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ABSTRACT

The Urban Mathematics Collaborative (UMC) project has the goal of contributing to the improvement of mathematics education in the inner-city schools by identifying models to enhance the professional lives of teachers and encouraging the entry of high school mathematics teachers into a larger mathematics community including mathematicians from higher education and industry. This document is a 5-year site report on the Philadelphia Math Science Collaborative from its inception in 1985 through June 1990. The intent is to reflect on the development of the collaborative, noting the changes that have taken place in regard to the context in the collaborative operated, the collaborative's management structure, and the focus of its activities. This final site report addresses the major influences exerted on the collaborative and the directions the collaborative has taken. Some conclusions are reached regarding both the collaborative's development and achievements in light of its specific goals as well as the goals of the total UMC project. (MDH)

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PHILADELPHIA MATH SCIENCE COLLABORATIVE

FIVE-YEAR SITE REPORT

A Final Report to the Ford Foundation on the Urban Mathematics Collaborative (UMC) Project

Norman L. Webb, Susan D. Pittelman, Thomas A. Romberg, Allan J. Pitman, Edel M. Reilly, and James A. Middleton

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Report from the
Urban Mathematics Collaborative Documentation Project

Wisconsin Center for Education Research
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Madison, Wisconsin

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I. INTRODUCTION

This document is a five-year Site Report on the Philadelphia Math Science Collaborative, from its inception in 1985 through June 1990. The intent is to reflect on the development of the collaborative, noting the changes that have taken place in regard to the context in which the collaborative operated, the collaborative's management structure, and the focus of its activities. It is not the intent of this report to review the development of the collaborative; this has been done in the annual reports. This final Site Report addresses the major influences exerted on the collaborative and the directions the collaborative has taken. Some conclusions are reached regarding both the collaborative's development and achievements in light of its specific goals as well as the goals of the total Urban Mathematics Collaborative project.

The Urban Mathematics Collaborative Project

In 1984, the Ford Foundation initiated the Urban Mathematics Collaborative (UMC) project to improve mathematics education in inner city schools and to identify new models for meeting the on-going professional needs of teachers. In February, 1985, the Foundation awarded five grants to establish urban mathematics collaboratives in Cleveland, Minneapolis-St. Paul, Los Angeles, Philadelphia, and San Francisco. In addition, the Ford Foundation established a Documentation Project at the University of Wisconsin-Madison to chronicle the development of the new collaboratives and a Technical Assistance Project (TAP) at the Education Development Center (EDC) to serve as a source of information for the collaborative projects (Romberg & Pitman, 1985). During the next 18 months, UMC projects were funded in Durham, Pittsburgh, San Diego, St. Louis, Memphis, and New Orleans, for a total of eleven collaboratives (Webb, Pittelman, Romberg, Pitman, Fadell, & Middleton, 1989). In August, 1987, an Outreach Project was funded at EDC to publicize and expand the UMC effort. In August of 1989, the Ford Foundation awarded replication grants to three additional sites: Dayton, Ohio; Columbus, Georgia; and Milwaukee, Wisconsin. In April, 1991, the fifteenth and final collaborative, the Greater Worcester Urban Mathematics Collaborative, was established in Massachusetts. A map indicating the location of UMC projects is presented in Figure 1.

The
Urban Mathematics Collaborative Project

Funded by The Ford Foundation

- **Cleveland Collaborative for Mathematics Education (C^2ME)**
  Cleveland, Ohio
- **Durham Collaborative: The Durham Mathematics Council**
  Durham, North Carolina
- **Los Angeles Urban Mathematics/Science/Technology Collaborative (LAUM/S/TC)**
  Los Angeles, California
- **Memphis Urban Mathematics Collaborative**
  Memphis, Tennessee
- **New Orleans Mathematics Collaborative (NOMC)**
  New Orleans, Louisiana
- **Philadelphia Math Science Collaborative**
  Philadelphia, Pennsylvania
- **Pittsburgh Mathematics Collaborative**
  Pittsburg, Pennsylvania
- **St. Louis Urban Mathematics Collaborative**
  St. Louis, Missouri
- **San Diego Urban Mathematics Collaborative**
  San Diego, California
- **San Francisco Mathematics Collaborative**
  San Francisco, California
- **Twin Cities Urban Mathematics Collaborative**
  Minneapolis-St. Paul, Minnesota

Replication Sites

- **Columbus Regional Mathematics Collaborative (CRMC)**
  Columbus, Georgia
- **Dayton-Montgomery County Public Education Fund Mathematics Collaborative**
  Dayton, Ohio
- **Greater Worcester Urban Mathematics Collaborative**
  Worcester, Massachusetts
- **Milwaukee Metropolitan Mathematics Collaborative (M^3C)**
  Milwaukee, Wisconsin

Figure 1. The National Network of Urban Mathematics Collaboratives.

During the period covered in this Site Report mathematics education in the United States has changed. When the Ford Foundation initiated the UMC project in 1984, a consolidated effort to reform mathematics had not yet begun, although the potential of the mathematics education community for achieving reform was envisioned. In this regard, the UMC project was innovative in mobilizing a group of inner-city teachers to increase both their sense of professionalism and their connections with mathematicians in the business community and in higher education. Between 1985 and 1990, mathematics education in this country changed dramatically. In an effort to develop a new mandate based on such studies as *Renewing United States Mathematics: Critical Resource for the Future* (Commission on Physical Sciences, Mathematics, and Resources 1984) and *A Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence in Education, 1983), the Mathematical Sciences Education Board in 1989 issued *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* and the National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards for School Mathematics*. As the collaboratives matured, the movement to change mathematics education in the country took on momentum, creating a new environment for the collaborative network. What began as a project designed to enhance the professional development of urban teachers evolved into a catalyst for the reform of mathematics education.

At each site, the UMC project supports collaboration among school mathematics teachers and between teachers and mathematicians from institutions of higher education and industry; it also encourages teacher membership and participation in a broad-based local mathematics community. Although the guiding principle behind the UMC effort is that the teacher is and will remain at the hub of the educational process, it has become evident that many teachers--and especially those in inner-city schools--are overworked; lack support and material resources; and are isolated from their colleagues, from other professionals, and from the rapidly changing field of mathematics. Thus, the focus of the UMC project remains rooted in the premise that collegiality among professional mathematicians can reduce teachers' sense of isolation, foster their professional enthusiasm, expose them to a vast array of new developments and trends in mathematics, and encourage innovation in classroom teaching.

Structure of the Five-Year Summary

The Five-Year Summary presented in the following chapter is comprised of six sections. The first section provides a brief overview of the collaborative. In the second section, the purpose of the collaborative is presented, as stated in its proposals to the Ford Foundation. The goals outlined in the collaborative's final request for funds to the Ford Foundation are contrasted with those specified in its initial proposal. The third section discusses the context within which the collaborative operated and how this has remained stable or has changed over the five-year period. Topics addressed in this section include demographic information on the surrounding community, changes in school district administration and enrollment and in the teacher population targeted by the collaborative, and significant changes occurring in mathematics and in the professional environment. The fourth section of the report describes the management structure adopted by the collaborative and how this changed over the five-year period. The fifth section covers the collaborative's activities in relation to four major themes that emerged from the documentation process as dominant in most collaboratives: socialization and networking, increased knowledge of mathematics content, teacher professionalism, and teacher leadership. These themes are used as a focus to organize ideas and to reflect on the collaborative's development with respect to some overriding expectations of the UMC project. The sixth and final section presents the reflections of Documentation Project staff on the approach the collaborative took to achieve its goals and the perceived outcomes in the areas of collaboration, professionalism, and mathematics focus.

The information presented in the Site Report is both a condensation and synthesis of information collected over the span of the UMC Documentation Project. Data were collected through monthly reports, the electronic network, four large-scale surveys, two demographic surveys, site visits, and case studies. These data-collection instruments and procedures are described in detail in the *UMC Guide to Documentation* (Pittelman, Webb, Fadell, Romberg, Pitman, & Sapienza, 1991). Detailed information about the Urban Mathematics Collaborative project is presented in six annual reports, four technical reports, and a set of case studies prepared by the Documentation Project. All of these reports are listed in the References. The Site Reports, which offer a retrospective summary of each collaborative's efforts over the grant period, have not been reviewed by

collaborative personnel and thus present the reflections solely of the Documentation Project staff.

II. FIVE-YEAR SUMMARY

A. Overview

The Philadelphia Math Science Collaborative was one of the first collaboratives to be formed. Hosted by the Franklin Institute and established within a rich array of other programs in the Philadelphia area, the collaborative's initial efforts were shaky. After one year, it was restructured with the help of the Ford Foundation to target only six high schools, to clarify its relationship to the other activities available to teachers, and to encompass science as well as mathematics. Reorganized in 1986-87, the Philadelphia Math Science Collaborative has each year increased the number of high schools targeted until 1989-90 when the total reached 20. Thus, the collaborative involved nearly two thirds of the 33 high schools and approximately 450 mathematics and science teachers in the School District of Philadelphia during its initial funding period. Near the end of the five-year period, the collaborative transferred from its home at the Franklin Institute to a new host agency, PATHS/PRISM (Philadelphia Alliance for Teaching Humanities in the Schools/ Philadelphia Renaissance in Science and Mathematics).

