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ABSTRACT

During the past decade, the federal government, alongside the efforts of state, local, and private-sector groups, has promoted initiatives in the search for ways to improve the teaching of mathematics and science in the nation's schools. This report summarizes a 2-year study of the largest of such federal initiatives, the Dwight D. Eisenhower Mathematics and Science Education Program. Included are: (1) an introduction of the program as a professional development strategy; (2) the program's operation in terms of size and scope, individual state leadership components, local district funding, and grants to institutions of higher education; (3) the program's contributions to the reform of mathematics and science education with reference to teachers, classrooms, students, and the overall educational system; (4) the conclusions of the 2-year study that put the program in perspective with regard to enabling resources and its future functioning; and (5) an appendix of the data collection methods. Among the major themes in the findings of this report are that the program occupies an otherwise unfilled niche among reform initiatives; that the program expands the array of professional development opportunities for students; that the program supports leadership at all levels, but does not create it; and that the program provides a necessary, but insufficient, resource for promoting sustained change in mathematics and science teaching practices. (JJK)

National Study of the
Education for Economic Security Act (EESA) Title II Program
(Now the Eisenhower Mathematics
and Science Education Program)

THE EISENHOWER MATHEMATICS AND SCIENCE EDUCATION PROGRAM: AN ENABLING RESOURCE FOR REFORM

Summary Report

February 1991

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Readers wishing more detail on the findings and conclusions summarized here are referred to the full Technical Report (of the same title). That document contains the following sections:

The report is available from the Planning and Evaluation Service, Office of Planning, Budget and Evaluation, U.S. Department of Education, 400 Maryland Avenue, S.W., Washington, DC 20202.

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This report summarizes the findings and conclusions of the National Study of the Title II/ Eisenhower Mathematics and Science Education Program (State and Local Grants), a federal initiative supporting professional development of the nation's mathematics and science teachers.*

The overall conclusion of the study is this: The program provides a critical enabling resource that supports current efforts to reform mathematics and science teaching.

Size and Scope of the Program

- *Program size.* Relative to other federal education initiatives, the program is modest in size: approximately $100 million was available for state and local grants in the fourth year of the program (1988-89 school year), the time period to which most of the National Study data apply; for the 1991-92 school year, approximately double that amount has been appropriated to the program.

- *What the funds pay for.* The money pays for various costs associated with professional development activities—participant stipends, travel costs, consultant fees, training staff salaries, materials used in training, and so forth.

- *Who participates in the program.* Virtually all school districts in the nation (93% in 1988-89) receive program funds either directly or through an intermediate unit or consortial arrangement. In addition, across the first four years of the project, approximately 20% of all degree-granting institutions of higher education received one or more Title II grants. The number of teachers who participate in program-sponsored activities is large: an estimated one-third of all mathematics and science teachers in the nation (including elementary-level teachers) took part in some kind of Title II-supported activity in 1988-89.

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* The study was conducted by SRI International in collaboration with Policy Studies Associates and Inverness Research Associates, under contract to the Office of Planning, Budget and Evaluation of the U.S. Department of Education (Contract Number LC88029001). The views expressed in this report are the authors' own and do not necessarily reflect the views of the U.S. Department of Education. For further detail and technical information related to findings summarized here, the reader is referred to the full Technical Report (with the same overall title).

Program Components and Their Operation

There are three components to the program: state leadership activities, "flow-through" funding to school districts, and grants to institutions of higher education.

State leadership activities. State set-aside funds represent a small percentage (currently 4%) of program funds for states and districts under the program.

- These funds enable state agencies for elementary and secondary education (SEAs) and higher education (SAHEs) to exercise leadership by (1) assessing and setting priorities for the improvement of mathematics and science education, (2) offering technical assistance to school districts and others engaged in reform activities, and (3) supporting various "Demonstration and Exemplary" projects.

- State agencies are funding various activities, including conferences, teacher support networks, revision and dissemination of state mathematics and science frameworks, and the promotion of national reform agendas (e.g., as represented by the *Curriculum and Evaluation Standards for School Mathematics* of the National Council of Teachers of Mathematics).

- Program funds represent a large percentage—half or more, on average, in 1988-89—of all discretionary funds available to state agencies for mathematics and science improvement.

Flow-through funding to school districts. Currently, two-thirds of the program's state and local grant funding is allocated through SEAs by formula to school districts, to support professional development activities determined at the local level.

- The majority of these funds pay for low-intensity inservice training, averaging six hours of training per participant per year (in 1988-89).

- A substantial fraction of the flow-through funds also supports out-of-district professional development, including widespread participation in professional associations.

- LEA-sponsored training under the program is highly varied: at one end of the spectrum are focused, well-designed staff development events that have clear impact on teachers' thinking and classroom practice, while at the other are *ad hoc* training experiences that appear to contribute little to improved practice.

Grants to institutions of higher education (IHEs). The remainder of the funds (24% under the current formula) are awarded competitively by SAHEs to institutions of higher education, to support professional development projects of several kinds.

- The great majority of projects provide inservice teacher education, while a small percentage (12%) concentrate on, or include, preservice preparation of teachers (a few projects are concerned primarily with curriculum development or direct services to students).

- By comparison with district-sponsored activities, these projects are typically more intensive, averaging 60 hours per participating teacher, pay more attention to content in addition to pedagogy, and are more frequently focused on the needs of underrepresented groups (women and minorities).

- On the whole, higher education grant projects appear more consistently well designed than the activities in school districts and on average are more likely to have impact on classroom practice.

Major Themes in the Study Findings

Four themes summarize what the National Study learned about the program and its place among current initiatives aimed at the reform of mathematics and science education:

The program occupies an otherwise unfilled niche among reform initiatives. The design of the program and the way it has been implemented give it a unique function among current federal, state, and local reform initiatives. In particular, the program has especially wide reach, enabling it to serve all states and school districts in the nation, in addition to involving a substantial fraction of the nation's higher education institutions; the funding is flexible and easy to obtain; and the program targets the K-12 and higher education systems simultaneously and encourages their collaboration in efforts to improve mathematics and science education. No other reform initiatives have these attributes. Those that come closest (e.g., the teacher preparation and enhancement grant programs of the National Science Foundation) emphasize the development of national models through relatively large grants to a smaller number of grantees. The Title II/ Eisenhower program, by contrast, emphasizes small grants to state, regional, and local institutions to support the implementation of reform ideas developed by other means.

The program expands the array of professional development opportunities. Title II/ Eisenhower grants to school districts and institutions of higher education have substantially increased the array of professional development opportunities available to mathematics and science teachers. These opportunities are of mixed quality, but at a minimum they offer large numbers of teachers the chance to become aware of reform ideas, make connections with colleagues, and revive or expand their interest in mathematics and science teaching. Although there is no easy way to estimate incidence, a great number of these opportunities—perhaps the majority of higher education grant projects, but less than half of all school-district-sponsored activities—offer much more than this to teachers and are designed in ways that promise to have some lasting impact on teachers' thinking and classroom practice.

The program supports leadership but does not create it. Although it has mechanisms that encourage the focusing of funds on high-priority needs, the program does not chart the course for efforts to reform mathematics and science education. Rather, it offers a key resource to state, regional, and local leaders to implement reform ideas on a wide scale. In this way, the program depends on the environment of reform

activity that surrounds it. Thus, in school districts with well-focused agendas for improving mathematics and science education, the funds are likely to be spent well, while in other districts, the funds are less effectively used. At all levels, the program and the resources it offers appear to have empowered subject-area leadership.

The program provides a necessary but not sufficient resource for promoting sustained change in teaching practice. What the program offers is necessary to the success of reform efforts in several ways: it addresses a function (professional development in mathematics and science) that must compete for scarce local staff development dollars with other subject areas and with generic inservice, yet is key to the widespread adoption of new approaches to teaching. Among large numbers of teachers at all levels of K-12 schooling, the program builds awareness and a sense of rejuvenation—an essential first step in the reform process. For a smaller but substantial number of teachers, the program takes them farther along the road to reform.

But the program cannot revolutionize teaching practice on its own. Title II/ Eisenhower funds are not great enough to support professional development of sufficient intensity and for large enough numbers of the nation's teachers to make the deep and lasting changes in teaching practice that are currently called for. Furthermore, and perhaps more important, the program is not designed to address the elements besides professional development that must also be improved for lasting changes to occur—among them, facilities, teacher salaries, curriculum, assessment procedures, and the overall organization of school programs.

Implications for the Program and Its Future

The findings of the National Study have implications for changing and improving the program, for example, when the program is next reauthorized at the federal level. Three broad implications are as follows:

(1) *The three-component strategy of the program should be maintained.* The components serve different but complementary functions that are each essential to the overall success of the program as a professional development strategy. The generally low-intensity and short-term training offered by school districts is an effective means for building widespread awareness and rejuvenating large numbers of teachers; it also allows districts with well-developed improvement agendas to do more for their teachers. The higher education grant component offers a richer set of training experiences to teachers than what is available through most district-sponsored activities. The state leadership activities give direction to both of the other components and build an additional layer of support in terms of teacher networks, topical conferences, and other forms of information dissemination.

(2) *The program's funds should be allocated differently among the three components.* Study findings suggest that there is an imbalance in the current allocation formula, which was in fact exacerbated by the recent

reauthorization of the program: the component (flow-through funding to districts) offering the lowest intensity and widest variety in quality of training receives the lion's share of the resources, whereas the state leadership component, which is providing direction and support to large numbers of districts, operates with an extremely small share of the resources. A better balance can be struck by proportionately increasing the share allocated to state leadership activities and grants to institutions of higher education.

(3) *A variety of additional leadership activities at the federal, state, and local levels would strengthen the program.* Because the program depends on the vision or sense of direction of those who receive the funds, further steps should be taken to strengthen leadership at all levels of the program. Additional leadership and direction need not involve extensive regulation and can be accomplished without reducing the program's flexibility and administrative simplicity—for example, by exhortation, dissemination of information, and similar means.

INTRODUCTION

During the past decade, the federal government once again joined the search for ways to improve the teaching of mathematics and science in the United States. Alongside the efforts of state, local, and private-sector groups, federal legislation and resources have been directed at various aspects of the perceived crisis in mathematics and science education. The largest of these initiatives, currently named the Dwight D. Eisenhower Mathematics and Science Education Program and formerly Title II of the Education for Economic Security Act (EESA), has been in place for six years. By now, sufficient time has passed to take stock of the program and what it is contributing to improvement goals.

This report summarizes a two-year National Study of the Title II/Eisenhower Program (State and Local Grants).* The document describes the operation of the program and what it is accomplishing. The findings of the National Study make it possible to identify the unique role played by the Eisenhower program in relation to other federal, state, and local initiatives aimed at reforming mathematics and science education.

