, in Annual Reports, and in journal articles, were essentially in keeping with the AYI objectives cited above. Concern with the broader, long-range objectives of the program were evident in a comment made early in 1957 by Dr. Harry C. Kelley of the Foundation Staff, when he said:

> The ability of the U.S. to succeed in its expanding responsibilities in world affairs, to maintain its technological leadership, to preserve our freedom, and to expand the welfare of our people depends in large measure on the quality of education we make available to our youth.[13]

Anticipation and awareness of possible limitations on the ultimate size of the AYI program is evident for the first time in comments made by the Director at the budget presentation that same year:

> This fall sixteen Academic Year Institutes will begin. About the same number is contemplated for 1958-59. These year-long institutes will train only about one-half of one percent of our high school science and mathematics teachers each year. Despite the enthusiastic endorsement by both teachers and school officials, we believe this program should not be expanded beyond the present level lest too many active teachers be withdrawn from their classrooms.[14]

Recognition of the undesirability of this depletion effect on the high school teacher supply was to remain a factor in Foundation policies concerning AYI expansion throughout the entire history of the program. Unanticipated factors, however, appear to have evolved in later years that resulted in expansion of the AYI program beyond the level implied above. The Eighth Annual Report stated:

> In academic year 1959-60 the Foundation plans to support about 30 Academic Year Institutes, the maximum level it is felt this program should attain.[15]

But even this limit was far surpassed by the more than seventy AYI's sponsored during several years in the late 1960's. Undoubtedly the restriction placed on Foundation funds by the House Subcommittee, discussed earlier in this study, had much to do with the steadily-increasing numbers of institutes sponsored each year. The chairman of the subcommittee reviewing the budget for fiscal year 1959-60 appeared to recognize that the need for the teacher-training provided by the AYI program would not be a temporary or short-lived phenomenon. Mr. Thomas commented to Dr. Waterman:

> If you have good men, you are not going to keep them all in a high school. They are going someplace else. So you have to keep them coming in and prepare for the new life.[16]

Mr. Thomas also felt that salary increases would do much to help retain good teachers in the classroom, but emphasized that this was the job of the local community and the state. Numerous studies and reports have indicated that most, and in the case of some institutes, all, participants in the program have realized significant salary increases following their AYI training.

Several new factors had appeared and affected the AYI program by 1958. Probably the most significant among these was the launching of the artificial satellite, Sputnik I, by the Soviet Union in October of 1957. A reflection of the impact of this event on the activities of the Foundation is found in the increased budget request for the 1959 fiscal year institute programs. The three-to-four-fold increase from $9,790,000 for fiscal year 1958-59, to the $35,500,000 request for fiscal year 1959 clearly shows this effect, since the 1958-59 budget was submitted and approved <u>before</u> Sputnik I, and the 1959-60 budget was submitted and approved <u>after</u> Sputnik I.

Concentration on subject matter with little or no attention to pedagogical methods was to remain the policy for AYI programs, according to comments made by Dr. Detlev Bronk, President of the National Academy of Sciences, and Chairman of the National Science Board, and also by Dr. Bowen Dees of the Foundation staff. Both men were in positions from which they could influence Foundation policy, and in 1958 both publicly expressed the belief that too many teachers had too much "method" or "how to teach" and not enough subject matter understanding. Recommendations to exclude "methods" courses or "education" courses from AYI programs again appeared in the budget hearing early in 1959. Sufficient change in Foundation policy occurred during the next decade, however, to bring about modification of this position to the point where an Ohio State University proposal was approved which enabled the University to conduct an AYI in education during the 1967-68 academic year.

Indications that the Foundation did not have intentions of perpetually sponsoring and supporting the AYI program are found in a reference to the program in President Eisenhower's budget message early in 1958, in which he states:

> With full awareness of our tradition of not involving the Federal Government in the Nation's public education process, this stimulation I have proposed must not be so over emphasized that the program cannot be later carried on by those who must continue to carry the responsibility - - the local school districts, universities, and industry.[17]

Thus in the late 1950's the Foundation had plans and intentions which, if implemented, would have gradually phased out the AYI program by having the universities take over and carry on training programs which they were to have designed and perfected during the years in which they conducted Foundation sponsored and financed AYI programs.

Increasing attention on the part of the Foundation to activities which might possibly increase the effectiveness of the AYI training program for secondary teachers resulted in supplementary grants being made in 1959 for the support of small numbers of college teachers in AYI programs already established and in operation at several different universities. The intent here appeared to be that of upgrading the subject matter knowledge of college teachers, thereby improving the quality of science courses being offered as part of the pre-service training of undergraduates who were preparing for careers in teaching, and also to provide an opportunity for college teachers to mingle with high school teachers of science and thus become better acquainted with the problems and needs of secondary teachers.

Authorization and funds were provided so that some of the institutes could offer an additional optional summer institute to selected

AYI participants, thereby making it possible for teachers enrolled during the regular academic year to complete requirements for an advanced degree.

During 1959, also, the effects of evolving "new" courses in high school science, such as the Physical Science Study Committee (PSSC) physics being developed under the leadership of Professor Jerrold Zacharias at Massachusetts Institute of Technology, were appearing in literature citing AYI objectives. This is clearly shown in the following comment made in 1959 by the Foundation Director in his Ninth Annual Report for the Foundation:

> The primary objective of the institutes program is to improve science instruction through making it possible for teachers in secondary schools and colleges to obtain additional knowledge of subject matter and to become acquainted with new developments in science and mathematics.[18]

The conclusion of fiscal year 1958-59 also marked the end of the third year of operation of the AYI program, and it was also a time for evaluation. According to a time table proposed earlier by the Foundation staff, support through the AYI program was intended to help universities establish, and then offer on a continuing basis, modern teacher-training programs, according to a three-phase program. Phase I was to include four full years of Foundation financing of AYI programs, much as it had been doing since 1956. Phase II was to be of shorter duration, during which funds would be provided to the university only for stipends for participants, and none to the university to pay salaries of those teaching institute courses or for course-related expenses. This would be followed at a later time, in Phase III, by withdrawal from the university of all Foundation funds and the awarding of fellowships to science teachers on a national basis. The teacher could then use his fellowship award at any university that had developed and was offering the kind of courses or program the Fellow felt would best meet his needs. The failure of this proposed phasing-out plan to materialize was manifest in the Foundation program for 1968-69, nearly ten years later, when more than seventy AYI's received continued Foundation funding for the 1969-70 academic year.

Still another significant event which occurred at the close of the 1950 decade was the establishment of a Federal Council for Science and Technology, based on a recommendation of the President's Science Advisory Committee. As constituted, membership on the Council included a representative from the Foundation, thus providing direct access for scientists to the President. This representation helped the executive branch remain better informed on the activities, interrelationships, and problems of science.

Comments made by Foundation officials during 1960 concerning the objectives of the AYI program were not significantly different from those made in 1959. Considerably greater emphasis appears to have been placed on the quality of the participants being selected for the institutes, and on their potential for developing into competent teachers. Dr. Bowen Dees of the Foundation staff responded to a question posed by Mr. Thomas, Chairman of the House subcommittee on appropriations, concerning selection criteria established and used by institutes by saying:

> Basically, that they are to select people again on the basis of their ability to profit from the institute's offerings. . . In some cases the institute will choose to set its sights so as to pick bright people who have had little training in

> science. In other cases, they will set their goals to pick up better teachers and to make them still better.[19]

Two members of the Foundation staff, Lewis Pino and C. Russell Phelps, conducted an evaluation study of the AYI program, and reported their findings in August, 1960.[20] This report acknowledged that the original plan for phasing out Foundation sponsorship of the AYI program would have to be abandoned. Reasons included reluctance on the part of universities to assume responsibility for the entire training program, and the continued growth of numbers of qualified universities which had been submitting proposals for these institutes. More importantly, the study by Pino and Phelps explored and evaluated program operations hoping to find answers to questions concerning AYI accomplishments, continued need for the program, possible improvements, effects on the universities, possible alternative programs, influence on the pre-service preparation of potential science teachers, and possible applications of the program to college teacher training programs.

Outside scientist-consultants were brought in by the Foundation to aid in the study, and these consultants were unanimous in agreeing on the effectiveness of institutes in the retraining of experienced in-service science teachers. Furthermore, evidence indicated that improvements in knowledge and understanding of science resulting from participation in the institute were bases for higher salaries, increased recruitment of participants by other school systems, and increased status of the participant in his school and in his community.

In terms of the effect of the participants on the university and its established programs, the report continues:

> The impact of these groups of mature, hard-working, yet poorly-trained teachers on the universities has created major curriculum and degree changes.[21]

This effect of the participants on the curriculum of the university was to have long-range implications, as evidenced by the 1967 Foundation Memorandum from J. Donald Henderson, then Program Director for Research and Academic Year Study Program, in which experienced AYI Directors were asked to respond to the following items:

> (1) What, if any, influence has there been to change the course offerings of the science and mathematics departments on your campus?
>
> (2) Does your graduate school make any "special" provisions for science teachers? Is a "special" degree available?
>
> (3) Has there been any significant change in the undergraduate program for prospective teachers? If so, how has the institute program influenced such a change?
>
> (4) Are there noticeable trends in the enrollment in your undergraduate or graduate science and mathematics teacher training programs, other than in those supported by the NSF?
>
> . . . .
>
> (5) What, if any, "permanent" changes on your campus have been brought about by the AYI program?[22]

Dr. Henderson's untimely death in 1968 left many of these questions unexplored. Others in the Foundation, however, appear to be still concerned with certain of them because the Foundation again in 1969 requested Directors to supply data, via a form to be completed and returned with the institute Director's Annual Report to the Foundation, concerning the effect of the AYI on the teacher training program of the university.

The scientist-consultants employed by the Foundation in the Pino and Phelps evaluation reported also that some institutes provided no special courses, but rather attempted to select participants with excellent recent training in the sciences and assign them to regular graduate courses. In another area, peripheral to curriculum, the investigators presented evidence which suggested that an old problem continued to plague AYI participants, that being the dissatisfaction of students with the counselling provided for them by the university. This problem--the lack of adequate, competent counselling--was frequently mentioned in studies of the first AYI held at the University of Wisconsin in 1956-57, and was still being mentioned by participants in studies conducted about a decade later.

