Summary Report on the Impact Study of the National Science Foundation's Program for Women and Girls

The Urban Institute
Education Policy Center

Prepared for

Division of Research, Evaluation, and Communication
Directorate for Education and Human Resources
National Science Foundation

December 2000

SUMMARY REPORT ON THE IMPACT STUDY OF THE NATIONAL SCIENCE FOUNDATION'S PROGRAM FOR WOMEN AND GIRLS

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National Science Foundation
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December 2000
Prepared under NSF Contract No. RED9452967

The conversion of this material to electronic format was supported by the National Science Foundation under Contract Number REC-9912177: Task 10 (B14036X), awarded to Temple University, Institute for Survey Research, Washington, DC.

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Acknowledgments

The Urban Institute staff who conducted the Impact Study of the Program for Women and Girls wish to thank a number of individuals for their contribution to the evaluation leading to this report. First, our gratitude to the Advisory Board members—Patricia Campbell, Elizabeth Fennema, Yolanda George, Jane Butler Kahle[1], and Marsha Matyas—who oversaw the impact study design and were available for consultation throughout the process. Their expertise and dedication to issues pertaining to women and girls in science, mathematics, engineering, and technology have enriched the field and this study.

We also wish to thank the staff at the National Science Foundation who supported the Impact Study: Luther S. Williams, formerly Assistant Director of the Directorate for Education and Human Resources; Roosevelt Calbert, Director of the Division of Human Resource Development; Dawn Pickard, Ruta Sevo, and Gretchen Klein, former and current directors of PWG; and Conrad Katzenmeyer, Bernice Anderson, and Jim Dietz (on leave) of the Division of Research, Evaluation and Communication.

Dorothy Bennett of the Education Development Center, Inc. shared her database on PWG projects and their products to assist us in the design of our product review process. Instructional products created by PWG projects were reviewed by a group of experts who served as consultants to the Urban Institute. We are grateful for the contributions of the following reviewers:

- Susan Beal – Saint Xavier University
- Joanne Rossi Becker – San Jose State University
- Cornelia Brunner – EDC/Center for Children & Technology
- Linda Caleb – Holton-Arms School, Bethesda, MD
- Cinda-Sue Davis – University of Michigan
- Arlene S. Chasek – Rutgers University
- Catherine Jay Didion – Association for Women in Science (AWIS)
- Kay Gilliland – retired (formerly of EQUALS, University of California at Berkeley)
- Larry Goldberg CPB/WGBH National Center for Accessible Media (NCAM)
- Richard Greenberg – University of Arizona
- Wanda Guzman – Austin Collaborative for Mathematics Education
- Shelly Heller – The George Washington University
- Sharon Woods Hussey – Girl Scouts USA
- Betty Iannuccilli – Andover High School, Andover, MA
- Nancy Kreinberg – EQUALS, University of California at Berkeley
- Noel Krenkel – San Francisco Unified School District
- Phyllis S. Laine – Xavier University
- Linda Levi – University of Wisconsin at Madison
- Sarah A. Lindsey – Midland Public Schools, Midland, MI
- Ellen F. Mappen – Douglass College, Rutgers, The State University of New Jersey

[1] Jane Kahle resigned from her official role on the Advisory Board in 1999 when she accepted an appointment to serve as the Director of NSF's Division of Elementary, Secondary, & Informal Education (EHR/ESIE).

- Cheryl L. Mason – San Diego State University
- Susan Staffin Metz – Stevens Institute of Technology; President, WEPAN (Women in Engineering Programs & Advocates Network)
- Margaret R. Meyer – University of Wisconsin at Madison
- Jenny Piazza – University of Southern Colorado
- Stephanie Ragucci – Andover High School, Andover, MA
- Sue Rosser – Ivan Allen College, Georgia Institute of Technology
- Dorothea M. Smith – Binghamton High School, Binghamton, NY
- Gerhard Sonnert – Harvard University
- Jill Tietjen – University of Colorado at Boulder
- Faedra Lazar Weiss – Girls Incorporated
- Diane Willow – The Children's Museum, Boston
- Bernie Zubrowski – Center for Science Education, Education Development Center, Inc.