The Title II/Eisenhower Program

The science and mathematics education program created in 1984 by EESA Title II (Public Law 98-377) was designed primarily to support training and retraining of elementary and secondary teachers. Under the Hawkins-Stafford Elementary and Secondary School Improvement Amendments of 1988 (Public Law 100-297), the program was reauthorized with some modifications as the Eisenhower Mathematics and Science Education Program.

Because in most respects the Title II and Eisenhower versions of the program are identical, this report refers generically to them as the "Title II/Eisenhower program."** Most of the data from the National Study apply to the 1988-89 school year, the last year before reauthorization changes took effect. Because the programs are so similar, the findings of the National Study apply equally well to both versions of the program. Where reauthorization changes have a particular significance for the operation or impact of the program, these are discussed.

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* The study does not address the national component of the program—that is, the federal set-aside (9% of the total appropriation under Title II, 4% under the Eisenhower program), which supports a variety of research and demonstration activities.

** The primary changes at the time of reauthorization included: (1) different percentages for distributing funds among program components—see Exhibit 1; (2) elimination of several program set-asides; (3) change in LEA application requirements; (4) minor changes in the types of institutions eligible to receive higher education grants; and (5) elimination of foreign languages and computer education as target subject areas.

The Title II/Eisenhower program limits the use of funds to particular subjects (now exclusively mathematics and science) and types of improvement activities (principally inservice training or other forms of professional development). At the same time, the program puts a great deal of discretion into the hands of state and (especially) local educators to solve problems as they see fit. The program has three components:

- *Funding for State Leadership Activities.* State agencies for elementary and secondary education (SEAs) receive a set-aside for "Demonstration and Exemplary" projects. In addition, these agencies and their counterparts responsible for higher education have small amounts that can be used for technical assistance, administration, or other activities that fulfill a leadership function.

- *Flow-Through Funds for Local Education Agencies (LEAs).* All school districts are eligible to receive an annual formula allocation of funds from their respective state agencies; in some cases (e.g., small rural districts), the funds can be received by an intermediate education agency or consortial arrangement on behalf of the LEAs.

- *Grant Funds for Higher education Institutions.* State agencies for higher education (SAHEs) are allotted funds to be distributed to institutions of higher education or other nonprofit institutions through grant competitions or as "cooperative" projects (the latter option was eliminated at the time of reauthorization as a required separate category of SAHE activity, but such projects may still be supported; the reauthorization also required that all SAHE funds be distributed by grants to institutions of higher education).

The flow of funds among components is illustrated in Exhibit 1. The majority of program funds are allocated to states and localities by formula, each state and district in the nation being eligible to receive specific amounts determined on the basis of student population and poverty level—states and districts with larger numbers of low-income children receive proportionately more money.

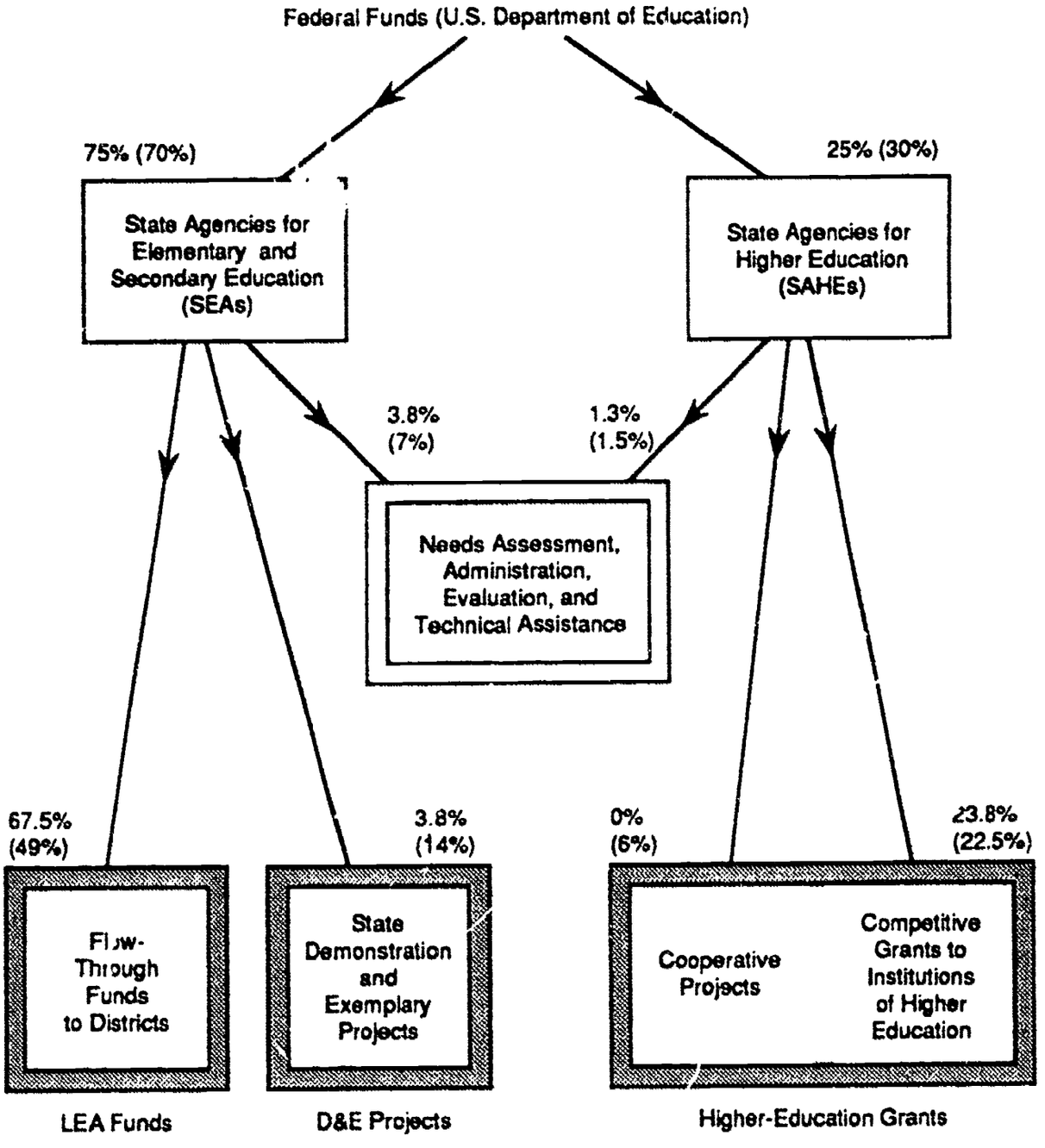
The Program as a Professional Development Strategy

The nationwide movement to reform mathematics and science education is multifaceted, but central to nearly all analyses and change scenarios is extensive professional development for current and prospective teachers. Other aspects of the national reform agenda—revamping the content of curricula, attracting and retaining a high-caliber teaching force, changing the dominant approaches to teaching—depend, in part, on the nature of opportunities teachers have for improving their professional skills.

To understand whether—and how—the Title II/Eisenhower program supports such opportunities, one must begin with a picture of good professional development.

Exhibit 1

THE DISTRIBUTION OF PROGRAM FUNDS



Explanation of Figure: The current percentage for distributing Eisenhower funds is shown first, based on the formula used in the reauthorized version of the legislation. In parentheses are shown the corresponding percentages for EESA Title II, the predecessor. Actual distribution of funds may differ slightly from the target percentages.

Funding Levels: Total program funding for the activities shown has varied year by year. For the first 5 years, beginning in school year 1985-86, the funding levels (in millions) for the 50 states (plus the District of Columbia) were: $87.4, $38.0, $70.6, $105.7, and $124.0 The last of these amounts, for school year 1989-90, was the level for the first year of the Eisenhower program with its revised formula for allocating the funds.

Good Professional Development

The view of professional development on which this study is based stems from a conception of teachers as professionals and as active agents of change, both in their own teaching and in the school programs of which they are a part. From this perspective, the task is not to "train" teachers in the use of particular classroom techniques that they are lacking. Rather, the goal is to "educate" them in ways that expand their views of themselves, their profession, the content they teach, and the pedagogy they employ. The result is intended to be a cadre of teachers who view themselves as learners, shapers of curriculum, and colleagues contributing to a mutual process of reforming mathematics and science education.

Accordingly, there is growing understanding among reformers that professional development is a cumulative, long-term process, and that a variety of experiences is necessary for educators to grow. Good professional development thus includes many things—not only the inservice training that districts offer their teachers, but also coursework, degree programs, and participation in professional associations or other practitioner networks. Together, these and other experiences can broaden and deepen teachers' knowledge, pedagogical skill, and commitment to their work.

Good professional development experiences come in various sizes and shapes, but collectively they share these characteristics:

- *Awareness of developments in the professional community.* Teachers are acquainted with developments in the wider professional field.
- *Deeper learning of content.* Teachers are exposed in new and deeper ways to the content they teach, including "relearning" of what they already know but at a more sophisticated level.
- *Appropriate pedagogy.* Professional development experiences give teachers new ideas, both large and small, about pedagogy appropriate to the content being taught—what is often referred to as "pedagogical content knowledge."
- *Opportunity for experimentation and reflection.* Teachers are able to try out ideas and reflect on their appropriateness and value in their own classroom practice.
- *Contact with peers and other professional staff.* As part of professional development, teachers meet and interact with other practicing professionals whom they did not know well before.
- *Participation in planning.* Teachers have the opportunity to help define the direction and shape of the professional development experience—for example, by participating in planning for staff development.

Experiences marked by these qualities lead over time to changes in the way teachers view their profession, commit themselves to their work, and imagine possibilities for their teaching.

Other requirements exist for teachers to be able to realize their new beliefs, commitments, or ideas in their classroom teaching. Experts on staff development generally agree that classroom practice will be more likely to change when the design of professional development reflects the following conditions:

- *Relationship to long-term improvement goals.* Professional development is most likely to "stick" when it is related to a long-term program of activities to change mathematics and science teaching. "One-shot" activities tend not to transfer to practice if they do not connect to other attempts to improve the program.

- *Intensity.* Professional development experience should be of sufficient intensity to enable teachers to understand new ways of thinking and doing, and to integrate these understandings into their repertoire. Although there is a place for professional development experiences of any intensity, longer (e.g., several days or more) or multiple-session activities are likely to have more substantial impact on teachers.

- *Colleagueship.* Teachers should participate in teams, not as isolated individuals—that is, several teachers from the same school or district should participate in professional development together and thereafter can work with each other over time.

- *Connection to teachers' classroom assignments.* When professional development experiences bear some direct relationship to teachers' current teaching assignments, there is a better chance that teachers will try out ideas picked up during training and integrate them into their classroom repertoires.

- *Follow-up.* The design of professional development should include follow-up of some kind—reinforcement sessions, individual visits by a trainer or colleague to the teacher's classroom, and so forth.

- *Administrative and policy support.* Administrators should understand and support the goals of professional development, even to the point of requiring changes in practice advocated in professional development. In addition, supportive policies need to be in place, including those related to testing, textbook acquisition and use, scheduling, and class assignment that reinforce desired changes in classroom practice.