In evaluating the need for continued AYI's, the study concluded that two important objectives of the program must continue to be achieved: to remedy inadequate previous training, and to keep up with modern advances in subject matter. On the basis of this conclusion it would appear that the AYI program is destined to become a permanent feature of this Nation's teacher training activities.

Although inclusion of instructional methodology in institute programs had initially been recommended against by the Foundation, the investigators were less opposed, for the report points out that:

> Respect for and knowledge of the subject matter and sensitivity to the capabilities and needs of a class are not incompatible; the good instructor in any course must have both.[23]

It would appear, however, that the Foundation, by maintaining its exclusive emphasis on increasing the subject matter knowledge of the participants, is operating on the assumption that this alone will result in the production of more effective high school science teachers and teaching.

Based on field observations of institutes in progress, which included discussions with participant-teachers and institute staff, the scientist-consultants and Foundation staff further recommended that the AYI be supplemented with sequential optional summer institutes; that the curriculum development for the retraining of high school science and mathematics teachers and for pre-service training of science and mathematics teachers be continued; and that the AYI programs already designed for poorly-trained college teachers be expanded.

Several new areas of teacher training were explored and tested during the 1960-61 academic year. One of the innovations was the acceptance for AYI participation of some who had no teaching experience, thus reversing earlier Foundation policy of requiring participants to have three years of teaching experience. As in past years, there was continued emphasis on achieving the objectives of developing special courses and curricula for updating and upgrading secondary science and mathematics teacher training. The Foundation's self-imposed limitation of providing institute opportunities for no more than one percent of the total population of high school teachers of science and mathematics was maintained. There was no noticeable change in the assumption made by the Foundation that increasing subject matter competence exclusively would produce better classroom teachers.

Considerable emphasis on Master's degree programs appeared in comments and papers by Foundation personnel during the 1960-61 academic year. In a paper by Dr. Neville Bennington of the Foundation staff,[24] under a section titled "Accomplishments of the AYI Program," four of the seven categories of activities reported by him had to do with some aspect of Master's degree programs for participants. Earning an advanced degree was becoming an increasingly important objective of AYI participation. Dr. Bennington also pointed out that 62 percent of AYI participants over the first four years of the program had qualified for and received their Master's degree, and that many of the remaining 38 percent had already earned their advanced degree prior to participation in the program.

One of the several significant changes made in the AYI program during 1961 was that of reducing the number of participants accepted for any one institute. The Eleventh Annual Report points out that this number was reduced from an average of 47 to an average of 37, the objective being to effect a wider geographical distribution of institutes. This average number of participants per institute was further reduced in later years. A more important change, however, was the Foundation's expansion of the AYI program to provide unique training opportunities for upgrading the training of pre-service secondary science teachers, and for upgrading the science knowledge of "teachers of teachers." The rationale behind the pre-service training program, first initiated at Oklahoma State University in 1960, is supplied in the staff paper by Dr. Bennington in which he said:

> These pre-service teachers are to be selected from among recent promising graduates of teacher training institutions who have met the professional education requirements, including practice teaching, but have insufficient background in mathematics or science.[25]

Yet another program was designed and pioneered at the University of Wisconsin. This was a post-Master's level program intended to prepare secondary supervising teachers, and represented an attempt to help overcome what appeared to be inability or reluctance on the part of school administrators to effectively utilize the training and experience of AYI graduates, particularly with respect to curriculum revision.

Participation of college teachers in earlier AYI programs was justified on the basis of possible benefits to be gained by interaction between secondary school teachers and college "teachers of teachers," with expectations that college teachers would become better acquainted with activities of secondary school science teachers as well as with their needs and problems. Proposals submitted for the 1961-62 academic year included, for the first time, AYI's which were for college teachers exclusively, and several others which were for secondary teachers and college teachers combined. For the college teachers attending the combined institutes, emphasis was to be on upgrading the subject matter knowledge of these "teachers of teachers" while other institutes, for college teachers exclusively, emphasized in-depth subject matter training, thereby increasing their degree of specialization.

According to Dr. Bennington's staff paper, the need for the AYI program would not diminish over the years but, on the contrary, would become increasingly necessary. Dr. Bennington reasoned:

> The point is frequently raised that with so many participants receiving institute training, the need for maintaining support at the present levels will soon become unnecessary. Nothing could be farther from the truth. If the total efforts of the 1960 institutes programs had been devoted to the secondary school teaching force, it would have fallen far short of meeting the needs of this group alone, not to mention those of the poorly equipped teachers added in previous years or those of the initially well prepared who are now in need of updating.
>
> The program will have to be increased many fold before it reaches a satisfactory level for meeting the "updating" and

> "upgrading" needs of the secondary school teacher as well as those of the college and elementary teacher which have not been considered in this study.[26]

According to a journal article authored by two Foundation staff members in 1961, the AYI program should be retained as a long range continuing enterprise:

> Most important of all, we must continue to give most serious attention to the problem of keeping up to date in science, a problem which is continuous even for the best trained of teachers. . . . In time we can eliminate the need for remedial programs for basic training by improving undergraduate teacher training; but the "sabbatical-year" type of study needed to maintain a teacher's competence in science will represent a continuing need for supplemental work and training.[27]

In the journal article it was further pointed out that the "sabbatical-year" type of study was to differ significantly from that offered in AYI's in previous years:

> In earlier years institutes could be planned on the simple assumption that all participants would need training in fundamentals of science and mathematics. This is still needed for many; but there are numerous other teachers who are now interested in progressing beyond the beginning levels. Some institutes are needed for teachers specializing in a field and capable of advanced study therein, as well as for beginners.[28]

Apparently the Foundation was no longer concerned, as it was in the late 1950's, that intensive training of secondary teachers in a specialized discipline (e.g. chemistry or physics) would make them increasingly attractive prospects for recruitment by industry and government.

From another perspective, some support for the Foundation's position of advocating continued sponsorship of the AYI program was provided by Dr. Bennington, who supplied data and calculations showing that the AYI program was less expensive to operate than was the summer institute program. Dr. Bennington calculated that the AYI programs were costing $152 per week, per participant, while summer institutes were costing $160 per week, per participant. For an average school year of 40 weeks then, the Foundation would need to provide $6,000 per participant for the AYI program.

Description of the AYI experience as a "group training" approach is first noted in Foundation literature in 1962. Its significance was, perhaps, in the increasing concern within the Foundation that institutes were more frequently allowing participants to design their study programs around existing regular courses rather than structuring and teaching specially designed courses for institute participants. During that same year further broadening of programs, and consequently the variety of courses available to participants, was evident in the establishment of new programs offering supplementary, refresher subject matter training for retired military personnel who wished to enter the teaching profession. Selection of participants from this group was influenced strongly by the amount of background education in science or mathematics which these retired personnel had.

Programs designed to facilitate the upward mobility of secondary teachers to the college level appeared to gain Foundation sanction with acceptance by the Foundation of a proposal for the ". . . preparation of selected secondary school teachers for teaching positions in junior colleges."[29] Additional interest and emphasis on college teacher training and on curriculum development at that level by the Foundation is evident in statements by the Director in the Foundation's Twelfth Annual Report:

> At the college level these programs show increasing concern with "teachers of teachers." A secondary objective of the program is, therefore, to encourage colleges and universities to establish "pre-service" courses or curricula that more effectively meet the subject matter needs of teachers in science, mathematics, and engineering. . . .[30]
>
> A trend which will be of increasing significance in the future is the marked growth in the portions of the program directed toward college teachers. . . . Since the emphasis in this program is on training opportunities for "teachers of teachers" in liberal arts colleges, teacher training institutions, and junior colleges, the effects upon the future graduates of teacher training programs will considerably multiply the present direct efforts.[31]

Long standing Foundation policy concerning the relative unimportance of including teaching methods in the AYI experience, as opposed to subject matter training, was further reinforced by Dr. Bowen Dees at a 1962 budget hearing in Washington where he said:

> We think teachers should know how to teach, but this is not the Foundation's business. It is our business to try to see to it that the teachers learn enough science so they can teach science.[32]

Implicit in his comment also, is the notion that knowing subject matter exclusively is sufficient to ensure successful teaching of it.

The 1962-63 academic year was the seventh in which AYI's were conducted by the Foundation, and by June of 1963 more than 8 thousand secondary and college teachers of science and mathematics had participated in the program. If this program was to show any progress in achieving its stated purposes of producing greater numbers of competent science teachers to stimulate and motivate students to careers in science, one would expect manifestations of it to be extant. Such was not the case, however, for the Director observed in his _Thirteenth Annual Report_:

> . . . in spite of the large funds that have been made available to academic institutes for the support of science and engineering, the proportion of students majoring in science has remained approximately the same, about 20 percent, and the proportion enrolled in engineering has actually decreased substantially during the past 5 years.[33]

An interpretation which directly contradicts this pessimistic evaluation appears in a staff paper by Dr. C. Russell Phelps in July, 1963. In his evaluation of the effects of institutes on secondary teachers, Dr. Phelps stated:

> Perhaps a more important effect, in the long run, has been the steady increase in numbers of students entering college highly motivated toward careers in science and mathematics. This is in great part a direct result of their increased respect for, and guidance by, the many high school teachers who have been updated and upgraded through institute participation.[34]

During academic year 1963, and increasingly as the 1960 decade progressed, greater emphasis was being placed on programs which had potential for producing the "multiplicative effect" in the training of teachers, a goal suggested several years earlier by one of the pioneer institute directors, Dr. James Zant of Oklahoma State University. That there was emphasis upon programs of that type was reflected in the statement made by the Foundation in one of its budget item requests for fiscal year 1964:

> The depth of training offered in this program is sufficient to enable the successful participants to function in leadership positions in the revision of secondary curriculums in science or mathematics upon their return to their teaching positions.[35]

The necessity for continued as well as increased support for AYI programs for college teachers was partly a consequence of the emergence of new science courses and their rapid infusion into many high schools. College teachers whose training dated back several years were quite unprepared to offer science courses that would meaningfully complement the newly developed courses being taught in secondary schools. Additionally, as pointed out in the staff paper by Dr. Phelps, the AYI's were annually reaching less than three percent of the approximately 110,000 teachers of science, mathematics, and engineering in the Nation's universities, colleges, and junior colleges. That rate of less than three percent annually who were reached by programs was hardly sufficient to keep up with the more than 4,000 new full time instructors who entered college teaching without the doctorate during the 1962-63 school year. It goes without saying that increased opportunities for AYI participation would mitigate the problem of inadequate training. On the other hand, however, increased AYI participation by secondary school teachers resulted in greater numbers annually transferring to college teaching. This had a negative effect on the problem, according to Dr. Phelps, and was an unexpected effect of participation in institutes, since in-service AYI training for secondary school science teachers in actuality served for some as a springboard for transfer into college teaching, thereby increasing the numbers in college teaching who had inadequate training.