Beginning in its second year, the coordinator was a major force behind the collaborative's activities, determining its course under the guidance of the director. As collaborative coordinator, one of her primary roles was that of an in-school collaborator, meeting regularly with individual teachers, assessing their needs, and then trying to develop activities around those needs. In 1989, the collaborative was transferred to PATHS/PRISM and a new coordinator was appointed. At this point, the Program Planning Committee, which consisted of department heads and teachers from targeted schools, assumed more responsibility for collaborative planning. Over the years, the collaborative developed a variety of programs, including the Professional Enrichment Grants program to cover conference expenses for teachers; networks to enhance communication among Mathematics in Applications teachers and among users of the *Geometric Supposer* software; luncheon meetings for department heads and teachers; and after-school programs and receptions. One school received assistance in developing lunch-time seminars for students. The collaborative also sponsored workshops on relevant topics, including new software, and facilitated the distribution of software to teachers. It published a monthly newsletter and assumed major responsibility for organizing and

conducting the Annual Mathematics, Science, and Technology Conference, first held in September, 1989. In addition, the collaborative paid teachers' dues to the local mathematics and science teachers' professional organizations. At the end of the reporting period, the collaborative was planning a teacher center.

Although operating in an environment already rich with professional development opportunities, the Philadelphia Math Science Collaborative was able to make an impact on teachers, on departments, and on the district as a whole. Serving as a clearinghouse, the collaborative kept teachers informed of the many opportunities and grants available to them and encouraged some mathematics and science teachers to become more professionally active by attending professional meetings, making presentations, and becoming more aware of national trends and reform. By nurturing the use of technology, the collaborative introduced an increasing number of teachers to the use of computers and calculators with their students. Individual teachers were urged to assume more leadership and take the initiative in organizing programs for other teachers. The influence of the collaborative also extended to school mathematics and science departments, which met with each other and discussed the relationship between the curriculum in the two areas. Some departments organized a series of presentations at their regularly scheduled meetings. Recognition of the collaborative as a major force at the district level came when it was asked to help organize the Mathematics Science and Technology Conference. In retrospect, the impact of the collaborative was greatest among the teachers. Persons from higher education and business were occasionally used as resources and participated on the governing committees, but they did not work closely with teachers over any extended period of time. At the end of five years, the collaborative had touched on many aspects of the mathematics and science program in the School District of Philadelphia and the direction of the collaborative was shifting to take advantage of energized teachers willing to work toward systemic change.

B. Purpose

The stated purposes of the Philadelphia collaborative changed over five years, reflecting the change in collaborative administration. In its first statement of purpose, the goals of the collaborative were directed toward improving teachers' effectiveness in the classroom and activities were designed to: promote collegiality among school teachers and

other practicing mathematicians; upgrade teaching skills; share information; promote a more professional feeling on the part of teachers; and establish mathematics department leadership. The statement of purpose, which had been written primarily by the collaborative director and a staff member of the Franklin Institute, conveyed the idea that the collaborative was to be created *for* teachers rather than as a cooperative effort *with* teachers.

When the collaborative was reorganized during its second year, the statement of purpose indicated a different focus. Influenced by the new coordinator, who was a mathematics teacher and department head, the collaborative goals shifted to promoting teacher leadership and team building a d to contributing to an understanding of mathematics teaching for the future. In the new statement of purpose, teachers were envisioned not as objects of change, but as instrumental in deciding what the change should be. The revised goals included: increasing teacher participation in professional development activities by forming partnerships between teachers and those in academia and industry; creating opportunities to enhance teachers' knowledge and skills; and helping teachers gain new ideas for mathematics instruction through the use of technology and by combining the teaching of mathematics and science. Also included was the creation of a position of in-school collaborator to serve as a catalyst for change. One unique feature of this stated purpose was that it called for documenting and evaluating the impact of the in-school collaborator and the collaborative programs on the quality of teachers' professional lives. The collaborative took responsibility for this documentation over a two-year period.

In the final proposal to the Ford Foundation, the collaborative's stated purpose changed once again when the responsibility for the collaborative was shifted from the Franklin Institute to PATHS/PRISM. This statement of purpose, which eliminated the in-school collaborator position in favor of stressing teacher leadership and team building, included a focus on a cohesive vision of mathematics teaching for the future. The collaborative goals, succinctly stated, were to: foster communication among teachers; serve as a catalyst for innovation and change; and increase teacher participation in professional development experiences. Thus, whereas the initial concept of the collaborative was to improve teacher effectiveness, its goals evolved so that the efforts of the collaborative were directed at promoting teacher leadership that would in turn lead to innovation and change. This transformation in thinking reflected both the increased involvement of

teachers in the decision-making process for the collaborative and the collaborative's five years of experience in increasing the professional involvement of teachers.

C. Context

From 1985 to 1990, the population of Philadelphia has remained close to 1,700,000 although the enrollment in the School District of Philadelphia, the fifth largest in the country, declined by 4 percent from 198,000 in 1985 to 189,511 in the 1989-90 school year. Thirty-one percent of the students eligible to attend public schools attended private or parochial schools in 1989-90. Over the five-year period, the proportion of white students enrolled in the district declined from 27 percent to 23 percent. In 1989-90, the ethnic composition of the student population was 63 percent black, 23 percent white, 10 percent Spanish-Hispanic, and 4 percent Asian. Forty percent of the students came from families receiving AFDC and three percent of the 1990 high school population spoke English as a second language. In 1989-90, the annual dropout rate for high school students in the district was 17 percent.

A seven-member school board oversees the district's expenditures, which in 1989-90 totaled $1,083,083,800. Nearly 58 percent of the district's expenditures come from state funds, about 40 percent from local funding, and 2 percent from federal funding. In April, 1990, when Dr. Constance E. Clayton was serving her seventh year as the superintendent of the School District of Philadelphia, the Board of Education adopted a series of five-year goals, including objectives to reduce the dropout rate, raise test scores, and improve student attendance. In 1989-90, the district was comprised of 254 schools: 30 senior high schools, 39 middle schools, 172 elementary schools, and 13 other schools. In 1986-87, the collaborative targeted the mathematics and science teachers in 6 high schools for participation and by 1989-90 had expanded the number of targeted high schools to 20. From these schools, the Philadelphia Math Science Collaborative achieved a membership of approximately 250 mathematics teachers and 200 science teachers.

In the 1989-90 school year, the district employed 9,758 teachers, an increase of 7 percent from the 9,069 teachers employed in 1985. Of a total of 2.478 high school teachers, 69 percent were white, 29 percent black, and 2 percent from Spanish-Hispanic, Asian, and American Indian ethnic groups. In 1989-90, there were 332 mathematics

teachers in the high schools, all of whom had tenure. Teachers are represented by the Philadelphia Federation of Teachers. Beginning in September, 1988, a newly negotiated four-year contract limited teachers to 20 hours of staff development and departmental meeting time during the year and prohibited department meetings and staff development sessions during school hours. The new contract made Philadelphia teachers among the highest paid urban school teachers in the nation. The starting salary for a teacher with a bachelor's degree was $22,000 in 1989-90 for a 185-day school year; the average teacher salary was $36,800.

The district employed a Director of Mathematics until the position was eliminated along with 54 other administrative jobs in July, 1989, as the result of a district reorganization prompted by revenue shortfall. The individual divisions of mathematics education, science, and other content areas were consolidated into a unified office of curriculum. Similarly, the curriculum directors in each of the seven K-12 school subdistricts were replaced by supervisors. Prior to the reorganization of district administration, the Secondary School Mathematics Curriculum Committee (SSMCC) comprised of administrators, instructional leaders, mathematics teachers, and mathematics educators met four times each year to review and make recommendations regarding the objectives, content, instructional support, and articulation among mathematics courses.

The standard mathematics courses are General Mathematics I and II, Algebra I and II, Geometry, Elementary Functions, Calculus, and Mathematics in Applications. The latter course was developed in 1985 when the state instituted a third-year mathematics requirement for graduation. In 1988-89, 87 percent of the 46,629 high school students were enrolled in mathematics classes. Of the 14,564 ninth-grade students, 9,340 took algebra and 5,224 took general mathematics. Only 62 percent of the algebra students and only 48 percent of the general mathematics students passed. District guidelines for determining final grades were implemented beginning in 1986-87: Grades were to be based 60 percent on teacher-developed tests, 10 percent on city-wide midterm and final examinations, 15 percent on classwork, and 15 percent on homework assignments.

The Philadelphia area provides an enriched environment of opportunities for mathematics and science teachers. The Philadelphia Alliance for Teaching Humanities in the Schools (PATHS) and the Philadelphia Renaissance in Science and Mathematics (PRISM) represent the nation's largest, most comprehensive public/private partnership for

staff and curriculum development, serving all K-12 educators in the School District of Philadelphia. PATHS/PRISM directs more than 30 projects in the humanities and sciences each year, including grants programs for teachers and schools, summer institutes, colloquia and special topic symposia, and other professional enrichment programs. Since 1984, more than 9,000 teachers in the district have taken part in these projects. PATHS/PRISM provided mini-grants of $300 to fund individual teachers' school-based projects, and collaborative grants of $3,000 for a team of two or more teachers working together with resource people from area universities, scientific and cultural institutions, and corporations to develop innovative curricula in the arts, humanities, mathematics, and science.