The absence of these characteristics does not necessarily mean that professional development activities are doomed to fail. But, it does mean that the odds are not as favorable. Isolated teachers, participating in activities without follow-up or administrative support, are less likely to change the way they teach, no matter how rich the professional development experiences they may have.

Not all professional development experiences need to be the same—that is, all equally intensive, fully supported by administrators, rich in content and pedagogy, and so forth. Brief, one-time events, for example, can effectively make teachers aware of new developments in the field, bring teachers into contact with other colleagues, increase their interest in the content area, and introduce them to a limited number of teaching ideas. More intensive forms of training can go much farther and deeper into issues of content and pedagogy and hold more promise for affecting classroom practice in significant ways. There is a role for both nonintensive and intensive experiences, and to a degree there is a different "market" for each—many teachers are neither willing nor ready to participate in intensive training events, yet are happy to attend shorter workshops or a conference, if given the opportunity. Good professional development, then, is best thought of as the **combination** of experiences over time that engages the widest range of teachers in a cumulative process of professional growth.

Program Design as a Strategy for Supporting Professional Development

The Title II/Eisenhower program is one strategy for encouraging or enabling the nation's mathematics and science teachers to encounter an appropriate mix of short- and long-duration professional development activities over time. Four characteristics of the program identify the unique nature of this strategy. The program:

- *Targets inservice education primarily.* Although preservice teacher education is a goal of some program-supported IHE projects, the primary emphasis of the program, in legislation and in practice, is on professional development for currently practicing teachers.

- *Combines multiple approaches to stimulating professional development for science and mathematics teachers.* A variety of approaches are embodied in the various set-asides, including state-supported demonstration projects, competitive state grants to institutions of higher education, and formula funding to school districts to support training activities.

- *Strikes a balance between focus and discretion.* The program targets particular subject areas and types of activity, but is also designed to allow a wide range of state and local discretion. The resources can be used to address many priorities and, in fact, are used very differently across states and localities.

- *Maximizes breadth of coverage rather than depth.* Because of modest funding levels overall, the set-asides established by law, and a formula that distributes funds to all states and districts nationwide, the program does not concentrate resources but rather disperses them across a large number of activities and settings.

The combination of these characteristics in a single program is somewhat of an experiment. In particular, it is without precedent for the federal government to attempt in one program to mobilize state education agencies, the higher education sector, and the

elementary/secondary education sector in pursuit of a common nationwide improvement goal. To understand the results of this experiment, the basic operation of the program and its three parts must be appreciated, as summarized in the next section.

THE OPERATION OF THE PROGRAM

Operationally, the program can be best understood in terms of its three separate components (leadership activities by state agencies, flow-through funds to districts, and grants to institutions of higher education). Before highlighting key findings for each part of the program, it is important to understand the amounts of money involved, how the funds are divided among components, what the money pays for, and the numbers of teachers who participate in the program.

Size and Scope of Program Operations

Among federal education initiatives, the Title II/Eisenhower program is not large, although the amount of money allocated to it has increased substantially since the program's second year, as demonstrated in Exhibit 2. In the 1988-89 school year (the fourth since the program's inception), to which most of the National Study data pertain, the program totaled slightly more than $100 million for all three components combined. Projections for the 1991-92 school year indicate that approximately twice that amount will be available for state agencies, local education agencies, and higher education projects.

The relative amounts allocated to the three components of the program differ substantially, and they changed considerably following reauthorization. As Exhibit 2 indicates, LEA flow-through funds currently account for the majority of the funds, whereas state demonstration grants and other leadership activities comprise few of the funds, and less in absolute terms than before reauthorization.

These funds pay primarily for the costs associated with professional development activities of various kinds—stipends, travel costs, consultant fees, materials used in training, and so on, as demonstrated by Exhibit 3 for LEA and IHE activities. (Some LEAs used the funds for equipment purchases or to support curriculum development work, but these are exceptions and, under Title II, generally required a waiver from the state agency; the Eisenhower program has greatly restricted equipment purchases and eliminated the waiver provision.)

Typically, program funds cover only part of the total cost of training events or other professional development activities. The remainder is taken care of by other special programs (e.g., federal Chapter 2 dollars), local district money, and in-kind contributions. On average, IHE project budgets include an amount of in-kind or matching funds that roughly equals the amount of Title II funding.

Exhibit 2

THE AMOUNT OF TITLE II/EISENHOWER FUNDS ALLOCATED TO PROGRAM COMPONENTS OVER TIME

Program Year	Amounts of Funding Received by State Agencies[a] (in $1000s)			
	State Demonstration Grants, etc.[d]	Flow-Through to LEAs	Higher education Grants, etc.	Total
Under original version of the law				
Year 1 (1985-86)	18,361	42,844	26,231	87,436
Year 2 (1986-87)	7,985	18,632	11,407	38,024
Year 3 (1987-88)	14,836	34,618	21,195	70,649
Year 4 (1988-89)	22,195	51,789	31,707	105,691
Under reauthorized version of the law[b]				
Year 5 (1989-90)	9,530	85,770	31,766	127,066
Year 6 (1990-91)[c]	9,411	84,700	31,370	125,481
Year 7 (1991-92)[c]	14,991	134,914	49,968	199,874

[a] Table based on all 50 states and District of Columbia.

[b] The Hawkins-Stafford Educational Amendments of 1988 reauthorized Title II of EESA as the Dwight D. Eisenhower Mathematics and Science Education Improvement Act.

[c] Estimate based on federal budget information available as of 1/8/91.

[d] This column includes funds used for state administration and technical assistance.

Source: Federal budget documents, using legislated percentages to generate each column's figures.

Exhibit 3

WHAT TITLE II/EISENHOWER FUNDS PAY FOR

Expenditure Categories	Percentage of All Funds Received By LEAs in 1988-89	Percentage of All Funds Received By IHE Projects in 1987-88 and 1988-89
Materials and supplies (used in training)	21	11
Salaries (including benefits)	17	41
Travel costs (e.g., for conferences)	16	6
Participant stipends	16	21
Consultant fees and expenses (e.g., for training staff)	16	8
Equipment	8	3
Overhead	--	4
Other	6	6
	100	100

Exhibit 4

PARTICIPATION IN ACTIVITIES SUPPORTED BY TITLE II

Activities Sponsored by Districts and Intermediate Units	Number of Participants in 1988-89	
Inservice training	385,000	
Out-of-district professional development (e.g., conferences)	112,000	
College or graduate courses	23,000	
Other	26,000	
Subtotal		546,000
Higher Education Grant Projects		
Inservice training	58,000	
Preservice preparation	5,000	
Subtotal		63,000
Total (duplicated count)		609,000

The program is serving large numbers of the nation's teachers. In fact, survey data show that more than 600,000 opportunities for professional development ("slots" or openings) were fully or partially supported by the program in 1988-89, as shown in Exhibit 4. Because these data may double count teachers who participate in several events, the totals in the table do not necessarily indicate the number of different teachers served. Still, it is likely that the program is reaching a third or more of the nation's mathematics and science teachers each year (including elementary teachers).*

The data shown in this table do not include teachers, supervisors, students, and others served by state Demonstration and Exemplary projects each year (over 700 such projects were supported in 1988-89). Thousands of additional participants would be added from these projects; however, the surveys did not request exact data.

The State Leadership Component

The program provides opportunities to the state agencies for elementary and secondary education (SEAs) and for higher education (SAHEs) to exercise leadership in the improvement of mathematics and science education by setting priorities, offering technical assistance, and supporting a wide variety of projects. The priorities of the SEAs are most clearly reflected in the Demonstration and Exemplary projects that they support, while the SAHE priorities are reflected in the nature of the higher education grants they make. (SEAs are also able to influence the use of the flow-through funds by school districts, but more often priorities for these funds are established by the districts themselves.)

The study data show that many states are using program funds to support projects that reflect particular state priorities. In both types of state agencies, in fact, these funds provide a significant portion (half or more, on average) of the "discretionary" monies available to support improvement in science or mathematics education. In 1988-89, for example, the Title II/ Eisenhower program was an important source of funds for state education agencies to use in disseminating information about key state priorities for improving mathematics and science education and in training a leadership group of teachers, district supervisors, and other key subject-area leaders to improve and carry out a reform agenda in science and mathematics. The program enabled the states to take a more proactive role and to conduct more expensive activities (such as training) than they otherwise would have done. Examples include the following:

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* Based on data from the National Center for Education Statistics and the National Education Association, the statement about teacher participation presumes that there are about 1.24 million elementary teachers who teach either science or mathematics, as well as about 240,000 secondary teachers in these disciplines.

- *Promoting the use of mathematics manipulatives.* One state developed a mathematics manipulatives kit before the program was created but trained few teachers to use it until Title II funds became available. Since then, thousands of teachers have received training to use the kits.

- *Implementing new "frameworks."* Distinctly new mathematics and science curriculum frameworks were published in another state in recent years. Title II funds have been used by the SEA to educate a leadership group of teachers about what these mean and how best to use them.

- *Implementing the National Council of Teachers of Mathematics (NCTM) Standards.* In several states, the NCTM affiliates (state associations of mathematics teachers) have developed sets of recommendations to supplement the NCTM Standards, and Title II funds have been used to disseminate and implement these recommendations statewide.

- *Initiating efforts to increase SAT scores.* In a state with very low SAT scores, the state education agency implemented a statewide effort to improve SAT mathematics scores, using Title II funds. The objective was to train teachers how better to teach the kind of mathematics tested.

- *Addressing the needs of under-represented groups.* Several states have used a portion of their higher education funds to support projects especially focused on the needs of women and minorities. In one state, a series of "cooperative" projects were aimed at inner-city minority children's needs.

The combination of state priorities (such as these) with Title II/Eisenhower program funds to help carry them out is a powerful one. Some of this power has been lost, because the reauthorization that created the Eisenhower program sharply reduced the percentage of funds allocated to the states, especially the state agencies for elementary/secondary education. Even the larger fiscal year 1991 appropriation will not result in funding the state Demonstration and Exemplary projects at the same level as in the 1988-89 school year.

Flow-Through Funds to Districts

The "flow-through" funds, allocated under Title II and Eisenhower to school districts on the basis of formulas based on population and poverty levels, provide a small but significant resource at the local level. In most states, the allocation amounts to an average of approximately $30 for each teacher in the district, or slightly more than the cost of a typical high school mathematics or science textbook. (Districts need not spread the funds to serve all teachers but may choose to serve particular groups, such as middle school mathematics teachers or high school physics teachers.) In the typical case, LEAs concentrate on a particular segment of their teacher population in one year, then shift focus to another segment in the following year.