In his first Annual Report after taking over as Director of the Foundation in 1963, Dr. Leland Haworth, understandably, did little more than reiterate previously-stated objectives of the AYI program. Although they constituted the official Foundation position, they should not necessarily be considered as representative of Dr. Haworth's personal views or expectations. A better idea of where his own professional concerns would lie can be inferred from his comment in the Fourteenth Annual Report of the Foundation in 1964:

> Thus while the Foundation properly supports science education programs at many levels, the goal is to strengthen the potentialities for national research capability.[37]

A publication issued by the Foundation in that same year indicates continued concern with the scientific manpower supply in saying:

> They (the institutes) are directed toward broadening teachers' scientific knowledge and increasing their capacity to motivate students to consider careers in science, mathematics, and engineering.[38] (Parentheses mine.)

Data included in a 1964 report submitted by Dr. Paul Carnell of the Foundation staff reflects, in the nature of questions to which he sought answers, some objectives of the AYI program implicit in sponsorship. The following list of questions and effects explored by Carnell provides an indication of the concerns of the Foundation with respect to achievements of the AYI program.

1. What percentage of teachers who were in AYI programs remained in secondary school teaching?

2. What percentage of the AYI participants migrated into college teaching?

3. What percentage of the AYI participants left teaching for other types of employment (e.g. non-school)?

4. What changes has AYI participation produced in school programs?

5. Changes in remuneration as the result of AYI participation.

6. Changes in professional status as the result of AYI participation.

7. Changes in the nature of responsibilities as the result of AYI participation.

8. Changes in percentages of students studying science in their schools as a result of AYI participation.

9. What would happen if the AYI program were to be discontinued?

10. Has the AYI program exhausted its market?

11. Should the AYI program be continued at a reduced or increased level?

12. Are there practical alternatives to government support for stipends--such as sabbatical pay or private fellowships?

13. To what extent can, or would the type of course programs offered to AYI participants continue to be available during the academic year on a regular "catalog" basis supported by tuition, but without guarantee on numbers of registrants?

14. What experimental patterns should continue to be explored in the AYI program?

15. What new experimental patterns might be considered in the AYI program?[39]

Six of the first seven topics proposed above are concerned with the direct effect of the AYI experience on the welfare and activities of the teacher, while most of those remaining appear to be centered on possible variations of, and alternatives to, the program itself. Curiously, only one is clearly directed at finding out what kind of effect the AYI program has had on the high school student.

Following his second full year as Director, Dr. Haworth continued to view the welfare of the Nation as being related to operation of institute programs, as indicated in 1965 in his statement in the Fifteenth Annual Report:

> Proposed activities had to take into account the overall objective of NSF-supported educational activities--that is, to ensure that the Nation produces adequate numbers of well-trained scientists and engineers to do the things our national goals require.[40]

This broad concern, later in that same report, is narrowed down to emphasis on the contributions which institute programs were making to realization of the national goals, as shown by the Director's comment that:

> It is in the high school that science first appears in the form of specific courses taught by specialized teachers. Hence, not only is the high school a crucial point in science education, but it is also the stage of the educational process in which the greatest and most effective impact can be achieved rapidly by teacher improvement.[41]

In his 1966 Annual Report Dr. Haworth again emphasized the desirability and feasibility of early exposure of students to the best possible instructional materials and the skilled teachers needed to put the materials to most effective use. The long range effect of this early exposure is then pointed out by Dr. Haworth:

> A child's experiences with science and mathematics during the pre-college period largely determine whether he becomes motivated and adequately prepared to undertake a scientific career. For this reason the Foundation seeks to support programs that make available the best possible instructional materials, the skilled teaching needed to put these materials into effective use, and the special opportunities that permit students to achieve their maximum learning potential.[42]

Farther along in the same report are listed goals toward which programs were to be oriented; nearly all of which could be achieved by the AYI program:

1. Further train high-quality graduate students and scientists.
2. Improve subject matter competence of teachers of science, mathematics, and engineering at all academic levels.
3. Provide modern materials of instruction and courses of study.
4. Increase the scientific knowledge and experience of talented high school and undergraduate students.
5. Improve science instruction at the undergraduate level.
6. Improve the American public's understanding of science.[43]

Increasing awareness of the need for a more localized and specific approach to some persistent problems in high schools, and in undergraduate teacher training programs, prompted the Foundation to petition Congress for greater flexibility in using funds that were restricted to supplementary education for secondary school science and mathematics teachers. (See pp. 131-32 this study.) The increased flexibility would permit the Foundation to launch an experimental program which would strengthen science education at the school system level by working on the scene with teachers who needed help. The program would thus simultaneously deal with school level problems and with the teachers and students involved in those problems. A program much like this has since been listed in the literature as the Cooperative College-School Science Program. Had Congress permitted this degree of flexibility, the emphasis would then have shifted somewhat away from AYI programs and more attention would have been given to helping needy school systems to improve both their science instruction and the science program. Some of the causes behind this proposed shift in emphasis were to be found in the inability of school systems to adequately judge the merits, procedures for adoption, and training requirements, in connection with the plethora of new science curricula being made available at the secondary level. Other facets of the rationale behind the proposed shift in emphasis were brought out by Dr. Thomas Fontaine, Associate Director, Education, at a budget appropriations hearing in 1967:

> Most authorities are now convinced that improvements in their own schools are both needed and feasible. They want to do something about it, but many do not know what to do or how to do it. Further, although the training a teacher obtains in an institute does increase his knowledge of his subject, it does not necessarily do so in ways directly relevant to the immediate needs and plans of his own school. For these reasons the Foundation has been trying to help develop a companion program to the institutes.[44]

The Foundation's <u>Seventeenth Annual Report</u> of 1967 contained a summary listing of institute objectives. Perusal of the list, which follows, and comparison of it with the proposed objectives of science education programs listed for the previous year (p. 154, this study), provides strong evidence for changes in direction as well as emphasis of the institutes program. Institute objectives for 1967 were as follows:

> Institutes focus on one or more of the following objectives:
> Remedial training for teachers who were initially ill-prepared.
> Updating of subject-matter knowledge for those who were once adequately prepared.
> Specific background training to equip teachers to teach the newer curricular materials.
> Training in depth to enable teachers to meet new, higher (e.g. Master's) standards.
> Advanced specialized training for teachers and supervisors preparing for positions of leadership.
> Introduction of teachers to research methodology.[45]

The latter three objectives are relatively recent innovations, and the last one cited appears for the first time among formally-listed Foundation objectives, very likely a consequence of Dr. Haworth's strong emphasis on research activities. Objectives apparently receiving less attention in 1967 than in 1966 were motivation of high school students and improving the public's understanding of science.

As part of a special study concerning goals and achievements, the Foundation staff in 1967 proposed a rather comprehensive list of topics for further evaluation. Here again, one can gain unique insight into the expectations held for the institutes program by the Foundation through examination of the kinds of questions the Foundation sought to answer. The questions posed by the Foundation which are of relevance to this study were as follows:

1. What has been the impact of individual teachers trained at institutes on their school system?

2. What are the characteristics of the teacher population that attends, or applies for, in-service institutes?

3. What has been the total effect of 12 years of Academic Year Institutes on the participants?

4. To what extent are institutes needed in the next several years?

5. What is the ultimate effect of teacher institutes upon the students of these teachers?[46]

Answers to several of these questions, obviously, will be very difficult to determine, but it is commendable that the Foundation recognizes the necessity for pursuing them. It is particularly heartening to the writer that among them is an attempt to appraise the effects of the AYI program on the high school science student.

The effort on the part of the Foundation to reduce the scope of the AYI program was apparently unsuccessful, as the budget presented for fiscal year 1969-70 stated that institutes and related programs for improving the subject matter competence of secondary science and mathematics teachers would be funded at the same level as in fiscal year 1968-69. This was further supported by the Director's acknowledgement of the value of the supplementary training program, in his statement in the Eighteenth Annual Report:

> The quality of instruction provided by the Nation's schools is dependent to a large extent upon the competence of teachers. Rapid changes in scientific knowledge, coupled with initial training which emphasized teaching techniques rather than the substance of science, have created serious problems for many teachers of science and mathematics. Consequently, the NSF places strong emphasis on the supplementary training of teachers of these subjects, particularly at the secondary school level.

> Teacher training institutes have been the most notable of the Foundation's support for upgrading the subject-matter knowledge of pre-college science and mathematics teachers.[47]

Additional changes in AYI purposes were yet to come, however, as seen by statements farther along in the Eighteenth Annual Report which indicate that more attention was to be given to leadership training and to new course materials:

> . . . an increasing number of the Academic Year Institutes are being redesigned to provide advanced specialized training for potential leaders in secondary school science. At the same time, other AYI's are able to upgrade the academic level of their programs because their participants have improved their prerequisites in Summer or In-Service Institutes. . . . Of the 61 Academic Year Institutes receiving support this year, 22 explicitly include instruction in the effective use of new course content materials, and 11 will train teachers for work with advanced placement courses in their school systems. A few institutes will prepare already competent science teachers for supervisory positions in the schools.[48]

Thus, although AYI's were retained as a significant feature of the Foundation's program for "education in the sciences," their objectives were now to be more clearly centered on course content materials, advanced placement training, and the training of leadership and supervisory personnel.

Activities of the Foundation during the most recent year for which adequate data were available include variations of earlier programs as well as introduction of some that were new. A 1969 news release by the Foundation announcing AYI grants for 1970-71 included the usual objectives of "helping high school teachers improve the quality of their teaching," and "concentrate on improving their own knowledge of skills." Program innovations appearing for the first time among Foundation offerings include an institute designed to prepare secondary school mathematics teachers for service in "inner-city" schools, introduction of teachers to the use of computer-assisted instructional materials, and training teachers to serve as consultants in economics education in their local school systems.*

Considerable attention was also given, in 1969, to efforts at increasing the homogeneity of the group of participant-teachers selected for a particular AYI. It will be recalled that recommendations were made during the very early years of AYI operation for establishing selection procedures which would result in institute groups having more homogeneous backgrounds and training experiences. This could be the cause, or effect, or both, related to the continuing decrease in numbers of multiple-field institutes being supported by the Foundation.