In 1989-90, a $3.7 million grant from NSF and $300,000 from Merck, Sharp, and Dohme funded the Comprehensive Regional Center for Minorities (CRCM), which was created to lay a foundation for increasing minority access to education in careers in the sciences, mathematics, and engineering in the Philadelphia area. Philadelphia was chosen by the American Association for the Advancement of Science (AAAS) as one of six national sites for Phase II of Project 2061, a long-term effort to improve the scientific literacy of the nation's students. PATHS/PRISM is the Philadelphia facilitating agency. A 25-member team was selected to design a curriculum model for science, mathematics, and technology for Grades K-12. The final draft of the model curriculum will be presented to AAAS by the end of June, 1991.

The Philadelphia Teachers in Industry Program (PTIP) provides annual fellowship stipends for mathematics, science, and computer science teachers to make teachers more aware of the relationship of these academic subjects to the corporate world. The Association of Teachers of Mathematics of Philadelphia and Vicinity (ATMOPAV) is very active and sponsors semi-annual meetings and a newsletter.

Throughout the five-year reporting period, Beaver College offered a series of colloquia for the mathematics and science community. During 1989-90, GTE Corporation sponsored a grant program for secondary school science and mathematics teachers in 19 states, including Pennsylvania. The Office of Human Resources of the School District of Philadelphia has expanded the opportunities for teachers to conduct inservice courses for fellow teachers. In the spring of 1989, six Philadelphia teachers (five from the collaborative) were selected by Indiana University of Pennsylvania to participate in an NSF-supported program, Project EXCELS (Expansion of Computer Education in Learning

the Sciences). After attending a three-week training session in the summer of 1989 on the use of computer technology in the classroom, the six teachers and Indiana University faculty represented workshops for Philadelphia mathematics and science teachers in January and February, 1990. In the summer of 1989, Pew Charitable Trusts awarded a three-year $8.3 million grant to evaluate and restructure the public high schools, representing an attempt to initiate major restructuring in the comprehensive high schools.

D. Management Structure

Throughout its development, the Philadelphia Math Science Collaborative operated with a basic organizational structure that provided for a director, a coordinator, and advisory committees. However, the collaborative's history can be separated into three stages, each influenced by a coordinator who had an impact on the direction of the collaborative. During 1985-86, the collaborative experienced great difficulty in establishing itself in an area where many other professional opportunities were already available to area teachers. A reorganization led to the second stage during which the collaborative operated under the tutelage of a coordinator who served as an in-school collaborator for three years. In the third stage, the responsibility for the collaborative shifted from the Franklin Institute to PATHS/PRISM, which again influenced the collaborative's direction.

The initial invitation by the Ford Foundation to establish a collaborative in Philadelphia was made in 1984 through Alex Tobin, who, at the time, was the mathematics supervisor for the Philadelphia Schools. He suggested that the Franklin Institute, one of the foremost science museums in the country, host the project. The Franklin Institute submitted a proposal to the Ford Foundation, and a grant to establish a collaborative was awarded in February, 1985. Wayne Ransom, director of education programs for the Franklin Institute, assumed the position of collaborative director.

The collaborative's difficulty in developing a unique identity among many other existing programs during its first year was exacerbated by the fact that the coordinator lacked the energy and vision necessary to launch a viable program. A related issue was that the Franklin Institute staff members had strong science backgrounds but lacked knowledge of what was needed in mathematics education. The project director from the

Ford Foundation intervened and suggested that the collaborative's proposal for continued funding focus on only a targeted number of schools, address the issue of how the collaborative would relate to the other activities already available in Philadelphia, and reconstitute the collaborative to encompass both science and mathematics. With the approval of this proposal, Sue Stetzer, a district mathematics teacher and department head, was appointed as the coordinator. An agreement was reached with the district and the union for the district to continue to pay Ms. Stetzer's salary while the collaborative paid the salary of a beginning teacher who would fill a vacant teaching position. In this way, the collaborative was able to obtain a coordinator with the level of experience needed to launch its programs effectively within its budget constraints.

During the period 1986 to 1989, the collaborative was strongly influenced by the coordinator's role as an in-school collaborator, which included visiting teachers in their schools and linking them with needed resources and opportunities. Beginning with six targeted high schools and increasing the number by two or three each year, the coordinator was able to give each of the schools and their teachers her personal attention. In 1986-87, an Advisory Council of 18 members was organized; it included teachers from the targeted schools, the district's Director of Mathematics, and representatives from other professional and support organizations, business, higher education, and the Philadelphia Federation of Teachers. The primary function of this group was to advise and offer support to the coordinator. At this time, the collaborative was also linked to PRISM, a component of the Committee to Support Philadelphia Public Schools, through meetings the collaborative director had with the PRISM Board and through the collaborative teachers who served on PRISM advisory groups. PRISM also provided the collaborative with operating funds so that it did not have to do its own fund raising.

In 1987-88, the governing structure changed. The Advisory Council, which had become too large to be effective due to the increase in targeted schools, was replaced by a 14-member Steering Committee comprised mainly of teachers that would establish policy for the collaborative and two working committees, Communications and Program Planning. By the third year, 1988-89, the collaborative reached 13 target high schools. The Communications Committee disbanded because its functions were being served in other ways. Over this middle period of the collaborative's growth, the Franklin Institute bore administrative responsibility for the collaborative. The coordinator was given office

space in the Franklin Institute and was supported by clerical staff from Dr. Ransom's office.

In its third stage of development, the responsibility for the collaborative was transferred from the Franklin Institute to PRISM, which was later administratively united with PATHS to form PATHS/PRISM. During this transition, which began in the 1988-89 school year, a program coordinator from PRISM observed and worked with Ms. Stetzer and the director of PRISM attended the collaborative's Steering Committee meetings. In 1989-90, the administrative responsibility was formally transferred to PRISM and a collaborative coordinator from the PRISM staff was appointed. Clerical help and office space were also provided by PRISM. The former coordinator, who served as a consultant for a time, assumed a position in the district's curriculum office. With the appointment of the new coordinator, Joe Merlino, the governing structure was again modified. The Program Planning Committee was reconstituted to include about 75 science and mathematics teachers who volunteered to attend meetings. No restrictions were placed on who could attend these meetings. Five subcommittees of this group developed plans for the collaborative and drafted the "Report of 1990" that projected a course of action for the coming year. The Steering Committee found it necessary to meet only twice during the school year. Thus, during the initial five years of the collaborative, the organization progressed from a loosely managed organization to one strongly influenced by its coordinator, to one in which teachers comprised the major decision-making group and the coordinator served more as a convener.

The transfer of responsibility for the collaborative from the Franklin Institute to PATHS/PRISM and the change in coordinators have had a major impact on the operation of the collaborative. To a significant extent, these changes reflect the differences in the two host organizations and the mode of operation of the two coordinators. The collaborative, for example, was unique among the programs operated through the Franklin Institute, which generally oriented its programs toward students, both within the museum and as outreach. With its focus on teachers and professionalism, however, the collaborative was on the periphery of the Franklin Institute's mission and consequently held a special status. Because the collaborative was one of a kind, there were very few constraints on its development, which seemed advantageous in its formative years.

On the other hand, the collaborative's effort to develop teacher professionalism closely matched the mission of PATHS/PRISM, with the result that with its transfer to PATHS/PRISM the collaborative joined other programs with similar purposes. As such, the collaborative lost its only-child status and became one of several worthy programs vying for the attention of the PATHS/PRISM administration. PATHS/PRISM was an ideal host agency for the collaborative due to its wide sources of funding, its ability to provide administrative services, and its capability for coordination with other programs. Toward the end of the 1989-90 school year, responsibility for the collaborative's operation was distributed among several PATHS/PRISM staff; one staff member was responsible for the collaborative newsletter, another for preparing materials in preparation for the collaborative meetings, and a third for working with grants and professional development workshops. Currently, the coordinator retains the major responsibility but networks with other staff members to cover all bases.