Because so many districts in the United States are small, there are very large numbers of districts that receive $3,000 or less (about half in 1988-89). Even in large districts, the flow-through dollars are modest compared with many other state and federal programs. As an example, in one large southern school district visited as part of the study, Title II provided about $53,000 that year, while the federal compensatory education program (Chapter 1) and the block grant program (Chapter 2) together provided about $5.5 million.

The study found that a steadily growing number of districts in the United States have participated in the program. Currently, the great majority of districts participate, including many smaller districts that receive services through intermediate units (such as Education Service Centers), which administer the funds on their behalf.

As Exhibit 5 shows, the program in school districts is supporting primarily inservice training in mathematics and science, as well as opportunities for out-of-district professional development. Notably, this latter includes expanded opportunities for teachers to attend professional conferences in science and mathematics education. Study data suggest that attendance at state and local professional meetings in mathematics and science has grown significantly since 1985, when Title II began, and that Title II/ Eisenhower program funds have been a key resource in promoting this participation. For many teachers (especially at the elementary level), these may be the first professional meetings focusing on science and mathematics that they have attended outside their district.

During the 1988-89 year, LEA activities were primarily in mathematics and science and included, in roughly equal proportions, events targeted to "lead" or master teachers (who were then to train others), adequately prepared teachers, and those who were underprepared for their current teaching assignment. Two-thirds of all LEAs in that year focused some or all of their mathematics-related activities on the elementary level, and nearly the same percentage did so for science activities. Half or more of the LEAs targeted some or all of their program-supported professional development to higher grade levels.

The variety of activities supported by Title II/Eisenhower funds at the district level is enormous and difficult to summarize. Teachers are trained to use particular curricula or instructional strategies (such as mathematics manipulatives), participate in summer workshops focusing on state or district priorities, develop new materials, or attend conferences. Special districtwide events are sometimes planned. At times, large proportions of teachers participate, while in other cases the funds are targeted only to particular grades, subjects, or types of teachers. In a few cases, districts have used program funds to pay for graduate-level training; some teachers interviewed for the study would not have received master's degrees in science or mathematics except for the support provided to their districts.

Exhibit 5

PROFILE OF THE PROGRAM IN LEAs: WHAT THE PROGRAM SUPPORTS AND WHO PARTICIPATES

What the Program Supports	Percentage of Districts Using Title II Funds in 1988-89 for Each Purpose
Type of activity	
Within-district inservice	48
Out-of-district professional development (e.g., conferences, courses)	48
Curriculum development	13
Direct services to students	0
Preservice teacher preparation	7
Subject area	
Science	79
Mathematics	79
Computer education	20
Foreign language	8

Who Participates in Program-Supported Activities	
Types of teachers targeted	
"Lead" or master teachers	40
Adequately prepared teachers	53
Underprepared teachers	42

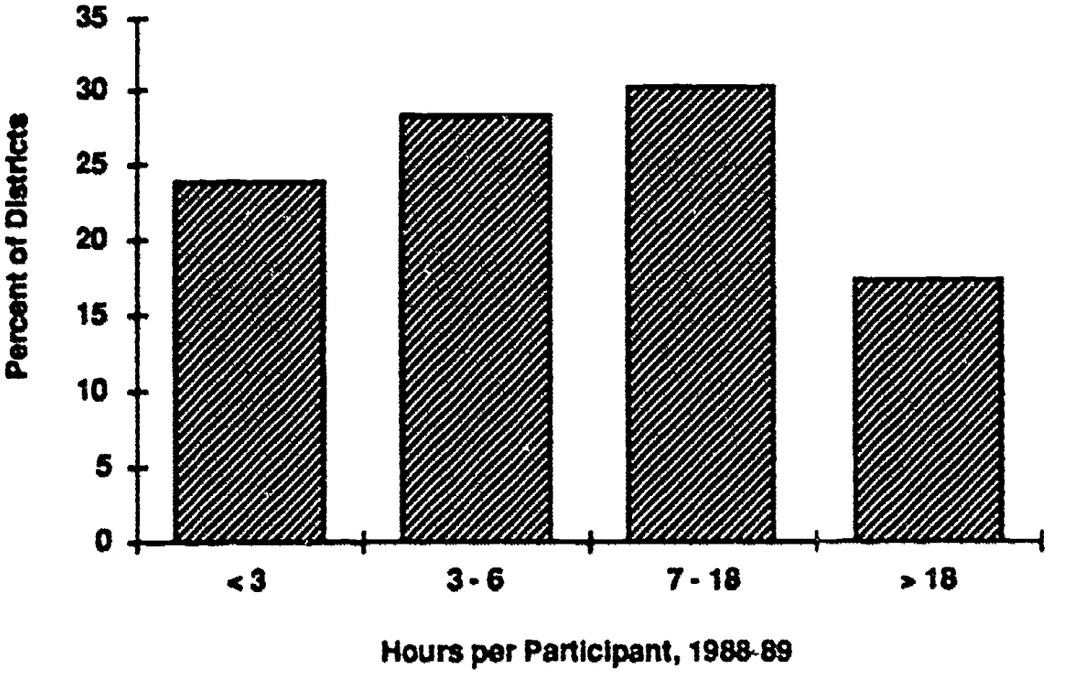
Grade levels of teachers targeted...	...In Professional Development Aimed at: Mathematics	Science
Elementary school	67	58
Middle/junior high school	57	55
High school	51	51

Typically, however districts do not use Title II/Eisenhower money to support high-intensity, long-term training, partly because the allocations are small. The median exposure for a participating teacher in a given year (based on 1988-89 data) is six hours or about one day of inservice, but a wide range of activities is supported, and the duration of these is quite varied (as shown in Exhibit 6).

Principles of good professional development suggest that experiences lasting only one day, by themselves, are not enough to help teachers make the kinds of significant changes in classroom practice that many groups are recommending. Nonetheless, as pointed out in the introduction to this report, experiences at this level of intensity can play a useful role in the overall mix of professional development that teachers experience. National Study site visitors encountered numerous instances of one-day activities that were linked to a longer-term agenda for improving mathematics and science education, that built awareness of key reform ideas, and that broadened teachers' networks of colleagues from whom they might draw support.

Exhibit 6

INTENSITY OF LOCAL INSERVICE TRAINING SUPPORTED BY TITLE II



The role and importance of the program funds at the district level varies from extremely important to almost negligible. As one would expect, the districts with more focused agendas for improving mathematics and science education typically make better use of funds than those without such clear agendas. Also, as one would expect, the

hallmarks of good professional development apply as much to this program as to any other. In other words, the more the activities are consistent with principles of sound professional development (as outlined earlier), the greater the chances that classroom practices will change.

The data on numbers of teachers served and intensity of training at the district level suggest that district-level decisionmakers have difficult choices to make. There can be real value in raising teachers' levels of awareness about the kind of ideas represented by new state mandates, the NCTM Standards; the Scope, Sequence, and Coordination project of the National Science Teachers Association (NSTA); or Project 2061 of the American Association for the Advancement of Science (AAAS). At the same time, many teachers definitely need sustained involvement with content and pedagogy in order to change their approach to teaching mathematics and science (which may, in some cases, mean teaching elementary science virtually for the first time). Although most have not supported high-intensity training, districts have approached the trade-off between numbers of teachers served and intensity of training in a variety of ways, and there is no simple recipe for success.

Grants to Institutions of Higher Education

During 1987-88 and 1988-89 (the third and fourth years of the program) about 1,600 higher education projects received Title II grants from the SAHEs. The great majority of these provided inservice training for practicing teachers, while small fractions focused on preservice teacher preparation, direct services to students, curriculum development, or alternative certification, as indicated in Exhibit 7. Nearly two-thirds of all projects focused on science and half on mathematics (projects often had a combined focus on both). Unlike LEA-sponsored activities, IHE projects were more likely to aim at the middle/junior high school level, although a large fraction (nearly half) of all projects involved elementary and high school teachers as well.

The study data show that these projects play quite a different role for teachers than do typical district-supported activities. Higher education projects offer teachers many more hours of exposure to content and pedagogy, averaging 60 hours per participating teacher (in 1987-88 and 1988-89). More frequently than in districts, the higher education projects take place during the summer, involving perhaps 35 teachers at a time in a several-weeks-long "institute" or course, often offering graduate-level credits. Like the district-supported activities, the higher education projects blend a focus on particular science and mathematics content with an emphasis on pedagogy. However, taken as a group they have a greater content focus, and often more of a focus on leadership training, than typical activities supported by flow-through funds to districts.

Grants are typically about $31,000 per project (the distribution of grant size is shown in Exhibit 8). Large projects (i.e., those over $100,000) are very rare. Few projects are funded for more than one year at a time, although often project directors who reapply in subsequent years are successful in finding funds to continue the same or a similar type of work.