Additionally, this most recent year was a period of much greater emphasis on training teachers for leadership positions and responsibilities, evidenced by Foundation sponsorship of seven institutes with programs for training coordinators, specialists, and supervisors. Corroboration of this direction of emphasis was supplied during a personal interview earlier this year of the writer with Dr. Michael Frodyma, Program Director, Research Training and Academic Year Study Program of the Foundation. Dr. Frodyma expressed his personal view that the AYI program would increasingly trend toward leadership training. This leadership training would then be available for those wishing to train and/or supervise teachers in teacher-training institutions, in-service institutes, conferences, and localized in-school programs.

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*Authorization for training in economics education was provided in the 1968 amendment to the National Science Foundation Act of 1950, which called for increased emphasis on social science activities, of which economics is one.

The following Table 9 provides a consecutive annual tabulation of categories of objectives of the AYI, which represents the federal perspective of the purposes of the AYI and also makes more easily discernible any changes which may have occurred over the years. The manner in which any single objective of the program is worded or expressed will vary according to factors such as the style of the individual, the reason for making the statement, and the medium through which the expression is to be publicized. For example, an official of the Foundation in a speech to a group of scientists may cite "supplementary training" as one of the objectives of the AYI program. The same Foundation official would find it necessary, in testifying at a budget hearing before a House subcommittee, to be more explicit and exact as to precisely what "supplementary training" consisted of. In this instance it would be incumbent upon him to describe the scientific discipline, the depth and breadth of treatment of subject matter, the background and qualifications of the participant group, and perhaps something pertaining to expected results. It was to facilitate most effective display and interpretation of these wide variations in modes of expression that the more than 100 statements of purpose selected from amongst many others in documents, reports, and journal articles were condensed into the following categories. Each category was then coded and listed in Table 9.

Categories of Purposes of the AYI Program

Category 1, coded as seven sub-categories of "Supplementary Education" in Table 9, includes the following purposes:

TABLE 9

PURPOSES OF THE AYI AS EXPRESSED BY FEDERAL OFFICIALS, 1956 - 1969

	Year in Which Purpose Was Cited													
Coded Categories of Purposes	56	57	58	59	60	61	62	63	64	65	66	67	68	69
1. Supplementary Education														
A. General	x	x	x	x	x	x	x	x			x	x	x	x
B. Modernize				x	x	x	x	x	x	x	x	x	x	x
C. Increase	x				x	x	x	x	x			x	x	x
D. Upgrade		x				x			x	x	x		x	
E. Refresh	x				x		x					x	x	
F. Remedial					x	x	x					x	x	
G. Broaden									x					x
2. Student Careers	x	x	x	x				x	x	x	x		x	x
3. Teacher Effectiveness	x	x	x	x	x	x	x	x				x		x
4. Assist Universities	x	x	x	x	x		x					x		x
5. Leadership				x		x	x	x				x	x	x
6. Curriculum Reform			x	x		x	x	x					x	x
7. Supply of Scientists	x				x				x	x		x		
8. Supply of Teachers	x					x		x				x		x

1. To provide supplementary education for participant teachers, emphasizing:

A. General--better knowledge of all subjects.
B. Modernize--update in field, introduce new curricula.
C. Increase--deepen knowledge in specialized field.
D. Upgrade--to higher level across disciplines.
E. Refresh--review knowledge of science.
F. Remedial--bring up originally poor, incomplete, inadequate training in field.
G. Broaden--introduce to new disciplines.

Category 2, coded as "Student Careers" in Table 9, includes the following purposes:

2. To prepare high school science and mathematics teachers to better identify, inspire, stimulate, motivate, encourage, counsel, or prepare capable students to consider and pursue careers as practising scientists, mathematicians, engineers, or teachers of these.

Category 3, coded as "Teacher Effectiveness" in Table 9, includes the following purposes:

3. To upgrade, improve, strengthen effectiveness, competence, capabilities, qualifications, skills, techniques, quality of teacher and of teaching.

Category 4, coded as "Assist Universities" in Table 9, includes the following purposes:

4. To encourage and assist universities in designing, developing, and teaching subject matter and degree courses, programs, or curriculums for preparing or improving teachers of science or mathematics.

Category 5, coded as "Leadership" in Table 9, includes the following purposes:

5. To train and prepare those with high potential for leadership for positions as college teachers, secondary supervisors, consultants, coordinators, teachers of teachers, and for in-service leadership of colleagues in local school systems.

Category 6, coded as "Curriculum Reform" in Table 9, includes the following purposes:

6. To train teachers to better stimulate, assist, introduce course content improvement in high school curriculum reform.

Category 7, coded as "Supply of Scientists" in Table 9, includes the following purposes:

7. To increase the numbers, competence, and supply of the Nation's scientists, researchers, mathematicians, engineers, and technical manpower.

Category 8, coded as "Supply of Teachers" in Table 9, includes the following purposes:

8. To increase the supply of capable teachers by training former science teachers re-entering the profession, those from other fields with science or mathematics backgrounds, those from other fields with little or no science background, and pre-service certified candidates.

Based on the frequency of data appearing in the first four numbered categories of Table 9 (1A, 1B, 2, and 3), it appears that federal officials most strongly perceived and expected the purposes of the AYI program to be:

(1) to increase the general subject matter knowledge of the participants;

(2) to increase the participant's knowledge of modern subject matter and curricula;

(3) to prepare participants to better motivate students to careers in science; and,

(4) to increase the effectiveness of participants as teachers of science.

Three of these four purposes appear with greatest consistency from the time of inception of the AYI program up through the final year covered in this study. The fourth of these frequently-listed purposes appearing above was recognized only after new courses, such as the PSSC Physics, became available for use in secondary schools after 1958.

Other purposes of the AYI program which were recognized to a lesser degree, but yet in more than 50 percent of the years included in this study, were those intended to facilitate development of teacher training courses by universities, and to provide participants with greater depth in specialized subject matter fields.

Two additional observations might be made concerning the tabulated data. The first is the complete lack of citations in over 50 percent of the categories for the consecutive years 1964, 1965, and 1966. Since data collection procedures were uniform across the years sampled, the erratic distribution of comments for those three years is due to some other, unknown cause. The second observation concerns the rather abrupt appearance and continued emphasis on curriculum reform (Category 6), modernize and introduce new curricula (Category 1B), and Leadership (Category 5). These might be considered examples of evolution of purposes of the AYI, in that they appeared several years after initiation of the program and have since been retained.

The Institutional Perspective

The manner in which college and university teachers and administrators view the objectives of the AYI program can best be determined by what they have said about it and how they have designed and conducted the institutes in their own schools. On this basis it seems reasonable that a fairly accurate evaluation of educators' perceptions of purposes of the institutes, changes in these perceptions, and possible reasons for the changes, could be carried out by gathering, organizing, and interpreting data from the following sources:

1. Documents on file in the Foundation Offices in Washington, D.C.;
2. Brochures, flyers, and other literature distributed by the institution which describes courses, eligibility requirements, and application procedures;

3. Evaluation studies conducted by or for the institution; and

4. News releases, journal articles, and correspondence originating with institution personnel.

All of the data under the first category above, and most of that under the second, were collected by the writer from documents on file in the National Science Foundation offices in Washington, D.C. over a two week period during March, 1970. Materials for each separate institute for each year were contained in a labeled file folder, and ordinarily would consist of the following:

1. The original proposal from the institution to the Foundation, requesting a grant for an AYI.

2. The final report of the Director of the AYI to the Foundation.

3. Brochures, flyers, and other literature describing courses, eligibility requirements and application procedures for each school.

4. Reports of visitations to institutes by scientist-consultants and/or Foundation personnel (if such were made).

For various reasons beyond the control of the writer, files were sometimes incomplete with respect to content in all four categories listed above, but in nearly every case a proposal or a Director's final report, or both, appeared in the file folder.

Because of the large number of AYI's sponsored since 1956 (in excess of 600) it was decided to examine a representative sample of all folders. It was considered essential to include a sample of all folders for the very earliest years, all folders for a single year soon after the Sputnik I event (about mid-way in the 15 year span of AYI operation), and all folders for the most recent year for which reasonably complete data files were available. Because numbers of institutes supported were small during the early years and because no radical changes in objectives would be expected after only a year or two of AYI operation, the writer treated the 1956-57 to 1958-59 folders as a single group. This procedure effected a more balanced sample size, yielding 37 institutes for the first sample period, 56 institutes for the 1962-63 sample period, and 72 institutes for the 1968-69 sample period. These represent more than twenty-five percent of all institutes sponsored since the AYI program was initiated in 1956. In addition, folders representing years to either side of the three sample periods were scanned and data therein appeared to be quite similar to that found in the folders which were selected for more thorough examination and use in this study.

Tabulated data in this section, as in the one previous, will be presented under coded categories which are more fully described in the text. Two sets of tables are presented here. One concerns eligibility requirements for admission to the institutes, and the other concerns institute objectives or purposes as stated or implied by directors of institutes. The first of these, Table 10, was included because the writer felt that it would provide additional insight and serve as a supplement to the data, considered of greater significance, presented in Table 11. Nevertheless, much can be inferred about institute objectives by taking note of the kind of target population at which the Director aims and presumably expects to assemble within his institute, and this can be done to some extent by examination of Table 10. The table of eligibility requirements, however, is to be of lesser import in drawing conclusions than are Directors' comments on purposes of the institutes because of the lack of consistency in relative emphasis given to various categories of eligibility requirements. In a number of instances, for example, certain schools would place little or no emphasis on letters of recommendation while other schools would attach considerable significance to them. In other cases certain schools indicated that grades were not a good selection criterion because of variations in standards of the many different schools represented in the applications, while others considered grades to be of greatest importance. Furthermore, the highly subjective nature of certain selection criteria (e.g. "be a successful teacher") seriously affects their reliability. Thus, eligibility requirements and selection criteria probably represent a biased index of institute objectives.