E. Project Activities

A primary goal of the Philadelphia Math Science Collaborative was to increase teacher participation in the many professional development programs already available in the Philadelphia area. The collaborative publicized the wide array of programs already being offered and encouraged and often funded the participation of secondary mathematics and science teachers in them. Among the professional development opportunities available to Philadelphia teachers were: programs sponsored by PRISM, including Woodrow Wilson Foundation Institutes, the 1986 Summer Institutes, the Academic Coaching Committee, the Secondary Teacher Enrichment Program, the Science Curriculum Forum, the school grant program, grant-writing workshops, the PRISM Grant Fair, the Mathematics Colloquium Series, the Philadelphia Teachers in Industry Program (PTIP), the PATHS/PRISM Colloquium Series, and the HI TECH Talk electronic mail bulletin board and teleconferencing system sponsored by PATHS/PRISM; symposia, workshops, training programs, and conferences sponsored by the School District of Philadelphia, including the Mathematics Leadership Conference, Secondary Mathematics Symposium, a five-week training program on Appleworks Software, workshops on conducting inservice programs, and summer institutes and colloquia series co-sponsored with Beaver College; programs sponsored by the Franklin Institute, including the Annual Teacher Overnight Science Program and the Math Seminar Series; institutes and workshops

offered by Temple University, and lecture series sponsored by Drexel University; programs sponsored by the Wharton Business School of the University of Pennsylvania, including "A Day for High School Mathematics Teachers"; activities offered by the Philadelphia College of Textiles and Science, including the Woodrow Wilson Foundation Statistics Institute and computer workshops; meetings and programs of professional mathematics and science organizations, including ATMOPAV, the Philadelphia Secondary Science Teachers Association (PSST), and the Pennsylvania Council of Teachers of Mathematics (PCTM); programs sponsored by the Philadelphia Federation of Teachers, including the conference "Programs for Teaching"; and activities sponsored by the Engineers Club of Philadelphia and by the Philadelphia Electric Company, including Teacher Energy Tours and conferences.

In addition to encouraging teachers to take advantage of the many professional opportunities already being offered, the collaborative sponsored a variety of activities and programs for mathematics and science teachers in the targeted schools over the five-year period. These programs were designed to increase teacher networking and collegiality, to integrate mathematics and science in the high schools and promote the use of technology in high school mathematics and science classes, to foster teacher professionalism, and to promote teacher leadership and team building. In some instances, these programs were opened to all mathematics and science teachers from the Philadelphia high schools.
In addition to the activities sponsored and promoted by the collaborative, mathematics and science departments in the target schools held many joint meetings and planned some of their own school-based activities. These in-school activities varied in nature and encompassed a variety of content and educational topics.

The activities of the Philadelphia collaborative addressed all four themes that had emerged from the documentation process as being dominant in programming for the collaboratives in general. These themes were: Socialization and Networking, Increased Knowledge of Mathematics Content, Teacher Professionalism, and Teacher Leadership. Socialization and Networking activities, especially prominent in the formative years of the collaboratives, were designed primarily to initiate interaction among teachers and between teachers and mathematicians from business and higher education. These generally large-group activities were important to a collaborative's evolution since they brought members of the mathematics community together, enabled them to get to know one another, and promoted networking. The second theme, Increased Knowledge of Mathematics Content,

encompassed activities designed to provide teachers with mathematics-directed experiences and to increase the knowledge of teachers and others regarding current trends in mathematics and mathematics education. Many of these activities helped to activate the agenda of the mathematics reform movement at the collaborative sites. The third theme, Teacher Professionalism, involved activities structured to enhance teachers' conceptions of teaching as a profession. Collaboratives provided opportunities and incentives for teachers to attend professional organization meetings and made mathematics teachers aware of available grants and other opportunities for professional development. Some collaboratives paid teachers' dues for organization and arranged for teachers to observe other teachers and reflect on their teaching. The fourth theme, Teacher Leadership, had not been identified at the beginning of the UMC project, but gained greater attention as collaboratives found that teachers lacked the skills needed to organize professional efforts, to plan, and to develop the power within their group to generate systemic change. This theme was advanced by the EDC through the UMC Teacher Leadership Workshops which, beginning in the summer of 1989, were attended by from one to four teachers from each of the collaboratives. However, since this training was initiated by EDC rather than by the collaboratives, it is not discussed in the reports of the individual collaborative.

In reflecting on collaborative activities as they related to the four themes, considerable overlap was noted, since most activities served multiple purposes. A single activity may, therefore, be discussed under several headings.

Socialization and Networking

A primary focus of the Philadelphia Math Science Collaborative was to improve communication and exchanges of information among mathematics and science teachers within each school and across the schools, as well as with the science and mathematics communities in the Philadelphia area. Programmatic efforts designed specifically to promote communication and networking included social events, Mathematics in Applications and *Geometric Supposer* Networks, department head meetings, department meetings, and a monthly newsletter. It should be noted that, unlike most other collaboratives, the Philadelphia Math Science Collaborative did not focus its efforts on

attracting representatives from the businesses and higher education communities to its social events.

Social Events

Over the five-year period, the collaborative sponsored several events, including four receptions, a luncheon, and a reunion, to provide mathematics and science teachers with an opportunity to get to know one another as well as to interact with administrators from the school district's mathematics and science departments. In December, 1986, the collaborative sponsored a reception to enable mathematics and science teachers in the six schools originally targeted by the collaborative to meet the school district's director of mathematics and director of science. The 40 teachers who attended the reception appreciated the opportunity to get together with one another as much as the chance to meet the directors. In October, 1989, the collaborative sponsored a similar event to introduce Joseph Merlino, the new coordinator of the collaborative, to the teachers from the 13 target schools. In December, 1986, the collaborative sponsored a dinner reception to welcome seven new schools into the PMSC. Thirty-one teachers attended the event and heard about new projects in the Philadelphia area, including future PATHS/PRISM projects, the Comprehensive Regional Center for Minorities, and Sue Stetzer's new role with the Office of Curriculum Support and the Philadelphia Schools Collaborative. In April, 1986, the collaborative, along with the ATMOPAV, PRISM, PSST, and the Franklin Institute, co-sponsored a reception to celebrate National Science and Technology Week and Mathematics Education Week. The reception, which was attended by approximately 200 K-12 mathematics and science teachers, featured a variety of mathematics and science displays.

In March, 1987, the collaborative sponsored a luncheon for mathematics teachers from the targeted schools and representatives from the district's mathematics departments in conjunction with the school district's Mathematics Leadership Conference. The luncheon provided an opportunity for teachers and administrators to meet, socialize, and discuss common concerns.

In February, 1986, the collaborative, along with the school district and PRIME, co-sponsored a reunion for teachers who had participated in the 1985 Summer Urban Teacher Institute on Mathematics, which the collaborative co-sponsored with PRIME. The teachers had developed strong bonds at the Institute, and the reunion provided an opportunity for them to re-establish connections and find out about the upcoming summer programs. Twenty-four people attended the reunion, including half of the 18 teachers who had participated in the Summer Institute.

Mathematics in Applications Network

During the 1986-87 school year, the collaborative established a network for teachers of Mathematics in Application (MIA), a new third-year nonacademic mathematics course designed to provide sample computer activities and resources to teachers. An important aspect of the network was the publication of ACCESS, a mailing of public domain and teacher-written software, accompanied by topic-related print materials. The initial ACCESS mailing in early 1987 was sent to all high school department heads and all MIA teachers. Teachers were then asked to join the network by returning either a blank disk of software they had created and/or worksheets they had developed. ACCESS materials were disseminated three times during the 1986-87 school year, four times during the 1987-88 school year, and three times during the 1988-89 school year. Topics addressed in the materials included problem solving, the organization of data, spreadsheets, Project Face Lift, application with sub-ordered tasks, probability, income taxes, calculators, introducing statistics, and templates. During the 1987-88 and 1988-89 school years, the ACCESS network had a core of 25 teachers who shared materials and returned disks. The Mathematics in Applications Network was not active during the 1989-90 school year.

Geometric Supposer Network

Following a collaborative-sponsored workshop on the *Geometric Supposer* in April, 1987, teachers from four schools, three target and one non-target high school, expressed interest in piloting the program in their schools and in joining an on-line national network

of *Geometric Supposer* users that was established by the UMC Technical Assistance Project at the Education Development Center (EDC). Using the telecommunications equipment already in their schools, the teachers were able to participate in the network, sharing their ideas and receiving feedback from other teachers using the software program, as well as from developers of the program who were also participating in the electronic network. During the 1987-88 school year, the teachers began to pilot test the *Geometric Supposer* in their schools, and in April, 1988, the pilot teachers met to discuss their problems and successes. In October, 1988, the collaborative hosted another meeting for teachers who were using or interested in using the *Supposer*. The five teachers who attended the meeting agreed to continue to share materials, with the collaborative serving as a conduit for information.

Department Head Meetings

The School District of Philadelphia sponsored periodic meetings for mathematics department heads, including an annual end-of-year luncheon meeting. The meetings provided an opportunity for the department heads to exchange ideas and discuss key issues in a social setting. Many of the department head meetings also featured guest speakers. At the May 1987 luncheon meeting, for example, two teachers reported on the PRISM grants they had received. The meetings also provided the collaborative with an opportunity to communicate with the department heads. At the September 1989 department head meeting, for example, the collaborative administrators discussed the collaborative's role and its plans to offer ATMOPAV memberships to each high school teacher. Over the five-year period, the collaborative hosted four luncheon meetings for the mathematics department heads: an end-of-year luncheon in May, 1987; two luncheons during the 1987-88 school year; and a holiday luncheon in December, 1988. The focus of the January 1988 luncheon was a discussion of the Curriculum and Evaluation Standards for School Mathematics being proposed by the National Council of Teachers of Mathematics. Dr. James Schultz, a professor of mathematics at Ohio State and a member of the Commission who developed the Standards for Grades 5-8, presented an overview and led a discussion regarding their impact. The program for the May 1988 luncheon included a report by district Mathematics Education Director David Williams and a

discussion of the Technology Conference planned for September, 1988, as well as a presentation to honor a retiring department head.