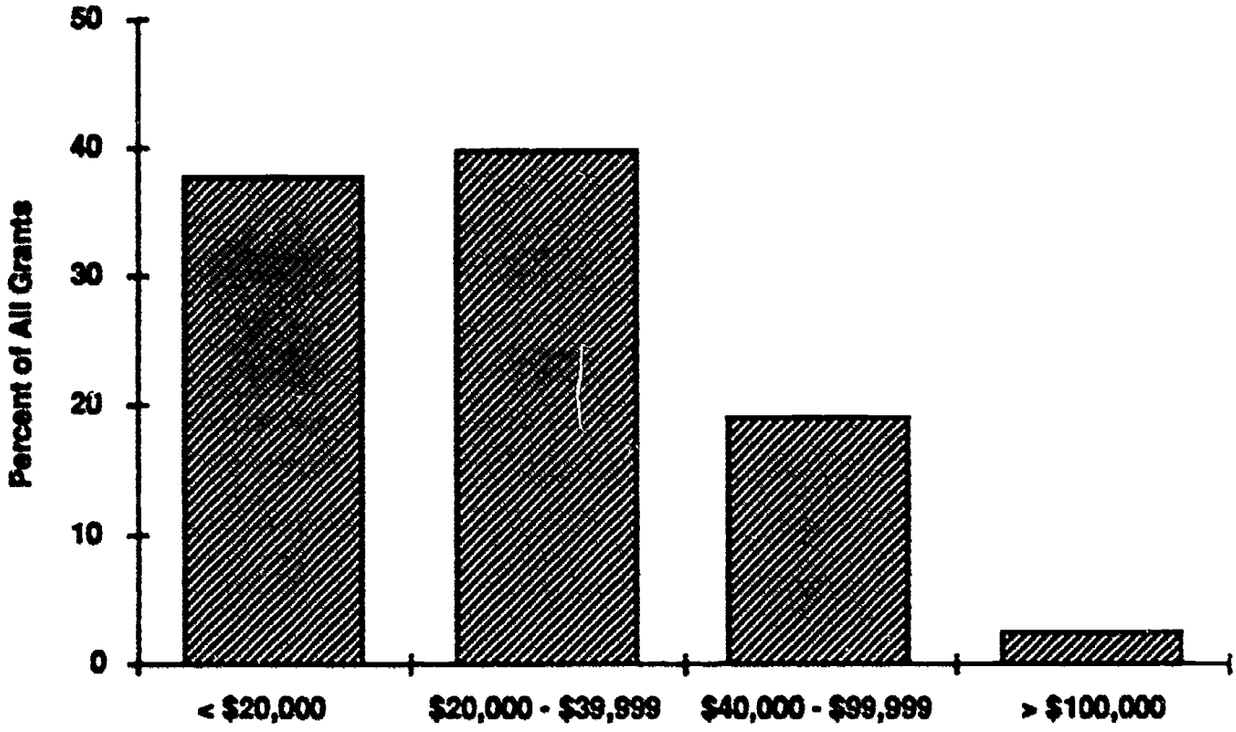
Exhibit 7

PROFILE OF THE PROGRAM IN IHE PROJECTS: WHAT THE PROGRAM SUPPORTS AND WHO PARTICIPATES

What the Program Supports	Percentage of IHE Projects Using Title II Funds in 1987-88 and 1988-89 for Each Purpose (Average Across Two Years)	
Type of activity		
Inservice teacher education	88	
Curriculum development	38	
Direct services to students	16	
Preservice teacher preparation	12	
Alternative certification	3	
Subject area		
Science	64	
Mathematics	49	
Computer education	15	
Foreign language	11	
Who Participates in Program-Supported Activities		
Types of teachers targeted		
Certified teachers inservice	69	
Uncertified teachers inservice	25	
Preservice teacher candidates	12	
Teachers in graduate school	18	
Grade levels of teachers targeted	Inservice	Preservice
Elementary school	47	6
Middle/junior high school	60	7
High school	49	5

Exhibit 8

HIGHER EDUCATION GRANT SIZE



Rather than being based in schools of education, more than half of the higher education project directors are faculty members in mathematics, science, or similar departments. The data suggest that many of these directors have not been involved in similar activities before, in part because there have been few comparable sources of support available to tap. Indeed, the program has brought a variety of institutions serving a diverse population into the business of professional development for practicing teachers (e.g., more than 10% of the projects in years three and four were in two-year colleges; although seldom considered primary providers of teacher training, these institutions offer content expertise in mathematics and science and have some faculty who take a particular interest in teaching and local-area schools). Without the Title II/Eisenhower program, many of these institutions probably would not be able to conduct such projects.

Only 4% of these grant monies, on average, are used to pay for indirect costs at the host institution. This is far lower than the indirect costs typically associated with scientific or educational grants to institutions of higher education, and it means that the dollars stretch farther. In effect, the institutions are contributing the overhead costs, which is unusual.

These projects have been referred to as "higher education grants," but for the first four years of the program (under Title II) other types of nonprofit institutions were also eligible to receive these funds as prime grantees. The study examined projects in museums and other nonprofits—a small minority of all the grants—and found that, as direct grantees, a number of these institutions were able to exercise an important leadership function in organizing useful and innovative professional development for local-area teachers. As such, these institutions have a place in providing professional development and other services to improve science and mathematics education.

WHAT THE PROGRAM CONTRIBUTES TO THE REFORM OF MATHEMATICS AND SCIENCE EDUCATION

Taken together, the activities supported by the three program components contribute to reform in mathematics and science education in various ways. These contributions are described below, first in terms of impact on teachers, classrooms, and students and, second, in terms of impact on the educational system.

Contributions to Teachers, Classrooms, and Students

The impacts of the Title II/Eisenhower program on teachers, classrooms, and students are best understood, first, by considering what the experience of professional development means to individual teachers. Here the program has its most immediate influence, as program-supported activities affect individual teachers' attitudes, knowledge, and ideas about teaching. Second, less directly, the program can influence classroom practice, and ultimately student learning, as teachers incorporate what they have learned in professional development into classroom practice. Third, the program can have impact on specific groups of teachers and students—in particular, those historically underrepresented in mathematics and science (women, minorities, the handicapped), who are singled out by the Title II/Eisenhower legislation for special attention.

What the Program Means to Teachers

There seems little doubt that the Title II/Eisenhower program has expanded the sheer volume of professional development activities available to teachers of mathematics and science. This was documented in interviews with teachers, supervisors, state agency staff, and others. More opportunities are available than five years ago, and more teachers are involved in a larger number of activities than at that time.

As one would expect from the large numbers served by the program, a wide variety of teachers are taking advantage of these opportunities. Many "typical" or "average" teachers benefit from the program. At the same time, some projects and some districts have focused on "lead" teachers (or lead teachers in the making), while a few have focused especially on underprepared teachers.

The most common type of impact on teachers is increased awareness: for example, through program-supported training, many teachers have been exposed for the first time to the *Curriculum and Evaluation Standards* of the National Council of Teachers of Mathematics (NCTM)), have had their first experience with "hands-on" science by

participating in a "make-it/take-it" elementary science workshop, or have learned about new state requirements for science and mathematics testing and assessment. Awareness is a necessary first step before people can change, and its importance should not be minimized.

- *Gaining first exposure to the NCTM Standards at a professional meeting.* In a rural midwestern middle school, mathematics in grades five through eight is departmentalized. There is only one mathematics teacher in the school; her total mathematics budget, for all purposes, is $50. She attended a regional conference of the NCTM affiliate, supported by the district's Title II funds, which also paid for a substitute while she was away. For her, the most significant professional event at the conference was learning for the first time about the NCTM Standards. Proposals to move algebra to junior high school were eye-opening to her, but she said the entire set of Standards was interesting and she wished more had been said about them.

Another common type of impact is the sense of excitement or renewal that is generated when teachers have a chance to meet with, and learn from, their peers. The study data contain many examples of teachers who expressed their belief that making professional connections (at a state or district conference, or at a summer institute), or working in teams in a project, was one of the most significant outcomes of participation in an activity supported by Title II or Eisenhower funds.

- *Learning from peers.* A veteran teacher recently received a master's degree from a state university and maintains contact with a science and mathematics education center located there. Title II funds have enabled her to learn new approaches from her peers. *"I have gotten to meet really exciting math teachers.... And I think the key thing they know how to do—and what they show me how to do—is to make math fun, particularly in the lower-level math I teach."*

Renewal, professional connections, and heightened awareness by themselves are not sufficient to reform mathematics and science teaching, but they are necessary first steps for many teachers. Additionally, study data show that there are many teachers who have, indeed, changed their approach to teaching based on experiences supported by the program, and these are the clearest "success" stories. Most often, these changes are associated with longer, more intensive professional development experiences. But the study's data show that shorter experiences can have an impact on teachers and classrooms, as the example illustrates:

- *Visiting other schools.* One science department chair in a rural high school made this comment about Title II: *"It's really made a difference to be able to go off to learn about opportunities [using Title II to pay for substitutes], and then be able to adopt new ideas."* For example, teachers in the school learned about National Diffusion Network (NDN) exemplary curricula by spending a day visiting schools that use them, and later they adopted these curricula for use in their schools. As a result, she said that *"all science teachers in the school have benefited directly or indirectly from Title II funds."*

The three examples cited above illustrate the kinds of impact that even short professional development experiences can have on participating teachers. Longer activities (often, but not always, associated with program-supported higher education projects) offer teachers opportunities to learn more content and to become thoroughly familiar with a variety of new approaches. Several examples illustrate the impact of these experiences on teachers:

- *Experiencing hands-on elementary science in a summer institute.* A first-grade teacher who teaches a multi-ethnic group of children (several of whom speak no English) is well trained in reading but applied for a Title II-supported summer institute in science "*because I felt so weak in teaching young children science.*" This institute, run by a mathematics/science center at a local university, trained pairs of teachers from the same school, and emphasized the importance of hands-on science. The teacher says she now performs a science experiment every day with her students, whereas before she taught strictly from the textbook. The institute provided her with resources and a support team. She and the other teacher who participated in the program from her school are now working with the PTA to set up a science laboratory in their elementary school.

- *Certifying physics teachers.* A predominantly black university has offered a physics certification institute for several summers, using Title II funds. The objective is to increase the supply of physics and physical science teachers in the area who are certified. One teacher interviewed for the study, who had taught biology in inner-city schools and wanted to add physics certification to her credentials, enrolled in the institute. This is her second year at the institute, where she says she has learned a lot of physics and has seen physics in use in the workplace (e.g., through field trips to a local power company).

The examples above illustrate the impact that many teachers report from their involvement in Title II/Eisenhower-supported activities. Not all their experiences are positive. In some districts visited during the National Study, teachers experienced Title II-supported activities as "the same old inservice." In other cases, the topics of program-supported training events seemed uninteresting, irrelevant, too technical, or not technical enough to some of the participating teachers. Not every teacher who attended a conference came away full of enthusiasm and new ideas. These were the exception rather than the rule, however, in National Study site visits—more often than not, teachers found something of value in the training events.

What the Program Means for Classrooms and Students

The impact of the program on classrooms and students is mixed—sometimes direct and immediate, often indirect and long-term, in many cases hard to trace or nonexistent. Because the program supports professional development activities of various kinds (including many activities aimed at awareness), this finding is not surprising.

A small number of Title II/Eisenhower-supported activities provide direct services to students (most often SEA-sponsored demonstration projects or "cooperative" higher

education grants—a category of grants specifically authorized under both Title II and Eisenhower). These offer the most visible examples of the program's impact on students. For example, one project visited as part of the study supported tutoring of urban high school science and mathematics students whose native language is not English; the tutoring was provided by successful minority students from a local college. In another project, located in a rural state, minority children in grades one through three, and their parents, participated in a variety of activities designed to increase interest and proficiency in mathematics and science and to help parents make use of easily available educational resources in the home and the community. Both projects involved classroom teachers, as well.

Most Title II/Eisenhower-supported activities, however, are aimed at teachers and do not provide a direct service to students. As implied by the examples provided earlier, the most visible impact of program-supported activities on classroom practice occurs where these activities:

- Have been explicitly designed to affect the classroom.
- Follow principles of good professional development design.
- Are part of a larger effort to improve mathematics or science teaching carried out by schools or districts, state agencies, or institutions of higher education.

These conditions pertain in many instances, especially in higher education projects. There, for example, the majority of projects provide intensive experiences (e.g., one week or more for participating teachers) and include follow-up components and special incentives for teacher participation. In such cases, teachers, principals, supervisors, and others interviewed for the study document clear impacts on classroom practices. In some cases, the change is dramatic:

- *Change in teaching practices in a rural high school.* A young woman teaching ninth-grade physical science in a rural area has participated in a wide range of professional development activities, several of which were supported by Title II funds. As a result of her experiences, she has changed the way that she teaches, using a greater variety of techniques to make students active learners (including cooperative learning, field trips, and more open-ended test questions). Her goals have advanced beyond simply teaching facts, and she now believes that students need to be more creative with what they learn. She is now acting as a "master teacher" in Title II/Eisenhower-supported summer workshops through a local two-year college, is helping to rewrite the district science curriculum (using flow-through funds), and has become a resource teacher whom others call on throughout the school year.