TABLE 10

FACTORS CONSIDERED IN SELECTION OF PARTICIPANTS

	Percent of Institutes Citing in		
Requirement or Criterion	1956-59	1962-63	1968-69
1. Leadership, Have Master's degree	13	18	24
2. Grade level, Subject field	47	53	52
3. Age, Experience, Years remaining	82	82	92
4. Geographic, School size	24	9	8
5. Academic record, Graduate School	82	68	61
6. Potential, Success as a teacher	79	47	47
7. Motivational, Academic background	71	79	71

TABLE 11

PURPOSES OF THE AYI AS EXPRESSED BY EDUCATORS, 1956 - 1969

Coded Categories of Purposes	Percent of Institutes Citing in 1956-59	1962-63	1968-69
1. Supplementary Education:			
A. Modernize	47	65	65
B. Remedial	18	12	5
C. General	0	0	0
D. Increase	85	91	84
E. Refresh	13	3	10
F. Upgrade	29	5	11
G. Broaden	37	50	45
2. Curriculum Reform	39	52	47
3. Leadership	13	17	24
4. Earn Advanced Degree	8	36	31
5. Student Careers	74	36	32
6. Supply of Scientists	42	10	2
7. Supply of Teachers	39	12	6
8. Assist Universities	47	22	23
9. Teacher Effectiveness	71	74	71
10. Sciences, Society, Relations	26	12	11
11. Set Example, Climate	26	17	32
12. Contact with Research Scientist	37	22	29

Categories of Eligibility Requirements and Selection Criteria

Category 1, coded as "Leadership, Have Master's degree" in Table 10, includes the following:

1. Have, show leadership potential, be, aspire to be a teacher-trainer, have Master's degree.

Category 2, coded as "Grade level, Subject field" in Table 10, includes the following:

2. Have taught, will teach, proper grade level, proper subject matter field, have administrator's cooperation for curriculum reform or advanced placement teaching, be of a non-science field, pre-service, or former teacher returning.

Category 3, coded as "Age, Experience, Years remaining" in Table 10, includes the following:

3. Age, years remaining to teach, teaching experience, plan to return to teaching.

Category 4, coded as "Geographic, School size" in Table 10, includes the following:

4. Geographic distribution of applicant, size of school in which teaching.

Category 5, coded as "Academic record, Graduate school" in Table 10, includes the following:

5. Minimum grade point average, good academic record, have Bachelor's degree, minimum test scores (e.g. GRE), qualify for admittance to graduate school, be a degree candidate.

Category 6, coded as "Potential, Success as a teacher" in Table 10, includes the following:

6. Have, show, potential as a teacher, currently a successful teacher, good citizen, good character, supply letters of recommendation, be a U.S. citizen.

Category 7, coded as "Motivational, Academic Background" in Table 10, includes the following:

7. Have proper academic and motivational background, minimum courses (strengths and weaknesses), show need for the program, have interest, motivation, aptitude. Have had no previous AYI or limited number of summer institutes.

Table 10 shows clearly directional trends in six categories, with the seventh fluctuating over the three selected time periods. The first three categories above show increased significance in the selection process, with the one pertaining to leadership showing the greatest percentage increase in use as a selection criterion. This is entirely in keeping with trends and patterns discussed earlier in this study. The increase in Category 2, Grade level and Subject field, would be an anticipated consequence due to increased numbers of institutes and the diversity of subject matter fields made possible through these greater numbers.

Decreases are noted in the significance attached to geographic distribution, potential as a teacher, and academic record. Here again, the larger number of institutes available is probably a factor, for with the greater number of institutes available there would be less need for attention to be given to geographical distribution of applicants. Likewise, with increasing numbers of institutes being sponsored, one would expect greater variation in academic ability to be manifest in the greater numbers of participants and consequently reduced emphasis on selecting from only the top of the grade transcripts. Not as readily explained, however, is the percentage decrease in numbers of schools using as a selection criterion the potential and success as a teacher, of those making application. To the contrary, with greater numbers of applicants to choose from one would expect not decreased, but <u>increased</u>, emphasis on the applicant's potential and success as a teacher. This, after all, is what the entire program was all about. The criterion, however, is quite subjective and perhaps was used more reservedly for that reason.

Part of the fluctuation in Category 7 may be a reflection of a recommendation by the Foundation, in the early 1960's, that restrictions be placed on the number of summer institutes which any one teacher might attend. If this tendency was then curtailed, the requirement would in turn decline in significance.

The data presented in Table 11 were derived primarily from proposals and institute Directors' final reports to the Foundation, and no distinction is made as to the source from which the tabulated data came. Wherever possible, however, the latter source was utilized in preference to the former, because there existed external effects or influences upon those writing the proposal for the university. The first of these was the possibility, particularly in the early years, that objectives stated in proposals were strongly influenced by a list of "understandings" concerning institute objectives that were emphasized in the letter of confirmation sent out by the Foundation to each Director whose proposal had been accepted. Since these objectives were spelled out and thus expected by the Foundation, it seems reasonable to assume that they would have had an effect on institute directors, who might then have possibly included them in subsequent proposals. A second factor which influenced objectives and changes cited by AYI directors was that resulting from the meeting of directors held annually in Washington, D.C. under sponsorship of the Foundation.

After the universities had received approval of their proposals for AYI's, but before the institutes began and before the proposal deadline for the next year, those who were to serve as institute directors were summoned to the meeting in Washington, D.C. for purposes which included orientation and suggestions concerning operation of the institute. Since many of the directors attending these meetings were already experienced, the benefit of these experiences as passed on to other directors, served as potential agents for subsequent change in institute objectives.

Furthermore, the Foundation at times utilized parts of these annual meetings to suggest and describe to the assembled directors new program aspects and objectives which Foundation officials perceived as desirable for inclusion in AYI programs. These new ideas were frequently generated by Foundation staff members, many of whom were themselves former AYI directors, and frequently reflected feed-back from field observations of on-going institute programs. The Foundation staff, of course, encouraged and persuaded the directors to infuse these objectives into their proposals for subsequent AYI programs. In this way, the Foundation staff has had considerable influence on the evolution of AYI program objectives that would normally be attributed to the universities.

Manifestations of both of these effects might later be reflected in the variation between objectives stated in the proposal and achievement of objectives cited in the Director's final report to the Foundation. Since the Director's Annual Final Report was sometimes written more than two years after submission of the proposal for the AYI grant, it would thus serve as a more reliable source of institute objectives as experienced, rather than as anticipated.

The categories of purposes of the AYI program, which strongly represent the perspective of institute directors, are coded and tabulated in Table 11 using essentially the same format as was used for Tables 9 and 10. Since descriptions have already been listed for categories 1 - 8 on pp. 160, 162-63 of this study, they will not be repeated here. Additional categories which appeared in comments and statements of educators, that were not found in statements by Foundation or Government officials, and which could not be incorporated into existing categories, will be appended to the list used for Table 9.

Additional Categories of Purposes
of the AYI Program

Category 4, coded as "Earn advanced degree" in Table 11, includes the following purposes:

4. To provide an opportunity for the participant to earn an advanced degree.

Category 10, coded as "Science, Society, Relations" in Table 11, includes the following purposes:

10. To help the participant improve his understanding of the interrelationships between the sciences and the place of science in society, and their part in producing an intelligent citizenry.

Category 11, coded as "Set example, Climate" in Table 11, includes the following purposes:

11. To provide an example, to influence, to encourage other departments and colleges to establish communications, create a climate, and generate interaction conducive to progress in science teacher training.

Category 12, coded as "Contact with research scientists" in Table 11, includes the following purposes:

12. To facilitate contact of high school teachers with research scientists, to stimulate interest and increase professional prestige.

Of greatest significance to this study is the fact that clearly distinguishable evolutionary trends in institute purposes, both positive and negative, can be noted in several different categories in Table 11.

Since these data are based primarily on Directors' Final Reports, which constitute first hand evidence, it can be stated with confidence as a fact that perceptions of educators, with regard to AYI purposes, have changed over time. Which purposes have changed, and how much, and in which direction, can also be stated as fact. The nature of these changes is also of considerable significance. Less certainty, however, can be attached to cause-and-effect relationships which are responsible for these changes, as they are inferential in nature. Nevertheless, the worth and usefulness of this study would have been distinctly diminished had these cause-and-effect relationships not been examined and included here.

Of the numerous events that seem most likely to have affected and changed the purposes of the AYI's over the years, perhaps three have been of signal importance. The earliest was the effect of the launching of the USSR's Sputnik I in October, 1957, which was shortly after the completion of the first pilot institutes. This was followed by the proliferation of curriculum reforms and simultaneously, the increasing impact of atomic age and space age science and technological achievements on classroom science education.

Four categories of AYI purposes show significant patterns of reasonably consistent increase in percentage over the three time periods of the study. There are sharp percentage increases in Categories 1A (Modernize subject matter), 2 (Curriculum reform), and 3 (Leadership). These three changing purposes were probably interrelated. Some of the increase noted, particularly that occurring between 1959 and 1962, was undoubtedly due to the widespread and intense curriculum modernization activities around the turn of the decade which produced new courses such as Physical Science Study Committee (PSSC) Physics, Chemical Bond Approach (CBA) Chemistry, Chemical Education Materials Study (CHEMS) Chemistry, Biological Sciences Curriculum Study (BSCS) Biology, and School Mathematics Study Group (SMSG) Mathematics. The subject matter of these new courses, as well as the skills and techniques necessary to teach them, frequently served as the core around which certain courses were designed and taught in some institutes. Efforts to infuse these new curriculum developments into high school classrooms necessitated some emphasis in institutes on curriculum leadership techniques.

An additional benefit expected from the increasing emphasis on preparing participants for leadership, evident as perceived objectives in all three groups, was that AYI participants would return to their local school systems and initiate in-service training programs for other teachers of science, particularly at the elementary grade levels, thereby producing the "multiplicative effect" desired by the Foundation. Studies by Brandou and by Bunnell appear to offer contradictory conclusions concerning the feasibility of training and using secondary teachers as leaders for in-service training. The conclusion reached by Brandou in his 1963 study of selected teachers was:

> This study indicates that the operation of in-service science education programs for elementary classroom teachers is entirely possible through the use of secondary school science teachers.[49]

In a study of AYI participants nearly two years later, however, Bunnell's conclusion, based on interpretation of his findings, was that:

> . . . teachers do not want local in-service training, nor do they want to give such training when they return from institutes.[50]

On the basis of these differing conclusions, derived from studying two different groups of teachers selected by different sets of criteria, the writer feels that perhaps the Foundation, in continuing its emphasis on leadership training, should more thoroughly distinguish between affecting the participant's desire, as opposed to improving his ability, to initiate and carry on in-service training in his local school system.