In addition to sponsoring the meetings of all mathematics department heads, the collaborative scheduled a special luncheon meeting for mathematics and science department heads at the nine target schools in May, 1988. At the luncheon, which was attended by 13 department heads and school administrators, the collaborative coordinator and director reviewed the collaborative's activities during the year and previewed the project's future.

Department Meetings

Each mathematics and science department is directed by the school district to hold a monthly meeting. These meetings provide an opportunity for teachers within a department to spend time together and to address important topics and issues related to their content area. The collaborative's impact can clearly be seen in the quality of these monthly department programs. Outside speakers were frequently invited to make presentations, many of them funded by PRISM grants that the collaborative had helped to secure. During the 1986-87 school year, for example, higher education professors and school district personnel spoke at eight department meetings at West Philadelphia High School, addressing problem solving and other current issues in mathematics.

In line with its goal that mathematics and science teachers interact on a more regular basis, the collaborative required target schools to hold at least half of their department meetings jointly. Often these meetings provided the first opportunity for formal interaction between mathematics and science teachers within a school. The in-school collaborator made a concerted effort to attend the joint meetings, where she worked with the teachers on a needs assessment that addressed teachers' participation in collaborative programming and also provided assistance to teachers in developing objectives for the school year. The program focus at joint department meetings, which ranged from a Mathematics in Application course to stoichiometry, is described later in this section under the heading Increased Knowledge of Mathematics Content.

Collaborative Newsletter

In November, 1986, the collaborative initiated the publication of a monthly newsletter that was distributed to all of the mathematics and science teachers in the targeted schools. Copies of the newsletter were also sent to the principles and to mathematics and science department heads of all Philadelphia high schools. By the 1989-90 school year, the circulation of the newsletter had reached nearly 650 people. The newsletter announces upcoming collaborative events, as well as events sponsored by the school district and other organizations in Philadelphia; provides updated information about the collaborative; presents topics of interest to mathematics and science teachers; and serves as a vehicle for teachers to express their views relating to mathematics and science education. The newsletter also serves to keep teachers informed of new classroom resources, including equipment and supplementary materials as they become available, thereby providing an important clearinghouse service to teachers. One issue of the newsletter included a list of outside organizations that will provide speakers for high school mathematics and science classes.

In addition to its own newsletter, the collaborative publishes information in a variety of other newsletters that are distributed to Philadelphia secondary school teachers. These include *Continuum* and *Continuum Update*, published jointly by PATHS and PRISM, and the PSST and ATMOPAV newsletters, as well as the newsletter published by the School District of Philadelphia.

Increased Knowledge of Mathematics Content

One of the primary goals of the collaborative was to increase teacher participation in professional development programs that offer new ideas and opportunities for mathematics instruction. In addition to encouraging teachers to participate in the numerous activities available in the Philadelphia area, the collaborative sponsored several programs of its own, many of which focused on the integration of mathematics and the sciences, the use of technology in mathematics and science instructions, and on topics related to the new Mathematics in Applications course. Collaborative programming included a summer institute; the Mathematics, Science, and Technology Conference;

Meetings of the Software Users Group; a series of after-school programs; workshops on the *Geometric Supposer* and on graphing calculators; and a discussion of a draft of the NCTM Standards. The departmental meetings discussed earlier also provided an opportunity to increase teachers' knowledge of mathematics and mathematics education.

1985 Summer Institute

During the summer of 1985, the collaborative sponsored an intensive four-week summer mathematics program at Drexel University. The Institute, which was jointly sponsored by PRISM, the School District of Philadelphia, PRIME, and Drexel University, was modeled after the Phillips Exeter program. Eighteen mathematics teachers from 11 high schools participated. Although the classes were held at Drexel University and the participants received university credit, the instructors were classroom mathematics teachers.

Mathematics, Science, and Technology Conference

A major theme for the Philadelphia Math Science Collaborative was technology, and the 1989 and 1990 Mathematics, Science, and Technology Conferences offered important opportunities to explore this theme and to increase teachers' knowledge of technology. The first Technology Conference, held in September, 1989, was co-sponsored by the collaborative and the Divisions of Mathematics, Science, and Computer Science and Technology of the School District of Philadelphia. The collaborative served as a catalyst to bring the three divisions together to sponsor the conference, which was an outgrowth of a collaborative-sponsored dinner meeting of science and mathematics educators at which discussion focused on promoting the integration of mathematics, science, and technology. The 1989 conference, which was attended by 240 teachers and administrators, featured keynote speaker James Rafferty, chairman of Cricket Software and one of the foremost graphics software developers in the country. Participants had the opportunity to attend three 75-minute workshops from among 27 different sessions, presented by teachers and other school district personnel, as well as by collaborative staff. Workshop topics included

Appleworks for Science and Math; Lego TC Lego; Leadership Needed to Enhance the Use of Technology in Your School; *Geometric preSupposer* and Telecommunications with the Apple II. At many of the sessions, teachers received software to use in their classrooms. The second Mathematics, Science, and Technology Conference was held in November, 1989, and drew a total of 221 participants. The conference, which was sponsored by the Philadelphia School District and the collaborative, offered 26 workshops on topics ranging from environmental science to interactive videodiscs. One social studies teacher with access via a modem to bulletin boards in this country and in Europe demonstrated how his students communicated with people in other countries. Costs of the conference were underwritten by the Philadelphia School District, Apple Computer, and PATHS/PRISM. Judah Schwartz, creator of the *Geometric Supposer* software and professor at both Harvard and MIT, was the keynote speaker.

Monthly Meetings of Software User Groups

In response to the enthusiasm generated by the Mathematics, Science, and Technology Conference, the collaborative sponsored a monthly series of after-school hands-on workshops on software appropriate to the curriculum. The meetings, which began in November, 1989, were open to all Philadelphia high school teachers and were publicized in the collaborative newsletter as well as through flyers sent to all mathematics and science departments. Presentations at the monthly meetings were conducted by collaborative teachers and staff. Topics of the meetings included LOGO and Problem Solving, Problem-Solving Software for General Mathematics, Graphing Software, Geometry Software including the *Geometric Supposer*, and Telecommunications. Teacher attendance at the six monthly meetings ranged from 5 to 26, with all but one session having a participation of between 5 and 8 teachers.

After-School Programs

During the 1987-88 school year, the collaborative offered four after-school programs to expand teachers' visions of mathematics and science beyond the classroom, and to offer suggestions of new ways to take advantage of educational resources in the

local academic community. The topics of the four programs were: Mathematics in Architecture; Research on Infectious Diseases; a Science Software Review; and Mathematics and Computers, presented by one of the co-creators of the BASIC programming language. Mathematics and/or science teachers and department heads were invited to the four programs, depending on the topic and the availability of space. Participation in the programs ranged from 6 to 27 teachers and administrators.

The Geometric Supposer and Graphing Calculator Workshops

The collaborative offered several workshops and demonstrations of the *Geometric Supposer* software package, which enables students to construct and measure geometric figures. In April, 1987, the collaborative sponsored a session conducted by a representative from Sunburst Communications Company that was attended by 31 high school mathematics teachers and supervisors. As a result of the workshop, teachers in three target schools and one non-target school pilot tested the *Geometric Supposer* in their geometry classes during the 1987-88 school year. During the 1987-88 school year, the collaborative also conducted hands-on workshops of the *Geometric Supposer* during mathematics department meetings at six of the target schools and a presentation for Lincoln High School students as part of the school's celebration of 100 years of American mathematics.

Beginning in spring, 1990, and continuing until the end of the 1989-90 school year, the collaborative offered seven free Graphing Calculator Workshops, each at a different high school. The workshops were designed to provide training for teachers who had never used a graphing calculator. Times and dates were arranged at the mutual convenience of the workshop leaders and participants. The Casio fx-7000 graphing calculator was used as a demonstration tool. The collaborative purchased ten calculators for training purposes and also paid the instructors for their teaching time.

Discussion on the NCTM Standards

In March, 1988, the collaborative and ATMOPAV co-sponsored a discussion on the Curriculum and Evaluation Standards for School Mathematics being proposed by the

National Council of Teachers of Mathematics. All ATMOPAV members, as well as the broader mathematics community in the Philadelphia area, were invited to attend the presentation by David Glatzer, Director of NCTM. After the presentation, the 20 people in attendance met in grade-level discussion groups.