However, not all activities supported by program funds have visible or traceable impact on the classroom. In many cases, the experience— participation in professional association activities or university-based courses, for instance—is linked only indirectly to a teacher's classroom work. In other instances, what teachers gain from professional

development cumulates over time, and it is difficult to trace impacts to one or another event.

In still other cases, professional development experiences do little or nothing to change what goes on in the classroom. This is often the case in brief, "one-shot" experiences (Title II/Eisenhower program funds support a number of these) and in professional development activities that are poorly conceived or executed. Several examples from National Study site visits illustrate program-supported professional development in which transfer to classroom practice is unlikely:

- *Insufficient exposure.* All fourth-grade teachers in one city attended a single three-hour session in which they were urged to adopt a problem-solving focus in their mathematics teaching. Although the idea sounded interesting, participants agreed that they received too little to help them know what to do.

- *Mixed signals from the district.* Program-supported workshops introducing first-grade teachers in a rural district to hands-on elementary science techniques were followed by the adoption of a new science textbook. Many teachers took the easier route and taught exclusively from the textbook.

- *Mismatch between training content and class assignment.* A week-long summer institute on new approaches to teaching geometry left one inner-city high school teacher frustrated when she could find no way to incorporate what she had learned into the ninth-grade, lower-track mathematics classroom, which does not include geometry.

There is no simple or direct way to estimate the number of districts or IHE projects in which Title II/Eisenhower-supported professional development is likely to transfer directly to the classroom. But some data from National Study surveys suggest that conditions encouraging transfer from professional development to the classroom exist in large numbers of districts and grant-funded projects—probably in fewer than half of all districts, perhaps in a majority of higher education projects, as indicated by Exhibit 9.

What the Program Means for Underrepresented Groups

Both the Title II and Eisenhower program statutes include provisions that require recipients of funds to:

> take into account the need for greater access to and participation in mathematics, science, and computer learning programs and careers of students from historically underrepresented groups, including females, minorities, individuals with limited-English proficiency, the handicapped, and migrants [and, in some cases, the gifted and talented].

The degree of emphasis placed on this goal varies considerably from one case to another. Several states have made service to underrepresented groups an active part of

Exhibit 9

SELECTED CONDITIONS ENCOURAGING TRANSFER TO THE CLASSROOM IN LEA- AND IHE-BASED PROFESSIONAL DEVELOPMENT ACTIVITIES

Conditions That Encourage Transfer from Professional Development to Classroom Practice	Percentage of Program-Supported Activities That Displayed Each Condition	
	LEA Activities in 1988-89	IHE Projects in 1987-88 or 1988-89
Intensity: hours per participant		
Greater than 18	18	85
Greater than 30	9	75
Greater than 100	<1	25
Teachers' participation in planning for professional development	41	38
Incentives for teachers' participation: use of program funds for teacher stipends	42	60
Opportunity to adapt what has been learned to teachers' own classroom situations		
Mathematics inservice	61	54
Science inservice	70	72
Follow-up		
Formal follow-up training for all participants	..a	40
Informal follow-up support to some individual participants	..a	62

[a] Data unavailable.

their leadership strategy under Title II/Eisenhower, but most have not. A specific focus on underrepresented groups does not appear to be an explicit emphasis of many activities supported by LEAs (only 13% of LEAs in 1988-89, according to the survey data), although a greater proportion of IHE projects (25% in the same year) and of state-initiated Demonstration and Exemplary projects (about 18%) have been designed with this goal in mind.

The formulas used for distributing program funds ensure that states and districts serving large numbers of low-income students receive a proportionately larger fraction of the monies. In this sense, the program is bound to serve these students—or, more likely, their teachers—more than others. Even in the case of the higher education grants (which are awarded competitively, rather than by formula), minority teachers have been served in numbers far out of proportion to their representation in the universe of all teachers of science and mathematics (21% of IHE project participants, compared with about 8% of all teachers). In LEAs, the proportion of minority participants is close to the national percentage, but still exceeds it by a wide margin (14% of all LEA participants in 1988-89 were of minority background). In both LEAs and IHEs, women comprise the great majority of participants in program-supported activities.

Perhaps most important, the kinds of active, hands-on modes of learning that are so often the focus of program-supported training are more likely to engage members of underrepresented groups in mathematics and science than the instructional approaches that are typically used in the classroom. Local professional development coordinators and project leaders often feel they are serving the interests of these groups through such means, and many teachers believe that what they have learned is especially useful with underrepresented groups of students.

Given the attention to this issue in the enabling legislation and the widespread sentiment across the nation that the issue is of growing importance (as the demographic profile includes more and more of these students), there are still many who believe that more could be done with program resources to address this particular need.

Contributions to the Educational System

The program performs certain essential functions in the educational system as a whole, in relation to the nationwide effort to improve science and mathematics education. At the same time, the program has little to do with other important functions (such as developing new curricula for science and mathematics).

The program's biggest contribution is to help move the state of practice toward the vision of excellent science and mathematics teaching that has been articulated by many groups (e.g., the National Council of Teachers of Mathematics, the National Science Teachers Association, and the American Association for the Advancement of Science). It does this in three ways: by expanding the base of informed teachers, by empowering subject-area leaders (especially at the state and district levels), and by encouraging

different sectors of the education system to work together on improving K-12 mathematics and science education. Each of these is discussed in turn.

Expanding the Base of Informed Teachers

It is one thing to issue a call for improvement or reform. It is quite another to carry the message to more than 100,000 public and private schools, let alone to implement the message at the school level.

One of the least visible, yet essential parts of implementing educational reforms on a mass scale is the task of attracting the attention of, and energizing, the "consumers" for reform ideas—that is, the classroom teachers who do not keep up with professional trends, school leaders who are busy with other problems, or district-level curriculum planners who may be charged with setting curriculum or district guidelines in a dozen different subjects. In short, something must be done to cultivate the "market" for reform, or else the exhortations of reform commissions and the mandates of state legislatures will fall on deaf ears. Worse still, the messages for changing things may never even reach the intended audiences.

Although this function is not especially glamorous, or all that visible, there is abundant evidence that Title II/Eisenhower funds are playing a key role in building awareness of, and demand for, reform ideas. For example, the program:

- Supports the attendance of large numbers of teachers at national, state, and regional professional meetings, many of them for the first time.
- Has directly or indirectly supported and strengthened the professional associations themselves, especially at the state level.
- Supports wide dissemination and popularization of certain reform ideas—for example, the idea that representing mathematical ideas through various manipulatives in elementary classrooms boosts understanding.

It often takes relatively little in the way of professional development funding to perform this function, and yet without the program these kinds of resources are often not available to teachers or administrators.

Empowering Subject-Area Leaders

Especially at the state level, but also in LEAs and institutions of higher education, the program is indisputably providing a key discretionary resource to individuals with ideas for addressing mathematics and science education needs. Along with other resources garnered by these leaders, the funds are helping to expand what the leaders are able to do and extend their outreach to other parts of the system under their purview. The important thing is that these individuals are generally those with curriculum-specific

expertise, something that has been in short supply in LEAs (and underfunded in many SEAs) over the past decade. The effect shows up as follows:

- *Empowering state leaders.* Science and mathematics curriculum supervisors in state education agencies have had much more to work with under Title II and (to a lesser extent) under the Eisenhower program than before. This has allowed them to support demonstrations, a range of technical assistance activities, an expanded regional support capability, and in some states ambitious networks of individuals providing professional development to mathematics and science teachers.

- *Supporting district leaders.* In many LEAs, individuals overseeing science and mathematics education have found that their staff development resources for these subject areas grew substantially in the five years of the program. Furthermore, the program has supported the training of specialists who provide school-level curricular expertise that is often missing (notably at the elementary level).

- *Activating leadership in institutions of higher education.* Program funds have clearly helped to bring new players into the arena, more often than not from disciplinary backgrounds. Furthermore, grants to institutions of higher education are often supporting the development of "lead" or master teachers in science and mathematics. Although the extent of the subject-area leadership exercised by these individuals when they return to their schools varies, many do carry out this role and credit their experiences in IHE-based workshops as an important part of their preparation.

The degree and direction of leadership supported by the program rests on the vision and energy of the individuals who gain control of the funds. The program has no magic for attracting the most qualified, nor can it engender leadership where a vacuum exists. Thus, its contributions to leadership are uneven. On the whole, however, subject-area leaders have benefited greatly.

Strengthening the "Connective Tissue" in the Reform Movement

The program performs an essential function of connecting diverse actors with one another. The program has increased connections between:

- *Individual teachers and sources of professional support.* Not only through attendance at professional meetings, as noted above, but through a variety of workshop experiences funded by the Title II/ Eisenhower program, teachers are encouraged or enabled, and in some instances required, to make contact with external groups that could provide them with ideas, advice, resources, and encouragement in their mathematics or science teaching. Examples include intermediate unit (IU) staff, professional association representatives, faculty from a nearby (or sometimes distant) university, and peers from neighboring districts or other schools within their own district.

- *Individual IHE faculty and LEAs.* Faculty in institutions of higher education can easily become isolated from schools and classrooms, especially those who

teach in disciplinary departments rather than among the education faculty of a university or other institution. The program has involved a number of such individuals and brought to them both greater awareness of the problems of teachers in schools and increased engagement with efforts to solve these problems.

- *Small LEAs and institutions that can help them with professional development needs.* Paradoxically, many of the school districts that have received the least (in absolute terms) from the program--those with enrollments less than 2,500--may have benefited more than larger LEAs in the sense that the funds have brought them into connection with institutions, typically regional IUs or nearby IHEs, from which they otherwise would receive little help on matters related to science and mathematics education.

- *State agencies of higher education and those responsible for elementary and secondary education.* State agencies responsible for higher education have become active players in the effort to improve mathematics and science education and have generally increased their communication with SEAs on this score. The Title II/ Eisenhower program has directly stimulated this relationship in most states.

To be sure, the program is not the only force that brings together these groups. Where such connections have come about through other means, the Title II/Eisenhower program provides a further occasion for continuing and strengthening an existing relationship. Elsewhere, where the connections had not yet been made, the presence of program funds or the program-funded activities themselves often became the impetus for different kinds of actors to get together in ways they would not otherwise have been able to do.

CONCLUSIONS: PUTTING THE PROGRAM IN PERSPECTIVE

Earlier, the report referred to the Eisenhower program, with its unique three-part structure, as something of an experiment. In a sense, then, the charge of the study team has been to explore the question, "How well is this experiment working out?"