The last of the four objectives which shows a meaningful pattern of increased emphasis is that of enabling the participant to earn an advanced degree, listed as Category 4 in Table 11. This objective, it will be recalled, was not among those listed in Table 9 in the section treating the Federal Perspective. The increased emphasis on the part of institute directors in providing opportunities for participants to work toward an advanced degree, the writer believes, was brought about and maintained primarily by economic pressures, with teachers increasingly coming to expect the AYI experience to result in their receiving an advanced degree and subsequently attaining a higher step on the salary scale upon return to teaching. Some mention also was made in the literature of the increased professional pride and prestige which the degree would bring to the institute participant.

Although it appears here as a fluctuating emphasis, the objective of providing supplementary education in broad fields (Category 1G) may be of greater significance than the small variation in percentages indicates. Within a year or two after initiation of the AYI program, some officials thought it necessary to discourage participants from using the AYI as an opportunity to prepare themselves in depth in a specialized discipline, with intentions of later leaving teaching for better positions in industry or government. The increased emphasis on broad, general supplementary education shown in the 1962 percentage may be a reflection of this concern.

Six categories showed a fairly consistent decrease in percentage between 1959 and 1969. The Sputnik event, and the level of sophistication of Russian science and technology which it represented, in all probability, in the writer's opinion, had much to do with the initially high level of concern over motivating capable high school students to careers in science. This is based on interpretation of data in Category 5 of Table 11. Further support for this interpretation is found in the initially high percentage of directors who perceived one of the purposes of the AYI to be that of increasing the Nation's supply of scientists, shown in Category 6, and also by the same phenomenon shown in Category 7 with respect to the supply of science teachers.

Since one would not expect a decline in these percentages as early as 1962-63, the fact that they did decline might be interpreted as being due in part to greater concern with other objectives, such as curriculum reform, which increased sharply after 1959, and training for leadership, which has increased consistently in each of the sample periods. The possibility exists also that the objectives of motivating students and increasing the supply of trained scientific manpower, were, after several years of emphasis, now being "taken for granted" since the shortage of scientists had been somewhat alleviated.

The decline in percentage of directors who perceived the objective of development of teacher training courses in the university (Category 8) as one of importance in the AYI is probably a consequence of failure of the Foundation to successfully implement an earlier plan it had for phasing out the AYI program. This plan has been described and discussed on pp. 139-141 of this study.

Supplementary education of a remedial nature in Category 1B shows a decrease in emphasis, which might be explained in part as being due to effects of increased attention and efforts on improving the quality of undergraduate science teacher training, following the chain of events catalyzed by Sputnik I, thereby making remedial programs less necessary.

The last of the objectives showing a decrease in emphasis is that of Category 10, to inculcate in the participants an understanding of the interrelationships between the sciences, and between science and society. The lack of continued emphasis on this objective appears anomalous, for this aspect of science teaching has, in the writer's opinion, become increasingly important over the past decade as a part of science course objectives.

Two categories which were cited frequently and consistently in the literature by the directors with no appreciable change in emphasis over the years, concern teacher effectiveness (Category 9 in Table 11), and supplementary education in depth (Category 1D in Table 11). Both of these apparently reflect the continuing concern of institute directors over maintaining an adequate supply of capable teachers well versed in their subject matter discipline.

Because of the fluctuations in emphasis manifest in the remaining four categories, attempts to describe their significance in a study of evolutionary trends would tend to be hazardous and perhaps ambiguous. Therefore, they will not be treated in this section of the study.

The objective of general supplementary education in Category 1C of Table 11 shows zero percentage throughout the table, and yet was cited in almost every year by Foundation and other federal officials, according to the data presented in Table 9. The reason behind this difference appears to be that for the Foundation this general supplementary education represented a broad, inclusive category, while institute directors saw fit to be more specific about the kind of supplementary education.

Longitudinal Study of Oklahoma State University

Oklahoma State University has conducted an AYI program during every year since inception of the program in 1956. A longitudinal study of the program at Oklahoma thus represents a unique perspective and for that reason it is included here. Data collected from the Washington, D.C. files and from officials at the University are tabulated on the following pages in Tables 12 and 13 in the same format as was used in preceding tables, thereby facilitating more meaningful comparison.

In many ways the purposes of the AYI program at Oklahoma State University parallel those represented by the sample data contained in Table 11. Clearly manifest among these are the continued emphasis on

TABLE 12

PURPOSES OF THE AYI AT THE OKLAHOMA STATE UNIVERSITY, 1956 - 1969

	Year in Which Purpose was Cited												
Coded Categories of Purposes	57	58	59	60	61	62	63	64	65	66	67	68	69
1. Supplementary Education:													
A. Modernize	x	x	x	x	x	x	x	x	x	x	x	x	x
B. Remedial								x	x	x	x	x	x
C. General													
D. Increase	x	x	x	x	x	x	x	x	x	x			x
E. Refresh													
F. Upgrade	x										x	x	
G. Broaden	x	x	x	x	x	x	x						x
2. Curriculum Reform					x	x		x	x	x		x	
3. Leadership								x	x	x			
4. Earn Advanced Degree					x	x		x	x	x			
5. Student Careers	x	x	x	x	x	x	x	x	x	x			
6. Supply of Scientists	x			x									
7. Supply of Teachers	x	x											
8. Assist Universities	x	x	x	x	x	x	x						
9. Teacher Effectiveness	x	x	x	x	x	x	x	x	x	x	x	x	x
10. Sciences, Society, Relations													
11. Set Example, Climate	x		x	x	x	x	x	x	x	x			x
12. Contact with Research Scientist	x	x	x										

TABLE 13

FACTORS CONSIDERED BY OKLAHOMA STATE UNIVERSITY IN SELECTION OF PARTICIPANTS, 1956 - 1969

	Year Ending 19__												
Requirement or Criterion	57	58	59	60	61	62	63	64	65	66	67	68	69
1. Academic record, Graduate School	x	x		x	x	x	x	x	x	x	x		x
2. Motivational, Academic background	x	x		x	x	x	x	x	x	x	x	x	x
3. Age, Experience, Years remaining	x	x		x	x	x	x	x	x	x	x		x
4. Potential, Success as a teacher	x	x		x	x	x	x	x	x	x	x		x
5. Grade level, Subject field	x	x		x		x		x			x	x	x
6. Leadership, Have Master's degree							x	x	x	x			
7. Geographic, School size	x												

supplementary education to increase depth and modernize subject matter, and on producing capable and effective classroom teachers as shown in categories 1D, 1A, and 9 in Table 12. Purposes emerging somewhat later, but still consistent with those appearing in the national sample data, are increased emphasis on leadership and earning an advanced degree, shown in categories 3 and 4 in Table 12. Evidence for an abrupt change in emphasis appears with the substitution of activities in Category 1B, "Supplementary Education, Remedial," for the one in Category 1G, "Supplementary Education, Broaden." Broadening the scientific background of participants was now to be abandoned as an institute objective, and replaced by one intended to remedy weaknesses of previous training programs. Some of the reasons leading to this change are described in the synopsis on pp. 182-83 of this study.

There is perhaps no more authoritative source from which data might be gathered to provide the rationale behind the evolution of the purposes of the AYI at Oklahoma State University than that supplied in documents written by the Director. The following synopsis was included in the 1968-69 proposal submitted to the Foundation by that University. It is reproduced here to highlight some of the changes that have occurred in the program of the University as well as the reasons for implementing these changes, and should serve as a supplement to the data presented in Tables 12 and 13.

<u>Synopsis of AYI Program at Oklahoma State University</u>

The Oklahoma State University has conducted an Academic Year Institute every year since the inception of the program in 1956. The original Institute was designed for experienced teachers of biology, chemistry, and mathematics and physics. After several years the program was modified to include only biology and mathematics. In 1960 the Pre-Service category was added to the program, the Pre-Service participant not having taught in a classroom except for his practice teaching. In 1962 a new classification was added to the participants. There was a demand for trained biology supervisors in larger school systems and state departments of education. Therefore a few teachers were selected at the Master's level to take additional graduate work and to undergo special training as biology and science supervisors.

This three-pronged Academic Year Institute - Regular, Pre-Service, and Supervisor, continued in both biology and mathematics until 1965. In the 1965-66 Institute the Regular category was dropped, as the Director and others felt that most applicants qualified to begin rigorous graduate training had little difficulty in obtaining an institute, and that Oklahoma State University should concentrate on the other categories.

A major change occurred in the 1966-67 Institute. The Pre-Service and Supervisor categories were dropped from the proposal. It was felt that the Pre-Service participant could apply as a regular participant at a later date; the Supervisor category was also dropped as it was felt that there was a group of regular participants needing Institute help much more urgently. The 1966-67 Institute was composed of 20 biology teachers having relatively few hours of formal course work in the field of biology. This group proved to be most dedicated and hard working.

The 1967-68 Institute is similar in its composition. Prior to 1966 this institute had tended to select as regular participants individuals of high scholastic standing, and of as broad and extensive a background as possible. This approach tended to ignore the biology teacher who had a reasonable grade-point average, but very few hours of course work in the biological sciences. These teachers are poorly prepared, but will continue teaching with or without an institute. This Institute proposes, therefore, as in the two previous Academic Year Institutes, to accept participants who are quite weak in their biology backgrounds.[51]

From reading the preceding synopsis, one senses the dynamic, pioneering nature and spirit of the program at Oklahoma. These persistent efforts at designing and offering programs to meet the greatest need, as well as attempts to anticipate and prepare for future needs, were reflected in the changing emphases on institute purposes shown earlier in Table 12. Tacit approval of these purposes by the Foundation is manifest in the fact that institute awards have been made to Oklahoma State University during every year since the program began in 1956.

The methods and criteria for selection of participants were also pioneered by institute personnel at Oklahoma, particularly under the early leadership of Dr. James Zant, who served as AYI Director there for the first nine years of the program. The data presented in Table 13 show the long-standing importance attached to factors such as the participant's past performance, his potential, and his need for the program. The isolated four year period of emphasis on Leadership, shown in Category 6, reflects the University's short-lived program for training supervisors.

The factor of Geographic distribution (Category 7 in Table 13) was clearly employed only during the first year of the AYI program, when the University deliberately selected less than half of the participants from within the State of Oklahoma, after which no further attention was given to geographic distribution as a selection factor. No data were available for the 1958-59 academic year.