Departmental Meetings

The departmental meetings required by the school district, and the joint meetings of the mathematics and science department required by the collaborative, provided an opportunity for teachers to address a variety of topics and issues. Some mathematics and science departments met to explore a topic of common interest to both disciplines, such as telecommunication, while others directly addressed the issue of interfacing mathematics and science. Frequently, outside speakers were invited to make presentations, including the in-school collaborator Sue Stetzer. Programs at department meetings included a series of eight sessions on the methods, pedagogy, and evaluation of problem solving; Islamic art and the creation of tessellations; a tour of the Mathematics Exhibit of the Franklin Institute; reviews of computer software; demonstrations of the *Geometric Supposer*; Mathematics for the Billions by Dr. Miriam Yevick of Rutgers University; utilizing computers to teach the Mathematics in Application course; spreadsheets; and ACCESS.

Teacher Professionalism

A major focus of the Philadelphia Math Science Collaborative has been on promoting a feeling of professionalism among mathematics and science teachers. To achieve this goal, the collaborative instituted an extensive grant program and also helped teachers to take advantage of grant opportunities available from other organizations, successfully encouraged teachers to become more involved in local professional organizations, held a program that addressed equity, brought teachers and department heads together to evaluate the collaborative's input, and sponsored a dinner meeting for mathematics and science educators to address the integration of science and mathematics instruction.

Grants

An important aspect of the collaborative's focus on increasing the professionalism of Philadelphia teachers was providing grant awards to support teachers' attendance at professional meetings, workshops and seminars, as well as to support innovative and experimental classroom projects. In addition to sponsoring its own grants award program, the collaborative encouraged teachers to apply for grants offered by PRISM and other organizations. The in-school collaborator met with teachers to help them identify and develop program ideas and to arrange technical support for preparing the grant proposals.

Professional Enrichment Grants. Beginning with the 1986-87 school year, the collaborative offered Professional Enrichment Grants (PEGs) of up to $250 to high school mathematics and science teachers in the Philadelphia Public Schools to attend professional meetings and workshops. During 1986-87, nine teachers from target schools and 12 from non-target schools received PEGs; during the 1987-88 school year, the collaborative awarded 38 PEGs, approximately 75 percent of which went to teachers from the target schools, who were given first priority in the application process. During the 1988-89 school year, the value of a PEG was raised to $300, and, for the first time, only collaborative teachers were eligible to apply for the grants. During the 1988-89 and 1989-90 school years, $9,000 was available to fund PEGs, and all teachers who applied received funding. During the 1988-89 school year, the collaborative awarded 44 PEGs. During the 1989-90 school year, a record number of 164 PEGs were awarded, including 95 totaling over $6,000 to teachers to attend either the fall or winter NCTM meeting or the NSTA regional conferences. Programs that teachers attended over the five-year period funded by PEGs included: the 1987 and 1988 Mathematics Leadership Conference sponsored by the School District of Philadelphia; the 1987 and 1989 Annual Meetings of the Philadelphia Council of Teachers of Mathematics; the 1987, 1988, and 1989 Annual Meetings of the National Council of Teachers of Mathematics; the 1988 Annual Meeting of the National Science Teachers Association; the 1987 and 1988 National Education Computing Conference; the Pre-Calculus Conference at Rutgers University in 1988; the ATMOPAV Spring Banquets and Fall Conferences; the Project T.I.M.E. (Teachers Improving Mathematics Education) Conference in California; the College Board Conference; ICASE in Australia; the National Teachers of Biology Association (NTBA) Conference in Chicago; the Science and Technology Conference in Virginia; an Apple

Works Course; the Junior Science Academy in western Pennsylvania; the EPECC (Eastern Pennsylvania Educator Computer Conference) at Valley Forge; the MacIntosh Conference at Valley Forge; the Manhattan College Advanced Placement Course; an Advanced Placement PASCAL Course; the Phillips Exeter Mathematics and Computer Conference; and a Woodrow Wilson Institute.

Post-Conference Workshop Grants. In March, 1990, the collaborative initiated a new grant program, the Post-Conference Workshops (PCWs). The program was created to expand the impact of the PEGs and was designed to multiply the benefits of teachers' professional growth experiences by funding post-conference workshops. Teachers who received PEGs were offered an opportunity to give a presentation on their conference experiences to other teachers in a workshop format. PCWs provide up to $200 per workshop to cover a small stipend for the presenter, refreshments, and classroom materials related to conference activities.

PRISM Grants. PRISM sponsors a generous awards program to support teachers, groups of teachers, or whole schools to implement innovative projects designed to enrich classroom experiences in mathematics and/or science. In 1987-88, for example, PRISM allocated approximately $100,000 for grant awards. There is a great deal of competition for PRISM grants, and the collaborative's in-school collaborator made a concerted effort to encourage individual teachers as well as departments to apply for the grants. The collaborative offered assistance, ranging from discussing ideas for grants to arranging for clerical support. These efforts were very successful. During the 1986-87 school year, of the 55 mini-grants awarded, 15 went to mathematics teachers, 3 of whom taught in the high schools. In addition, the collaborative helped high school mathematics and science departments apply for PRISM grants of up to $500 to purchase telecommunications equipment. During the 1988-89 school year, 14 collaborative teachers received PRISM grants. Five mini-grant proposals (individual grants of up to $300) were funded, including: a Computer Resource Library; software purchases; Magnetic Manipulatives in Mathematics; Mathematics in Applications Problem-Solving Contest; and the Development and Implementation of Student Group Lab Experiments. Three collaborative teachers received PRISM Collaborative Grants of up to $3,000, which provide groups of teachers with funding for innovative projects. The three successful projects were: Developing Resources for Teaching Problem Solving; Artificial Intelligence in the Classroom; and Software Database. Six collaborative teachers of the 12 who applied received Workshop

Grants ($300-$500) to enable teachers to share special talents and expertise with colleagues. The funded proposals included: Activities for Math in Application Classes; Algebra Courseware; Developing Computing Skills, Focus on Geometry; Computing Skills; and Live Animals in the Classroom. During 1989-90, of the 49 PRISM grants awarded, 10 went to collaborative teachers, with 83 percent of the grant applications from collaborative schools receiving funding.

Department Grants

The collaborative received a grant from the Education Development Center to enable target schools to develop programs that would promote mathematics-science dialogue following the 1989 NCTM Regional Conference in Philadelphia and the NSTA Regional Conference in New Jersey. This money was supplemented by funds from the collaborative budget and from PATHS/PRISM. Each target school was eligible for up to $200 for materials and/or refreshments for a joint mathematics-science workshop at which teachers who had attended the conference could share what they had learned with colleagues, both within their own disciplines and across departmental lines. The grants had originated with the November 1989 Teacher Leadership Dinner. One objective of the grants was to foster interaction between mathematics and science teachers. Schools were allowed to pool their $200 to sponsor a large affair. Each school follow-up meeting, although partly social in nature, was to include an agenda that allowed time for substantive discussion of conference topics, with priority given to agendas that stressed the integration of mathematics and science topics or activities involving more than one school. One teacher was designated as the principal organizer for each school. During the winter and spring of 1990, a series of follow-up workshops was held that involved a total of 319 teachers representing 13 high schools.

Promoting Participation in Professional Organizations

One way in which the collaborative worked to foster teacher professionalism was to work closely with ATMOPAV, the local professional organization for mathematics teachers. During 1985-86, the collaborative's first year, it paid the membership dues to ATMOPAV for all the mathematics teachers in the district. For the next three years, the collaborative sponsored memberships for the mathematics and science teachers of the

target schools in PSST, the local professional organization for secondary science teachers, or in ATMOPAV. The collaborative paid the full price of memberships for teachers in the new target schools and half the membership fee for second- and third-year participants who were willing to pay the remaining half. Membership benefits for both organizations included newsletters and regularly scheduled conferences. Both organizations scheduled their conferences after school and on Saturdays so professional leave was not a problem; attendance at these conferences has increased significantly because of the collaborative's support.

In addition to sponsoring memberships, the collaborative also promoted attendance at meetings of both professional organizations by awarding PEG grants to fund teacher participation. The collaborative also co-sponsored several programs with ATMOPAV, including luncheons at the ATMOPAV 1986 Fall and Winter Meetings, a speaker at the Spring 1987 ATMOPAV Banquet, and a program on a draft of the NCTM Standards in March, 1988.

NCTM 1989 Regional Conference

In 1989, Philadelphia hosted the National Council of Teachers of Mathematics (NCTM) Regional Conference. The collaborative made an effort to facilitate classroom coverage so that as many mathematics and science teachers as possible were able to attend the conference; Professional Enrichment Grants totaling $3,600 were awarded to nearly 60 teachers to subsidize their attendance. The theme of the conference was "Standardizing the Future: Let it Begin Again in Philadelphia." A special science strand included workshops on integrating mathematics and science in the classroom.

Models for Cooperative Learning

The collaborative, in cooperation with EDC, sponsored a presentation by Dr. Uri Treisman in May, 1990, which was attended by 120 educators. Dr. Treisman, a visiting professor at Swarthmore College, is a nationally known mathematics educator who pioneered cooperative learning strategies for underrepresented students.

Luncheon Evaluation Meeting

In May, 1987, the collaborative sponsored a luncheon meeting for science and mathematics department heads, directors, and teachers from the six target schools to provide an opportunity for them to discuss the impact that the collaborative had had and to evaluate its programming. At the meeting, teachers identified needs of the collaborative and suggested the next issues it should address, including in-school networking, inservice training on computers, and teacher leadership and motivation.