The findings reviewed in this report suggest that the experiment is largely successful. The program is providing a key enabling resource in support of attempts to reform mathematics and science education. As such, the program puts in place necessary conditions for the spread of new content and teaching approaches. At the same time, its contributions are not sufficient, in and of themselves, to promote sustained change in teaching practice. Furthermore, the program does not provide direction for reform; rather, it depends on the surrounding context of reform activities for the vision of good practice toward which educators should strive. In a phrase, the program is an *implementation resource*, not a vehicle for redefining what is taught or how to do it.

The following pages summarize what the National Study has learned about the Title II/ Eisenhower program (state and local grants) and draw implications about the program and its future.

The Program as an Enabling Resource for Reform

The Title II/Eisenhower program appears to have struck a useful balance between flexibility and focus. State and local educators have considerable latitude in deciding how to use the funds and have taken advantage of that fact in applying the money to a variety of improvement goals. At the same time, there is surprising consistency in professional development objectives, content, and even training approaches across the diverse settings in which the funds are used. In this sense, the program enables a great deal of reform-oriented activity to take place in state agencies, school districts, and higher education institutions across the nation, but does not determine the specific activities.

What the National Study findings indicate about the program as an enabling resource can be summarized as follows. The program:

- Occupies an otherwise unfilled niche among mathematics and science education reform initiatives.
- Expands and enhances the array of professional development opportunities available to the nation's mathematics and science teachers.
- Supports, but does not create, leadership by state, regional, and local individuals or groups with subject-area expertise.

- Provides a necessary but not sufficient resource for supporting sustained change in teaching practice.

The discussion below explains each of these statements.

The Program Occupies an Otherwise Unfilled Niche Among Reform Initiatives

Several features of the Title II/Eisenhower program distinguish it from other federal, state, or local reform initiatives and give it a unique function among efforts to improve mathematics and science education in the nation's schools.

First, *the program provides funding on an annual basis to all school districts and states within the nation (and to a substantial fraction of the nation's institutions of higher education).* It thus enables educators throughout the K-12 educational system to devote attention to improving mathematics and science education. Though the amount of funding is small, it comes in repeated annual increments, which makes it possible for local and state educators to devise long-term solutions to the task of improving their mathematics and science teaching. (Fluctuation of funding levels complicates long-term planning, however; funding for most components has increased steadily since the program's second year, but SEAs have experienced a sudden drop after Year 4.)

Second, *the funding is flexible and easy to obtain.* In relation to the overall target of improving professional development opportunities in mathematics and science education, the program permits a wide variety of approaches and solutions to be undertaken. Local education agency officials, for example, appreciate the flexibility they have under the program. Faculty in institutions of higher education (IHEs) find the Title II/Eisenhower grant funds easier to secure than, for example, demonstration grants from other public or private sources, which are often highly competitive. A number of IHE faculty would be unlikely to pursue grant funding for mathematics and science education improvement activities were it not for the availability of a resource like the Title II/Eisenhower program.

Third, *the program simultaneously targets three essential institutions within the educational system—state agencies, local education agencies, and higher education institutions—and encourages collaboration among them.* The degree of collaboration among these institutions historically has been weak, especially between the K-12 and postsecondary sectors, and, in many states, nonexistent in the case of mathematics and science education. The Title II/Eisenhower program has successfully promoted collaboration among these partners in a majority of states. In addition, there is ample evidence that the three components of the program complement one another and often work in tandem—for example, LEAs often use their Title II/Eisenhower flow-through dollars to send teachers to IHE projects supported by program funds; Title II Demonstration and Exemplary funds are used by some states to educate leaders within the state about improvement priorities that are subsequently addressed by program funds at the district level.

These characteristics are unmatched among the current array of local, state, and federal reform initiatives aimed at mathematics and science education. Local initiatives are just that—a local resource. They do not serve the nation at large, nor does the sum total of all local initiatives. Too many LEAs are simply unable to muster the resources to tackle professional development needs alongside their many other priorities. A similar pattern pertains at the state level: some states have the resources to mount targeted professional development programs, others don't. Furthermore, state initiatives are often focused on much more than professional development; their efforts to change curriculum, graduation requirements, and accreditation or certification standards, for example, intensify the need for professional development, thus stretching their already thin resources.

Other federal initiatives aimed at mathematics and science education are typically focused on demonstrations and as a consequence serve the nation's improvement needs differently than does the Title II/Eisenhower program. Professional development initiatives from the National Science Foundation (NSF) are a case in point. For example, compared with the NSF Teacher Enhancement program, which supports inservice professional development, the Eisenhower program serves many more teachers (though at various degrees of intensity). This is true whether one considers all components of the Eisenhower program or only the higher education projects (which are the most like NSF Teacher Enhancement projects). At the same time, the Eisenhower projects are smaller, and very few multi-year awards are made. In addition, Eisenhower-supported projects are not typically designed to be national demonstrations, as is usually the case with NSF projects. As a consequence, Eisenhower grant competitions attract a different mix of prospective project directors, many of whom are faculty in smaller, regional institutions with a strong service orientation and no track record (or interest) in nationally oriented research and demonstration work.

The Program Expands the Array of Professional Development Opportunities

The net effect of the program on professional development is to stimulate or promote a broad array of opportunities for mathematics and science teachers that would be unlikely to have been there without the program.

Taken together, these opportunities fulfill many of the requirements for sound professional development. Across the majority of the activities supported by the program, large numbers of teachers are becoming aware of new developments in their respective fields, are gaining exposure to appropriate pedagogy, and are making contact with other teachers struggling with the same issues. What is more, in a smaller proportion of cases (fewer than half of all districts, although a majority of higher education projects), Title II/Eisenhower-supported activities are designed with sufficient intensity, follow-up, and school support to make transfer to practice likely.

The requirements for sound professional development are not consistently met in all districts or higher education projects funded by the Title II/Eisenhower program. For

example, program-supported activities in LEAs are typically not focused on deeper learning of content. Especially in districts with unfocused improvement agendas, workshops supported by program funds are often short, one-time experiences that bear little relationship to long-term, locally developed improvement plans. The flexible, decentralized nature of the program permits such an outcome, alongside the higher-quality professional development found in other settings.

The Program Supports Leadership But Does Not Create It

As the findings summarized in this report have demonstrated, the Title II/ Eisenhower program derives much of its power and usefulness from the context of reform that surrounds it. The program came into being at a time of intense activity aimed at reforming not only science and mathematics education, but also many other aspects of the educational system. Across the lifetime of the program, reform activity has intensified in various arenas—among them, teaching and learning in many subject areas, the professionalization of teachers, and the restructuring of schooling, to name a few. These activities have been carried forward both by national movements and by initiatives originating within states, which have increasingly become the center of gravity for educational change efforts.

By itself, the program does not provide direction for these reform efforts, but it does offer a key resource for implementing reform ideas on a wide scale. It does so by putting flexible funds in the hands of leaders within school districts, intermediate agencies, higher education institutions, and state agencies. As noted earlier, the program is especially likely to do so with leaders who have expertise in mathematics and science curriculum. Thus, for example, districts with an already developed agenda for improving the target subject areas tend to make excellent use of the program's funds; others show less sign of using the resources effectively.

To be sure, the program includes mechanisms that encourage the focusing of funds on priority needs: state agencies are required to do needs assessments every three years as a condition of receiving the funds from the federal government, and they must also describe, in general terms, the types of activity they will fund. In applying for annual flow-through dollars, local education agencies must now indicate their curricular and training needs and how they will determine whether these needs are met. IHEs must submit grant proposals with objectives, plans of operation, and the means for evaluating their activities, in response to state agency RFPs, which can be designed to emphasize specific goals. In practice, these measures encourage conformity with important improvement needs but only at a global level. For example, in many states, district activities and IHE projects have concentrated on elementary science and mathematics in accordance with state priorities. But at a more operational level, the mechanisms built into the program do little to ensure that the use of funds is guided by a vision of improving practice, along the lines currently advocated by a number of professional societies and others.

The Program Provides a Necessary But Not Sufficient Resource for Promoting Sustained Change in Teaching Practice

The program offers a modest amount of funding for professional development on a wide scale, much of it low-intensity training or activities such as professional conferences. These resources are necessary to the success of reform efforts in various ways. First, the program addresses a function critical to the success of reforms—professional development—that is often given short shrift in local budgeting. The National Study encountered school districts in which Title II/Eisenhower program funds were the **only** source of support for mathematics and science related professional development. Second, the funding supports awareness building and a sense of rejuvenation among large numbers of mathematics and science teachers at all levels of K-12 schooling—so large, in fact, that across a five-year period it is possible for the program to reach virtually all such teachers in the nation. Building interest and awareness of reform ideas is a necessary first step in the widespread adoption of new approaches to mathematics and science teaching. Third, the program provides the option to virtually all districts and a sizable fraction of IHEs to mount the more intensive forms of training—institutes with extensive follow-up, multiple-session formats during the school year, among others—that are widely seen as essential to changing classroom practice. The program makes these forms of training available in many regions of the country—especially areas that were unlikely to have **any** intensive training opportunities for mathematics and science teachers before the program began.

But what the program offers will not—and cannot—revolutionize classroom practice on its own. For one thing, by themselves, Title II/Eisenhower funds are insufficient to support fully even the current array of training activities that benefit from the funds—typically, the program pays for part of a training event; other sources of funding or in-kind contributions pick up the rest. For another, intensive training experiences are needed on a wider scale than this program alone can support. Finally, and perhaps most important, good professional development is only one of many things that must change for mathematics and science education to improve—facilities, curriculum, teacher salaries, and assessment procedures must also change, and these lie beyond the scope of this program.

The Program and Its Future

The National Study began at the time Title II had just been reauthorized as the Eisenhower program. Now, the results are becoming available a year or two before a new set of reauthorization questions are likely to be raised at the federal level. The study's findings have important implications for reauthorization, or for other changes in the program's operation.

Summarizing across all the findings and analyses presented in the report, the study team has arrived at three broad conclusions:

(1) The three-part strategy that is central to the Eisenhower state and local grants program (investing in activities by states, districts, and institutions of higher education) is an important source of the program's strength and should be continued.

(2) Careful consideration should be given to allocating the program's resources somewhat differently among the components.

(3) A variety of additional leadership activities at the federal, state and local levels would help to improve the program.

Each of these ideas is further elaborated below.

Maintain the Three-Component Strategy

The components of the program serve somewhat different, but complementary functions. The district funds typically support short-term training that is closely aligned with local strategies for education improvement (such as the adoption of a new curriculum). The higher education projects support substantially longer, more intensive projects that are badly needed if teachers are to significantly change classroom practices. State leadership activities help translate the growing number and variety of state mandates (that tell schools and districts what they "should" do) into actions that have a reasonable chance of success.

All three kinds of investments in time and energy are necessary to support change in classroom practices. The three-component strategy provides support for a wide range of such activities, based in various institutions.

Change the Balance of Funding to the Three Components

Although it makes good sense to divide the Eisenhower funds among the three components, the balance of funding among the three is not optimal. In fact, the changes during the recent reauthorization run nearly counter to the directions suggested by evidence from the National Study.