Perceptions of Individuals Conducting Studies of the Academic Year Institute Program

Numerous investigations and studies have been carried out to explore various aspects of the purposes, operations, and effects of the AYI program. The relevance of these investigations to the writer's study lies only in the degree to which they explore the purposes of the AYI. Each study was reviewed and tabulations were made of all of the purposes investigated, stated, or implied by each investigator or author. These data were then arranged chronologically and are presented here in Table 14, using the same format as was used in preceding tables of purposes. Each study is coded by author and by year, and complete titles of each will be found in the Appendix in that same order.

Several patterns appear in this table which are consistent with those of similar tables presented earlier. The frequency with which Category 9 is cited is to be expected, for improvement of teacher effectiveness has always been strongly emphasized. There appears to be considerably stronger perception here of one of the purposes being curriculum reform and, in later years, on earning a degree, than appeared in data earlier cited from other sources. A decline in the frequency of Category 5 would be expected also on the basis of past patterns, but this does not occur. Since most of these studies were made by former AYI participants, perhaps this is a reflection of their earlier exposure to institution literature, which frequently cited Category 5 as a purpose of the institute. Their exposure to new and modern science curriculums while participating in the program is reflected in the greater frequency of Categories 1A and 2, both of which sharply increase in frequency around the beginning of the decade of the 1960's. Frequencies for the remaining categories are too low and too scattered to permit any meaningful interpretation.

Summary

Investigation of available sources has produced data presented in this chapter which show that perceptions of informed groups that

TABLE 14

PURPOSES OF THE AYI AS INDICATED IN INDIVIDUAL STUDIES AND REPORTS

Purpose	F-58	J-58	P-58	G-59	J-59	Y-59	H-60	L-60	O-60	S-61	H-62	F-63	J-63	S-63	M-64	W-64	B-65	H-65	B-66	W-66	I-67	C-68	D-68	R-68	S1-68	Su-68
1. Suppl. Education																										
A. Modernize						x	x	x	x	x				x	x	x	x	x	x			x			x	x
B. Remedial											x		x				x									
C. General				x					x	x			x						x	x		x		x		x
D. Increase		x				x	x			x						x		x				x			x	
E. Refresh					x										x	x										x
F. Upgrade									x		x	x										x			x	x
G. Broaden								x	x							x		x	x							
2. Curr. Reform					x	x	x		x	x			x	x	x		x	x	x				x		x	x
3. Leadership									x					x			x		x		x		x			x
4. Earn Adv. Degree					x	x								x		x						x	x	x	x	x
5. Student Careers			x	x		x				x		x	x	x		x		x	x						x	x
6. Supply Scientists				x	x		x					x			x											
7. Supply Teachers																							x			
8. Asst. University					x			x					x							x			x			x
9. Teacher Effect.	x		x	x	x	x	x		x	x	x		x		x	x		x	x			x		x	x	x
10. Sci.-Soc. Relation				x			x		x				x													
11. Set Example, Climate																										x
12. Contact w/Rsch. Sci.				x		x		x	x		x		x			x						x				

were concerned with the objectives and achievements of the AYI program have manifest themselves over time in one of four different ways by:

1. Originally perceiving a particular AYI objective as being not very important and later perceiving it as of considerable importance. This was indicated in the text by increased percentage of frequency of citation over the years.

2. Originally perceiving a particular AYI objective as being of considerable importance and later perceiving it to be of lesser importance. This was indicated in the text by decreased percentage or frequency of citation over the years.

3. Perceiving a particular AYI objective as having the same degree of importance or unimportance, which was indicated in the text by stable percentage or frequencies of citations over the years.

4. Perceiving a particular AYI objective as being of changing or fluctuating importance, which was manifest in the text by an inconsistent pattern of citations over the years.

Of greatest concern to this study are those objectives which over the years have shown a pattern of either increasing or decreasing frequency of citation in the sources investigated. Those which have shown sufficiently consistent patterns of change across all three perspectives as shown in Tables 9, 11 and 14, will herein be considered as examples of evolution of objectives.

The AYI objectives which have met these criteria are those coded in the tables as

1A. Supplementary Education, Modernize

2. Curriculum Reform

3. Leadership

4. Earn Advanced Degree

7. Supply of Scientists

The first four have been perceived as of increasing importance over time, and the last was perceived to be of decreasing importance over time.

Footnotes

[1]U.S. Congress, House, Independent Offices Appropriations for 1957, Hearings Before the Subcommittee of the Committee on Appropriations, 84th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1956), p. 551.

[2]U.S. Congress, House, Independent Offices Appropriations for 1958, Hearings Before the Subcommittee of the Committee on Appropriations, 85th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1957), p. 1408.

[3]*Ibid.*, p. 1294.

[4]U.S. Congress, House, Independent Offices Appropriations for 1961, Hearings Before a Subcommittee of the Committee on Appropriations, pt. 3, 86th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1960), p. 133.

[5]*Ibid.*, p. 134.

[6]U.S. Congress, House, Independent Offices Appropriations for 1966, Hearings Before a Subcommittee of the Committee on Appropriations, pt. 2, 89th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1965), p. 765.

[7]U.S. Congress, House, Independent Offices Appropriations for 1957 (1956), *op. cit.*, p. 15.

[8]U.S. Congress, House, Independent Offices Appropriations for 1957 (1956), *op. cit.*, p. 595.

[9]U.S. Congress, Senate, Independent Offices Appropriations for 1957, Hearings Before a Subcommittee of the Committee on Appropriations, 84th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1956), p. 378.

[10]National Science Foundation, Sixth Annual Report for the Fiscal Year Ended June 30, 1956 (Washington, D.C.: Government Printing Office, 1956), p. 70.

[11]National Science Foundation, Academic Year Institutes for Science and Mathematics Teachers (Washington, D.C.: Government Printing Office, 1957).

[12]U.S. Congress, Senate, Independent Offices Appropriations for 1958, Hearings Before the Subcommittee of the Committee on Appropriations, 85th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1957), p. 268.

[13]Harry C. Kelley, "The NSF's Programs in Education in the Sciences," The Educational Record, Vol. XXXVIII, No. 2 (1957), p. 91.

[14]U.S. Congress, House, Independent Offices Appropriations for 1958 (1957), op. cit., p. 1274.

[15]National Science Foundation, Eighth Annual Report for the Fiscal Year Ended June 30, 1958 (Washington, D.C.: Government Printing Office, 1959), p. 56.

[16]U.S. Congress, House, Independent Offices Appropriations for 1958 (1957), op. cit., p. 1280.

[17]"Eisenhower's Budget Message, January 13, 1958," School Life, Vol. XL, No. 6 (1958), p. 4.

[18]National Science Foundation, Ninth Annual Report for the Fiscal Year Ended June 30, 1959 (Washington, D.C.: Government Printing Office, 1960), p. 72.

[19]U.S. Congress, House, Independent Offices Appropriations for 1961 (1960), op. cit., p. 131.

[20]Lewis N. Pino and C. Russell Phelps, "The Academic Year Institutes Program: An Evaluation" (unpublished staff paper, National Science Foundation, 1960).

[21]Ibid., p. 4.

[22]J. Donald Henderson, "Memorandum to Selected Experienced Directors of Academic Year Institutes" (unpublished paper, National Science Foundation, 1967).

[23]Ibid., p. 9.

[24]Neville Bennington, "The Role of The Academic Year Institutes Program" (unpublished staff paper, National Science Foundation, 1961), p. 8.

[25]Bennington, "The Role of The Academic Year Institutes Program" (1961), op. cit., p. 11.

[26]Ibid., p. 6.

[27]Robbin Anderson and Lewis Pino, "Institutes in the Academic Year," Journal of Chemical Education, Vol. XXXVIII, No. 9 (1961), p. 453.

[28]Ibid., p. 454.

[29]National Science Foundation, Academic Year Institutes for Science and Mathematics Teachers 1963-64 (Washington, D.C.: Government Printing Office, 1962), p. 6.

[30]National Science Foundation, Twelfth Annual Report for the Fiscal Year Ended June 30, 1962 (Washington, D.C.: Government Printing Office, 1963), p. 96.

[31]Ibid., p. 102.

[32]U.S. Congress, House, Independent Offices Appropriations for 1963, Hearings Before the Subcommittee of The Committee on Appropriations, pt. 2, 87th Cong., 2nd sess. (Washington, D.C.: Government Printing Office, 1962), p. 906.

[33]National Science Foundation, Thirteenth Annual Report for the Fiscal Year Ended June 30, 1963 (Washington, D.C.: Government Printing Office, 1964), p. xv.

[34]C. Russell Phelps, "Memorandum to Members of the Divisional Committee for Scientific Personnel and Education" (unpublished staff paper, National Science Foundation, 1963), p. 16.

[35]U.S. Congress, House, Independent Offices Appropriations for 1964, Hearings Before the Subcommittee of The Committee on Appropriations, 88th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1963), p. 532.

[36]Phelps, "Memorandum to Members of The Divisional Committee For Scientific Personnel and Education" (1963), op. cit., p. 17.

[37]National Science Foundation, Fourteenth Annual Report for the Fiscal Year Ended June 30, 1964 (Washington, D.C.: Government Printing Office, 1965), p. xxi.

[38]National Science Foundation, Suggestions and Forms for Preparing a Proposal for An Academic Year Institute for Teachers of Science and Mathematics (Washington, D.C.: National Science Foundation, 1964), p. 1.

[39]Paul A. Carnell, "Evaluation of the Countrywide Academic Year Institutes Program" (unpublished staff paper, National Science Foundation, 1964).

[40]National Science Foundation, Fifteenth Annual Report for the Fiscal Year Ended June 30, 1965 (Washington, D.C.: Government Printing Office, 1966), p. 5.

[41]Ibid., pp. 16-17.

[42]National Science Foundation, Sixteenth Annual Report for the Fiscal Year Ended June 30, 1966 (Washington, D.C.: Government Printing Office, 1967), p. xxi.

[43]Ibid., p. 85.

[44]U.S. Congress, House, Independent Offices Appropriations for 1968, Hearings Before the Subcommittee of the Committee on Appropriations, 90th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1967), p. 353.

[45]National Science Foundation, Seventeenth Annual Report for the Fiscal Year Ended June 30, 1967 (Washington, D.C.: Government Printing Office, 1968), p. 140.

[46]National Science Foundation, "PPB - - Special Study - - 1967" (unpublished staff paper, National Science Foundation, 1967), p. 9a-10.