Mathematics and Science Educators Dinner Meeting

In December, 1987, the collaborative and Temple University co-sponsored a dinner meeting of science and mathematics educators to plan ways to bring mathematics and science teachers together. Discussions focused on ways to foster collegiality between teachers of mathematics and science, as well as on an examination of the commonalities between the two disciplines. Fifteen people attended, including nine mathematics and science teachers, two Temple University science professors, one Drexel mathematics professor, the assistant director of mathematics and the director of science from the Philadelphia School District and the collaborative coordinator. A strong dialogue was established at the meeting and three concrete proposals were developed. One outgrowth of the meeting was the annual Mathematics, Science, and Technology Conference, first held in September, 1988.

Teacher Leadership

The development of teacher leadership was an important issue in the Philadelphia Math Science Collaborative. In addition to the opportunities teachers had to influence collaborative programming through participation in the collaborative's Steering Committee and Program Planning Committee, some of the collaborative's activities were structured specifically to either promote teacher leadership or to enable teachers to take a leadership role.

One of the first activities that the collaborative sponsored was a one-day leadership institute for all mathematics department heads and principals. At the retreat, which was held in October, 1985, the participants received training in management and leadership skills.

During the 1988-89 school year, the collaborative arranged for EDC to present a leadership training dinner. At the dinner, which was held in November, 1988, EDC announced that it would fund deserving grant proposals that addressed the issue of developing leadership among teachers. As a result, teachers who attended the dinner prepared a proposal to fund workshops at the target schools to implement ideas presented at the 1989 Regional Conferences of NCTM and NSTA.

Teachers in Philadelphia demonstrated leadership in planning and/or presenting professional development experiences for their colleagues, including the 1985 Summer Institute, monthly meetings of software users groups, and the calculator workshops. In addition, the Mathematics, Science, and Technology Conferences held in 1989 and 1990 offered teachers an opportunity to present ideas to their colleagues on their own innovations and successful approaches to teaching using technology. As one participant commented, "This conference showcases the ability and dedication of Philadelphia teachers."

As a result of their collaborative participation, department heads began to demonstrate greater leadership and initiative. In April, 1986, a department head at a target school who was interested in setting up a computer network within the school organized a demonstration of the Corvus-driven computer network for department heads and other administrators at the school. The High School of Engineering and Science initiated a series of student lunchtime seminars during the 1988-89 school year. Distinguished speakers from the field of mathematics, science, and computer science were invited to speak to students and teachers during their lunch periods. The lunchtime seminars were designed to involve both teachers and students and to establish a dialogue between them. The collaborative provided funds for refreshments and selected the speakers for the first two programs, with the science department head of the high school identifying the speakers for the other seven seminars.

Philadelphia teachers are being recognized nationally for their expertise on the *Geometric Supposer*. Two teachers from Philadelphia were invited to give presentations on the *Geometric Supposer* by other urban mathematics collaboratives, and EDC sponsored the attendance of a collaborative teacher at the 1989 National Educational Computing Conference in Boston to make a presentation on the UMC *Geometric Supposer* Network for representatives from other UMC sites.

F. Reflections

The direction and impact of the Philadelphia Math Science collaborative, which changed noticeably after the first year and was modified toward the end of the five-year period, were associated with changes in the collaborative administration, in the number of targeted schools, and in the degree of teacher participation. The initial goal for the collaborative was to increase teacher effectiveness, but after the first year, the collaborative stressed the importance of the role of teachers in effecting change. At this stage of the collaborative's growth, the coordinator played a principal role in working with teachers, getting them involved, and making them aware of recommended changes in the mathematics curriculum. As individual teachers assumed more responsibility for collaborative planning, as the number of participating teachers increased, and as the administrative responsibility for the collaborative was transferred to PRISM, the collaborative focused more on teacher leadership and on the development of a vision for change. One indicator of this shift in emphasis was the teacher-comprised Planning Committee's proposal to the district for the development of a Teacher Center. The interest in establishing a Teacher Center resulted from the collaborative's history of stressing the increased application of technology in the teaching of science and mathematics, as well as the collaborative's evolution from an organization that provided opportunities for teachers to attend workshops and institutes for the purpose of upgrading their skills to an organization of science and mathematics teachers setting their own goals and seeking ways to better increase their communication with the district. The professional needs of teachers, as seen by the Planning Committee, included opportunities for peer discussion, information on the latest trends in curriculum and technology, a library of resources, and a database listing professional profiles of classroom teachers so that teachers in the system could locate others using specific teaching methods or having related experiences.

The Philadelphia Math Science Collaborative created an environment that encouraged mathematics and science teachers to become professionally more active and knowledgeable regarding current classroom innovations. The collaborative was successful in getting teachers with no previous grant-writing experience to write proposals and obtain funding for travel, classroom materials, and school projects. The in-school collaborator was effective in approaching individual teachers, supporting the development of their ideas, and helping in the preparation of the proposals. The collaborative also was successful in increasing mathematics and science teachers' experience with the use of technology in their classrooms. The collaborative sponsored workshops on software packages, promoted the work of teachers on curriculum committees that sought to develop the Applications in Mathematics course, set up a distribution mechanism for getting software to teachers, and coordinated a district-wide technology conference. The technology conference was particularly helpful because it gave teachers an opportunity to work with a software package or calculator that they could then use in their classrooms.

The administrative structure of the Philadelphia School District enables department heads to exert a strong influence on both the curriculum and the professional experiences of their department members. The collaborative worked closely with department heads to provide presentations at their meetings and to help them develop programs and activities for their departments. In addition, the collaborative provided teachers with opportunities to develop and use their leadership skills. Classroom teachers presented workshops, in Philadelphia and in other parts of the country, and planned activities and strategies to meet the needs of mathematics and science teachers that were not being met through the existing system. This resulted in a group of 75 enthusiastic teachers and department heads who, after experiencing five years of new ideas, access to events throughout the country, and the support and encouragement of the collaborative, had become actively involved in planning for their future.

The success of the Philadelphia Math Science Collaborative can be seen in its impact on teachers and on their interactions with one other. The collaborative was less successful in its attempt to involve people from business and higher education who were used as resources but never became central to the collaborative's activities. One reason was that Philadelphia already had many other programs that focused on involving representatives from business and higher education with students and teachers. An additional reason for the lack of participation by persons from other sectors is that the

concept of an in-school collaborator did not lend itself to integrating people from outside the school into collaborative activities.

Philadelphia's approach to collaboration depended heavily on the personality, experience, and working style of the coordinator. The coordinator's role as in-school collaborator worked well for three years because she was comfortable with it; however, this strategy was not further developed to address the increasing number of target schools. While the in-school collaborator could work with three to five new schools each year, someone, such as the department head in the schools who had been brought into the process earlier, needed to assume responsibility for continuing to offer the services and support that the collaborator had originally provided. A few department heads did this and orchestrated a rich professional program for teachers, but many did not. Without the frequent visits by the coordinator, teachers' activities settled to the frequencies that had prevailed before they became involved in the collaborative. The in-school collaborator demonstrated that having someone from outside the department periodically give teachers support and information about opportunities can be helpful. What was not demonstrated was a way to institutionalize the approach by either using it as model for department heads to work with teachers or making the district office aware of its advantages.

The collaborative also faced difficulty in developing stronger working relationships between school mathematics and science departments. Even though a condition of collaborative membership was that the two departments in a school hold joint meetings five times annually, this rarely happened. Perceived barriers of different locations in the building, varying schedules, and a tradition of not meeting with each other proved too great for many departments to overcome. In some schools, these barriers were transcended when teachers from the science and mathematics departments cooperated with one another, but such instances were more the exception than the norm. That a problem existed in getting departments within a school to communicate with each other is an indication of the isolation of the mathematics and science areas within the schools.

In retrospect, perhaps a few things could have been done differently to help institutionalize the role of the in-school collaborator, generate more interaction between the mathematics and science departments, and have a more interactive relationship with business and higher education. A long-range strategy for expanding the concept of in-school collaborator beyond the few target schools was needed from the beginning to ensure

a greater impact across the district. Developing long-range strategies while simultaneously creating the position would have been difficult. If, however, the ideas for providing individual support for teachers to become professionally active had been developed more fully, by the third and fourth years of the collaborative the issue of expanding the concept to a larger number of schools could have been addressed. The requirement that school mathematics and science departments meet during the year was not sufficient to generate greater interaction between mathematics and science teachers, partly because teachers perceived little benefit from their meetings and viewed them as only taking up more time. An approach specifying a focus for meeting together, such as developing an intradisciplinary course, probably would have generated greater interaction between teachers from the two fields than some of the efforts attempted.