The Eisenhower version of the program greatly increased the percentage of funding (and the amounts) that have gone to LEAs as flow-through funds, slightly reduced the percentage available to IHEs through grants (although the actual amount remained nearly the same because of an overall funding increase from 1988-89 to 1989-90), and substantially reduced the amounts and percentage of funding for state agencies of elementary and secondary education (SEAs). (The changes can be seen in Exhibit 2 earlier in the report, showing the funding by component for each year of the program.)

These changes may have been supported by attractive rhetoric (e.g., keep the funds closest to the child) and were certainly politically palatable (providing more funds for 15,000 districts as opposed to 50 state agencies or 3,000 institutions of higher education).

But the net effect is to shortchange the parts of the program providing the greatest subject-area leadership and most intensive experiences for teachers, while increasing funds for the most diffuse parts of the program. More specifically,

- The component of the program (LEA flow-through funding) offering the lowest-intensity training and the widest variety in quality of offerings now receives the lion's share of the resources—nearly two-thirds of all Eisenhower program funds. The district funds are very important—but the "return on investment" appears to be more mixed than in the other components of the program.

- The component of the program (state agency set-asides) with the greatest potential to assist states in providing subject-specific leadership was greatly curtailed. What is more, the agency with the greatest curricular expertise and knowledge of elementary and secondary systems—the SEA—took the greatest cut. In light of what has been learned about many SEAs' activities during the first four years of the program, the logic of this change seems flawed.

- Finally, the component (higher education projects) that, on average, provides the longest, most intensive experiences for teachers, received a slight decrease in funding under the reauthorization.

The thrust of analysis in this report points to reversing the priorities or, at the least, altering them in subsequent allocation formulas so that a better balance is struck between leadership (especially state leadership), intensive training (mostly through IHE projects), and generally nonintensive discretionary resources put at the disposal of LEAs. The results of the National Study do not point to any precise formula; a variety of allocation percentages would achieve the desired result, but capping the LEAs' share at roughly 50% of the overall amount of funds and splitting the remainder at 30% for IHE grants and 20% for state-initiated leadership activities represents one possible change.

Strengthen Leadership Activities at the Federal, State, and Local Levels

As currently authorized, the program is relatively simple to administer, and requirements are not considered burdensome. This simplicity in the law was motivated in part by a desire to encourage state and local flexibility in the use of program funds. The National Study confirms that this effect has been achieved, and that it is a strength of the program. Additional leadership and direction need not involve extensive regulation or requirements under law; much can be done by exhortation and by dissemination of information and suggestions.

One change in the law would permit a wider range of nonprofit institutions (e.g., science museums, professional associations) to compete for grants under the "higher education" component of the program. Because many of these institutions are increasingly expert in matters of teacher training and have established close relationships with school districts, they are in a position to take the lead, with or without IHEs, on

professional development activities. It seems unnecessary to exclude them as potential direct grant recipients as is now the case under the Eisenhower program.

Additional recommendations for leadership activities are shown in Exhibit 10.

What Should Not or Cannot Be Changed

It is tempting to seek changes that will tighten requirements of the program. Some new requirements may be needed, but on the whole the study found the current structure of the program to be working effectively. Furthermore, some types of requirements—such as the three highlighted below—can be counterproductive.

Do not strengthen the evaluation requirements under the program. The study affirms a widespread impression that evaluation under Title II/ Eisenhower is generally weak, and descriptive reporting is inconsistent (or simply missing) across states and localities. It is tempting to put stricter evaluation requirements into the law—for example, requirements that would require LEAs to submit better annual evaluation data to state agencies. Evidence from the study suggests that this would be an exercise in futility. Other than having workshop participants systematically filling out end-of-session forms, which tell relatively little about many important impacts of the program, there is no convenient or widely understood way of assessing the enormously varied range of activities supported, nor of getting at the subtle and complex effects of professional development on classroom and student outcomes, not to mention the various forms of institutional impact. Users of the funds tend to view evaluation and reporting as necessary (to the extent it is required) but a counterproductive use of their time. Given the complexity of the evaluation tasks, combined with the small scale of the activities that are typically supported, more elaborate and formal evaluation seems unjustified and is likely to produce little of value to state agencies or to the federal government.

Do not broaden the range of targeted subject areas beyond mathematics and science. In the earlier version of the Title II program, foreign languages and computer education were also included, although relatively few of the program's resources went to these subject areas. It is always a possibility that the program will become a more broadly focused staff development initiative (in fact, this proposal was among the Department of Education's recommendations several years ago). However, the findings reported here suggest that one of the most powerful features of the current program structure is the fact that it targets resources exclusively on mathematics and science education. By retaining this focus, the program guarantees that these subject areas receive attention, and that they are not treated in a trade-off relationship with all other areas of the curriculum in competition for staff development resources. Given the importance attached to these subject areas in current reform thinking, that targeting seems important to maintain. In addition, other subject areas that might be included may have been targeted by other federal programs (e.g., Title II, Part B, of the Hawkins-Stafford Amendments, which aims at foreign language education).

Exhibit 10

RECOMMENDATIONS FOR LEADERSHIP ACTIVITIES TO IMPROVE THE EISENHOWER PROGRAM

FEDERAL

1. ED should continue to support such leadership activities as national conferences of state coordinators, a national steering committee for the program, and publication of exemplary projects.
2. ED should clarify its nonregulatory guidance so all states understand what they can do—e.g., whether materials, supplies, and equipment can be purchased as part of teacher training. (Note that the study found that "greater regulatory clarity" was desired by many SEAs and SAHEs.)
3. ED should encourage states to ask or require that LEAs focus more of their funds on longer-duration training.
4. ED should encourage state agencies to use some of their funds to provide leadership activities for preservice education. Even if only a few low-cost activities are supported (such as state conferences for IHEs engaged in preservice education), such efforts can be important.
5. ED should continue to work on and improve guidelines for collecting uniform data from states and localities about activities supported by the program—but should focus on a relatively small core of basic data.
6. Federal agencies (including ED and NSF) should strengthen efforts to disseminate information about teacher education (both preservice and inservice) in science and mathematics to such key state leaders as science and mathematics supervisors.
7. ED should compile and disseminate descriptions of exemplary uses of Eisenhower flow-through funds that address the needs of groups historically underrepresented in mathematics and science programs.

STATE

1. SEAs should encourage LEAs to target funds more than in the past (i.e., to spend more dollars per teacher who participates), even at the cost of serving fewer teachers.
2. SAHEs should consider targeting at least a portion of higher education funds through their grant announcement (as some states now do). Focusing on underrepresented groups, or on particular grades or subjects, is a significant way to implement state priorities.
3. SEAs, in cooperation with SAHEs, should play a stronger role in annually disseminating information to LEAs (and ultimately to teachers) about a wide variety of teacher training opportunities available in the state, notably during the summer. Agencies could also use this information (gathered from NSF, private foundations, and other sources) to help develop long-term state plans for staff development in science and mathematics.
4. State agencies should consider using a portion of the program funds to support leadership activities (such as state conferences) to improve *preservice* teacher education in mathematics and science.

LOCAL

1. LEAs should focus at least some program funds each year on "high-intensity" training (e.g., graduate credit courses, inservice training lasting five days or more) and accept the implication that fewer teachers will be served.
2. LEAs should aim to have a "strong agenda" for improving science and mathematics. This means being clear about priorities and developing a multi-year plan to implement them. There are difficult problems to confront in this process, such as what to do about underqualified teachers who are reluctant to volunteer for professional development activities.
3. LEAs should play an active role in distributing information to teachers each year about the availability of summer workshops and other training opportunities. Teachers sometimes complain of announcements being "lost" at the district or the building level.

Do not impose more elaborate planning requirements. Perhaps most tempting of all, federal and state education agencies might insist on more detailed planning for the use of the funds than is currently the case, especially for LEAs. After all, the evidence is plain that many districts do not have focused improvement plans in place and, as a consequence, are less able to put Eisenhower funds to good use. The study's findings give little hope that more stringent planning requirements would change districts' behavior much. Even with recent increases in funding, the Eisenhower program is perceived as too small to warrant an elaborate planning process in its own right. The districts with focused improvement agendas have generally developed their plans with a larger frame of reference in mind than the use of Eisenhower funds per se. The best hope for encouraging more districts to do the same is to maximize the spread of reform ideas through the variety of leadership activities described above. Imposing elaborate planning requirements governing a small amount of money that partially funds improvement activities will most likely lead local administrators to resist, ignore, or comply in a pro forma manner. Conceivably, districts could be asked to demonstrate that they have a larger improvement plan in place into which Eisenhower funds fit, as a prerequisite for receiving flow-through dollars. But such a requirement presumes that local planners have a clear picture of what needs to change and how to do it.

In the final analysis, the federal government should recognize the trade-offs that exist between top-down control of the program and initiative from below. The Title II/ Eisenhower program appears to have struck a good balance between the two. As a consequence, the federal government should accept the mixed quality of LEA-sponsored professional development and the generally low intensity of training that characterizes much of what is supported by the program. But these facts are more than offset by the benefits of wide-scale awareness building, teacher rejuvenation, increased subject-area leadership, and the strengthening of connections among those who wish to improve mathematics and science education. Over time, these changes will provide the foundation for new visions of mathematics and science education to become a part of widespread practice.

Appendix

STUDY METHODS

Data collection took place during the fall and winter of the 1989-90 school year, but referred primarily to the fourth year of the program (the 1988-89 school year). The final data set includes mail survey responses from approximately 2,000 individuals, representing a wide variety of institutions, as well as interviews with more than 300 individuals. More than 100 teachers were interviewed as part of the study.

The study design included four mail survey samples, each with a response rate above 75%:

- A survey of 1,600 local education agencies (LEAs). This stratified random sample included LEAs that have received Title II/Eisenhower funds directly, others that received services through intermediate units (such as Education Service Centers), and some LEAs that did not participate in the program at all.
- A survey of about 700 directors of higher education projects that were funded by the state agencies for higher education during the 1987-88 or 1988-89 school years.
- A survey of all 50 state education agencies for elementary and secondary education, as well as the District of Columbia.
- A separate survey of all state agencies for higher education.

In addition, a sample of seven states representing a wide range of conditions was selected for intensive study. Interviews were conducted with state agency personnel in the SEAs and the SAHEs in each of these states (Arkansas, California, Iowa, New York, North Carolina, Vermont, and Wyoming).

- Within these 7 states, site visits were made to a total of 18 school districts and 7 intermediate units (serving LEAs), selected to represent a wide range of conditions.
- A similar set of site visits was made to 21 higher education projects in the intensive-study states. Several of these projects were located in museums and other nonprofit institutions, as authorized under the law.

Readers desiring further technical detail on study design, data collection, or analysis are referred to the Methodological Appendix of the full Technical Report, a companion volume bearing the same overall title as this Summary Report.