[47]National Science Foundation, Eighteenth Annual Report for the Fiscal Year Ended June 30, 1968 (Washington, D.C.: Government Printing Office, 1968), p. 174.

[48]Ibid., p. 176.

[49]Julian R. Brandou, "A Study of an Experimental Program for the In-Service Science Education of Elementary School Teachers." (unpublished Doctoral dissertation, Michigan State University, 1963), p. 146.

[50]Robert A. Bunnell, "An Analysis of Differential Participation in National Science Foundation Institutes by High School Teachers." (unpublished Doctoral dissertation, University of Chicago, 1965), p. 129.

[51]Oklahoma State University, "Proposal to the National Science Foundation for Support of an Academic Year Institute in Biology for Secondary School Teachers" (unpublished document, 1966).

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

Findings and Conclusions

This study investigated the circumstances and needs which culminated in establishment of the National Science Foundation and the subsequent creation and evolution of its teacher training programs, with particular emphasis on the Academic Year Institute Program.

The historical data collected and interpreted in Chapter II of this study supports the conclusion that the National Science Foundation was created in response to emerging and anticipated scientific and manpower needs following the close of World War II, and also in response to the challenge presented by Russia's intensified program for training manpower and carrying on scientific research.

In Chapter III it was shown that the primary objectives of the Foundation were to support basic scientific research and advanced education in the sciences, with these activities to be conducted on a national scale largely through the Nation's colleges and universities. It was expected that success in achieving these objectives would be manifest in an adequate supply of trained and competent scientists to conduct research activities which would contribute to the ultimate goal of assuring the continued world leadership of the United States in areas of science and technology.

World leadership in the discovery and application of new scientific knowledge has always depended heavily upon an adequate and continuing supply of trained and competent research scientists and engineers. Prior to World War II this country frequently found it necessary to draw upon foreign sources for both new knowledge and trained manpower. The hazards inherent in continued overdependence on foreign sources have served as motivating factors for the Foundation's vigorous pursuit of the objectives of its program of education in the sciences in order to produce and maintain the necessary numbers and quality of trained scientists.

This study has shown that the programs sponsored by the Foundation to achieve this manpower goal have been both diverse and fecund, with opportunities for training being available to science teachers of all grade levels and in nearly all disciplines of science. Emphasis in these training programs has always been on increasing the participant's subject matter knowledge. The institute programs, structured within the Foundation's broader program of education in the sciences, were designed and have served uniquely as instruments to implement the objective of providing supplementary subject matter training for science teachers.

Data collected for this study show additionally that institute programs have undergone expansion and modification in both magnitude and purpose since their inception in 1953. The number of different AYI subject matter offerings had increased five-fold by 1967. The origin and growth of these institute programs were shown in this study to have been in response to manifest as well as to anticipated needs, felt by the Foundation to be necessary to achievement of its broader goals. In particular, the institute programs were intended to produce better teachers of science with greatest emphasis being placed on the subject matter preparation of those teaching in the secondary schools.

From among these several kinds of institute programs, the AYI was selected and investigated in depth with respect to its origin, growth, and evolution of its objectives. The data and interpretations presented in Chapter IV show that the AYI program was originally established in response to Russia's increased manpower training program, and also in anticipation of increasing domestic needs for capable and trained scientific manpower in this country. The science teacher in the classroom, well trained in subject matter knowledge, was seen as the key to achieving that manpower goal and the AYI program was intended to provide that training.

Quantitative data presented in Chapter IV show the importance attached to the AYI program by the rapid increases, between 1956 and 1969, in the following areas:

1. Two AYI's were awarded in 1956, and this number increased to over seventy by 1969. The grand total of AYI's exceeded 600.

2. Funding for the AYI program increased from $504 thousand in 1956 to over $10 million in 1969. The grand total exceeded $118 million.

3. The number of participants increased from 95 in 1956 to over 2000 in 1964, and nearly 1700 in 1969. The grand total exceeded nineteen thousand.

In Chapter V, an intensive investigation was conducted of AYI programs and data was collected concerning the evolution of the objectives of this program. Data were collected from sources that provided at least three different perspectives on the objectives of the AYI program. Of primary concern was whether objectives had changed, and the nature of any changes which might have occurred, as perceived by three different groups.

The first of these was the federal perspective, derived largely from government documents which included Senate and House appropriations hearings and National Science Foundation Annual Reports.

Secondly, the perspective of educators and academic institutions was supplied primarily by data collected from documents on file in the Foundation offices in Washington, D.C. These files were examined at first hand by the writer and usually contained, for each AYI conducted, the institute Director's final report and other literature related to that particular institute.

The third perspective was that supplied by studies and reports on the AYI program, which were conducted and reported on by private (i.e. non-government) individuals or organizations. Personal communications were used, where possible, to supplement the above sources.

Following presentation and analysis of the data representing each of these three perspectives in Chapter V of this study, objectives of the AYI program were identified which had received either increased emphasis or decreased emphasis with sufficient consistency over time and these were designated as having undergone evolution. Significant temporal changes in emphasis on the following five objectives of the

AYI program were perceived in all three groups investigated. Those categories of objectives perceived as of increasing importance, between 1956 and 1969, were:

1A. Supplementary Education, Modernize: To provide teacher participants with supplementary education that would modernize and update their subject matter knowledge and to introduce them to new science curriculums. The percentage of educators perceiving this as of importance increased from 47 percent in 1956 to 65 percent in 1969.

2. Curriculum Reform: To train the teacher participant so that he might better stimulate and assist in the reform of his high school curriculum through the introduction of course content improvement materials. The percentage of educators perceiving this as of importance increased from 39 percent in 1956 to 47 percent in 1969.

3. Leadership: To train and prepare those with high potential for leadership for positions as college teachers, secondary supervisors, consultants, coordinators, teachers of teachers, and for leadership to bring about in-service training of their colleagues in the local school system. The percentage of educators perceiving this as of importance increased from 13 percent in 1956 to 24 percent in 1969.

4. Earn Advanced Degree: To provide an opportunity for the teacher participant to earn an advanced degree. The percentage of educators perceiving this as of importance increased from 8 percent in 1956 to 31 percent in 1969.

The one category of objectives which was perceived as of decreasing importance, between 1956 and 1969, was:

7. Supply of Scientists: To increase the numbers, competence, and supply of the Nation's scientists, researchers, mathematicians, engineers, and technical manpower. The percentage of educators perceiving this as of importance decreased from 39 percent in 1956 to 6 percent in 1969.

Implications and Recommendations for Further Study

A conclusion of this study was that the AYI teacher training program would in all likelihood remain as an integral part of this Nation's science teacher training program. This implies that the National Science Foundation expects a continued flow into our classrooms of inadequately prepared science teachers who graduate from our teacher training institutions. In schools where this occurs, at least part of the inadequate preparation stems from the lack of a well designed and effectively administered program of courses in science for those preparing to teach the sciences. Evidence presented in this study shows that there was early recognition on the part of the Foundation of this weakness, and some attempts were made to overcome it.

It was also found in this study, however, that educators perceived the AYI objective of assisting universities in designing and developing courses and programs for science teacher training, which would be much more directly related to the above problem, as being of decreasing importance over the years. The percentage of educators perceiving this as of importance decreased from 47 percent in 1956 to 23 percent in 1969. The decreasing emphasis on this objective appears

to the writer to be both anomalous and ironic, and suggests that further study might profitably be carried on to determine the degree to which Foundation AYI awards to universities are contributing to the evolution of more effective courses and training programs for science teachers.

Another important objective of the AYI program was to increase the participant teacher's ability to motivate pre-college students to prepare for and pursue careers in science. The Foundation expected its institute trained science teachers, particularly those intending to teach in secondary schools, to serve as part of the mechanism by which capable and talented students would be stimulated and ultimately join the Nation's manpower pool as practising scientists.

Data collected for this study show that perceptions of early objectives of the AYI program, among all three groups, included those of increasing the Nation's supply of scientists, the supply of science teachers, and the motivation of students to pursue careers in science. Interpretation of the data suggest that all three of these have declined in importance as perceived AYI objectives, and thus presumably have not recently been among expected or achieved goals of AYI programs. The changes in percentages of educators who perceived each of these three objectives as of importance were as follows:

a. The percentage of educators who perceived the objective of increasing the Nation's supply of scientists as being of importance decreased from 42 percent in 1956 to 2 percent in 1969.

b. The percentage of educators who perceived the objective of increasing the Nation's supply of science teachers as being of importance decreased from 39 percent in 1956 to 6 percent in 1969.

c. The percentage of educators who perceived the objective of motivating students to pursue careers in science as being of importance decreased from 74 percent in 1956 to 32 percent in 1969.
If these decreases in emphasis actually occurred, the effects should be manifest in shortages of scientists, and/or science teachers, and/or students majoring in science in our colleges.

The fact that no evidence was found showing that any of the above shortages actually exists appears to be inconsistent with perceived and achieved objectives of the AYI program and thus suggests a need for further study. Specifically, a study is recommended which would determine where practising scientists received their career motivation and how this is related, if at all, to influences exerted by AYI trained classroom teachers of science.

The assumption has long been held by the Foundation that increasing the teacher's subject matter knowledge would of itself ensure that the AYI participant would be a better and more effective classroom science teacher upon his return. The continued emphasis on increasing the participant's subject matter knowledge as an objective of the AYI program and the lack of data supporting its effect on the subsequent classroom performance of participants appear to create an urgent need for study to determine the degree to which the AYI experience is actually contributing to the teacher's classroom effectiveness.

Finally, it has been assumed that the inclusion of leadership training as an objective of the AYI program is indeed resulting in AYI trained teachers carrying on increased in-service training within the local school system. Based on data included in this study,

leadership training has been identified as one of the several AYI objectives which have evolved over the past fifteen years, and Foundation officials have indicated that they expect it to become an increasingly important objective of the AYI program in the future.

The studies by Brandou and Bunnell discussed in the previous chapter presented somewhat contradictory conclusions. This, in addition to the Foundation's intentions to further emphasize this objective, suggests the need for further study into the relationship between leadership training as an objective of the AYI program and the degree to which this training is being utilized in leadership activities at the level of the local school system. In such a study, particular attention ought to be given to investigating the possibility that a distinction has not been made between increasing leadership ability of the participant, and altering his desire to carry out this leadership function in his local school system.

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APPENDIX A

TITLES OF STUDIES USED IN TABLE 14

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