Finally, representatives from business and higher education were not fully brought into the collaborative process; consequently, the collaborative did not have their expertise to draw upon in facing some of its challenges. A natural entree would have been through the Steering Committee. However, the collaborative administration perceived the Steering Committee as advisory rather than developmental. Members of the Steering Committee were very willing to help, but needed to know what to do. At the same time, the coordinator was seeking advice on how she should be interacting with teachers, a need to which the Steering Committee was unable to respond. As a result, the Steering Committee never developed into a critical part of the collaborative, although it did provide a forum for addressing the transition of the collaborative from the Franklin Institute to PRISM. As in the case with classroom teachers, the Steering Committee could have been nurtured to provide a greater service to the collaborative administration and teachers. Based on the experience of other collaboratives, it seems evident that steering committees are more effective when members are given specific tasks to perform. For instance, individuals on the Steering Committee of the Philadelphia Math Science Collaborative could have been presented with the issue of effecting improved cooperation between science and mathematics teachers. Representatives from business and higher education could have been contacted to develop situations to bring mathematics and science together in a meaningful way. The members of the Steering Committee also could have helped develop a long-range strategy for expanding the concept of the in-school collaborator.

Collaboration Outcomes

The major form of collaboration throughout the collaborative's history was among the teachers themselves. With the help of coordinators, they worked together to write grant proposals, to introduce new software into the classroom, and to plan activities for themselves. This joint activity was exemplified by the work of the Program Planning Committee in 1989-90, which provided the central forum for collaboration. Through this group and its five subcommittees, mathematics and science teachers worked together to plan for the collaborative. These groups wrestled with defining needs and planning a course of action to serve the mathematics and science teachers in the district. In part, this form of collaboration had a social objective: to provide an opportunity for teachers to get to know each other. However, it was an attempt to produce a program that could effect change in the schools.

The fall Technology Conference was another collaborative event that brought teachers from different content areas together. One important collaborative outcome identified by teachers as a consequence of the collaborative's emphasis on interaction between science and mathematics was the dialogue generated among teachers from the two disciplines. One teacher noted that mathematics and science teachers are more united than they were prior to the existence of the collaborative.

The collaborative has not given a high priority to involving representatives from higher education and business. There was some interaction between teachers and those from higher education through the grants, and one representative from business and one from higher education served on the Steering Committee. Teachers also had internship programs, such as PTIP, available to them through other sources. Most of the experiences teachers had with representatives from higher education, however, were as a result of attending presentations, such as the Beaver College Colloquiums or the workshops provided by professors from Indiana University of Pennsylvania. In 1989-90, the collaborative presentation by Uri Triesman was an attempt to create a network of people in higher education who would provide support to public schools. This network, however, for the most part has not evolved further. PATHS/PRISM itself is well connected with higher education and business, having developed with the support of these sectors; it is possible that this form of collaboration will be enhanced as a result of the collaborative's new affiliation with PATHS/PRISM.

The 1990 Program Planning Committee Report noted that consideration was being given to having teachers serve as consultants to industry on how industry can best impact on the schools. Again, however, the interaction tends to be one way and does not promise true collaboration. Committees comprised entirely of teachers seem limited in their potential to explore new forms of beneficial interaction. As has been observed in other collaboratives, if those from higher education and business are to be significant partners in collaborative activity of any kind, it is essential that they be included as equal participants from the beginning. While the Philadelphia Math Science Collaborative has brought in representatives from business and higher education resources for funding, or as speakers, it appears that there is little interest or potential for involving them as true collaborators.

Professionalism Outcomes

As noted by teachers, the collaborative's main contribution to professional development has been through the professional enrichment grants which enable teachers to attend professional meetings that otherwise they would not have attended. This was evident in the number of mathematics and science teachers who attended the regional meetings of their professional organizations. As a result of participation in these meetings as well as in other events, teachers report an increased awareness of current trends in their content area and a greater enthusiasm for teaching. To deepen the impact of these meetings, teachers were able to get follow-up grants to conduct a workshop for teachers from their schools.

The impact of the in-school collaborator in helping teachers to apply for grants was clearly evident. One science teacher reported success in obtaining grant funds to acquire computers for her school and to equip the science laboratory. She credits Ms. Stetzer with encouraging her and helping her write her first proposal, which gave her experience and interest in seeking additional grants. Other teachers profited from professional activities they had learned about and had been encouraged to attend through the collaborative. Some of these teachers had been given the opportunity to present their own workshops at events such as the Technology Conference. This added to their confidence. One teacher was explicit on how the collaborative had contributed to his development of leadership qualities, "I've been continually encouraged to [develop] my own skills and to offer my support to other teachers."

Mathematics and science teachers who served on the Program Planning Committee were well prepared to discuss ideas with each other and to start developing future plans. The change in coordinators in the 1989-90 school year resulted in a break in the practices of the previous years. Whereas in the past, the in-school collaborator had provided support to individual teachers and encouraged them to write proposals or attend workshops, this year the support existed among the teachers themselves. Currently, the approach of the collaborative is to encourage the teachers to provide leadership. One teacher indicated that she has invited her colleagues to observe her class and is presenting workshops in which she urges teachers to teach different courses, to use computers, to apply for grants, and to conduct other workshops.

The results of the 1990 Survey of Teacher Professionalism indicate that teachers who had some involvement with the collaborative portray themselves as dedicated to work that has social benefit. These teachers, however, have a very strong feeling that their work does not receive the recognition from others that it deserves. This sense of alienation is expressed particularly strongly by those who had been frequent participants in the collaborative's activities.

As a group, collaborative teachers in Philadelphia have a very strong sense of themselves as teachers rather than as mathematicians. They are confident in their relationship to others and value and feel comfortable in interactions with mathematicians and other users of mathematics. They also recognize the importance of continuing their mathematical training, even when it competes with enhancing their teaching and classroom management skills.

Philadelphia teachers who responded to the Survey of Teacher Professionalism administered in the spring of 1990 felt that they did have control over the day-to-day decisions in their classrooms. A majority, but by no means all, of them felt that the responsibility for review of their work and of courses should generally reside with teachers. A higher proportion of the teachers who frequently participated in collaborative activities were in favor of professional organizations setting standards and implementing reforms than of teachers who were less active in the collaborative. They saw that professional organizations are relevant to teachers who are active in them. Those who were less involved in the collaborative did not value professional organizations and their work as strongly.

The view that collaborative members have of teachers as professionals as expressed in interviews reflects the contributions of the collaborative and the teachers' own increased professional activity. One teacher defined a professional as one who takes what he or she does seriously, is active in pursuing knowledge "about the why and how," and is interested in sharing this knowledge with others. Another teacher viewed a professional as someone who knows the content, who knows what is going on in the field, who is willing to expand his or her knowledge, and who asks questions. Both of these descriptions come from teachers who have been active in the collaborative and who are now being looked up to for the contribution they can make to its direction.

Mathematics Focus Outcomes

One main theme for the Philadelphia Math Science Collaborative has been technology, with the Technology Conference as a major vehicle for exploring this theme and increasing teachers' knowledge of the applications of technology in the classroom. Central to the Conference were the teachers who gave presentations describing how they have implemented technology in their classrooms. Those who attend the Technology Conferences see software demonstrated and then are given copies to take back with them to use with their students. In the process of learning more about technology, teachers are provided with opportunities to understand the implications of technology in terms of what students need to know about mathematics. For example, one keynote speaker argued for a visual approach to teaching algebra that can be supported with computers. Another teacher noted that it is important for students to be actively engaged in learning mathematics through computers. To do this, students need to work in a computer laboratory in which only one or two students share a computer.

It is clear that teachers have grown in their approach to mathematics education because of the collaborative. The collaborative has expanded some teachers' notions of what mathematics is and how it should be taught. Some department heads have indicated that the collaborative has generated a new commitment to integrating mathematics and science instruction with real-world applications. The collaborative has provided examples of what can be done to increase departments' expectations for inservice programming. The collaborative operated at a time when changes were being made that allocated more control over the curriculum to individual schools. For example, the district curriculum

committees disbanded because there was no time to meet as the result of the new teachers' contract; at the same time, the ninth-grade curriculum in comprehensive high schools was restructured through a Pew Foundation grant. In this restructuring, some of the collaborative teachers served as team leaders, making it possible for the collaborative and teachers who have benefited from the collaborative to exert a strong influence on district curriculum.

Conclusions

The Philadelphia Math Science Collaborative took an approach to collaboration--the use of an in-school collaborator--that met its needs. The in-school collaborator was successful in reaching teachers because of her extensive knowledge of the system and her experience as a department head and mathematics teacher. This was of singular importance in drawing teachers into the process in the early stages of the collaborative. The transfer of the collaborative to PATHS/PRISM and the appointment of a new coordinator propelled the collaborative toward expansion to a larger number of schools and forced it to assume another approach to collaboration--having a large group of teachers involved in setting its agenda. Without the work of the in-school collaborator, there is no question but that there would have been an insufficient number of teachers to assume the responsibilities of the expanding collaborative. The collaborative was successful in giving teachers a chance to demonstrate and use their leadership potential. It also was instrumental in identifying the many activities available to teachers and focusing on those that could be of the most benefit to them. The Philadelphia Math Science Collaborative has successfully established a place for itself in the fourth largest school district in the country and among the many other professional development programs in the area. The collaborative's impact on the use of technology and the advances it has made in developing teacher leadership have the potential of influencing the district well into the future.

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