Many other individuals contributed to the report in specific ways. We are grateful for the assistance of Patricia Campbell and Campbell-Kibler Associates, Inc. for their involvement in the field-test of the product review document and their assistance with the text. We would also like to thank Yolanda George, Ellen Wahl, and Jo Sanders for help field-testing the interview protocol. Lola Rogers served as consultant to the study team and provided valuable insight into the product review process.

The two-year study involved many staff members at the Urban Institute. Irene Steward, Michael Bowden, Laurie Forcier, Thenoa Davis-Googe, and Latasha Holloway provided administrative support for the study. Beatriz Chu Clewell, Katherine Darke, Thenoa Davis-Googe, Laurie Forcier, Sarah Manes, Jacqueline Raphael, Jorge Ruiz-de-Velasco, Lindsay Tartre, and Elisa Vinson contributed to research, data collection, and writing efforts. Katherine Darke prepared the report. Nancy Sharkey reviewed early drafts of the interview protocols and Ms. Sharkey and Stephanie Mudge advised the database construction process. Karen Callahan, Shannon McKay, Kristen Olson, and Andreas Pape provided technical assistance with data analysis and reporting. Harry Hatry and Jacqueline Raphael reviewed the report in later drafts to provide feedback. Robert Santos was generous in sharing his time and knowledge about data analysis and presentation. Education Policy Center director Jane Hannaway lent support and expertise throughout the project. Finally, we would like to thank our editor, Corinna Nicolaou.

This study would not have been possible without the generous contributions of time and perspective from the principal investigators, evaluators, replicators, project staff, participants, and others involved with PWG projects. We would especially like to thank the over 250 participants at the four sites we visited for sharing their observations in interviews and focus groups. Their openness and willingness to share their perspectives were invaluable.

Beatriz Chu Clewell, Principal Investigator
Katherine Darke, Project Director
November, 1999

Final Report on the Impact Study of the
National Science Foundation's Program for Women and Girls
Executive Summary

The National Science Foundation (NSF) has operated the Program for Women and Girls (PWG)[2] since 1993, funding over 180 projects designed to increase access for girls and women to study and careers in science, mathematics, engineering, and technology (SMET). PWG was created in response to alarming data indicating that girls are less likely than boys to be interested in SMET in elementary and middle school, less likely to take critical SMET electives in high school, and far less likely to begin or complete a SMET degree. Women are also underrepresented in SMET professions, which are among the most prestigious and well-paid careers. To remedy these discrepancies, NSF created PWG to fund opportunities for girls and women in SMET that promote their interest and retention in SMET.

In 1997, NSF's Division of Research, Evaluation and Communication contracted the Education Policy Center at the Urban Institute to conduct an impact study of PWG. The impact study is based on 119 PWG projects funded in fiscal year 1993 through fiscal year 1996. The Urban Institute conducted an in-depth study of a random, stratified sample of 40 projects to assess the overall impact of PWG. Data were collected and verified through a variety of methods, including interviews with principal investigators, project evaluators, and persons involved in the replication and institutionalization of PWG projects; examination of PWG products; site visits; and extensive review of PWG project evaluations. The study assessed the contributions of PWG to knowledge capital, social capital, and human capital.

Knowledge capital refers to the body of existing information about SMET and gender equity (for example, a compilation of theoretical or practical approaches to improve equity in SMET). The study found that some PWG projects (28 percent of the sample) contributed to knowledge capital by producing scholarly articles, even though production of scholarly articles was not a requirement of the program. Thirty-three percent of sample projects developed instructional products, although only three projects had been funded primarily for this purpose. Many sample projects contributed to the knowledge base about "what works" for girls and women in SMET by documenting benefits to participants over the course of the project. Positive changes for participants suggest strategies employed by the projects are effective at improving outcomes for women and girls in SMET.[3] These strategies include mentoring/role modeling, extracurricular SMET activities, summer camp, professional development for educators, and activities for parents.

Social capital refers to the resources available to members of a community to address common problems and facilitate coordination and cooperation for mutual benefit. The study found that PWG is the nation's largest funder of efforts to increase participation of females in SMET. In addition, the study found that PWG projects contributed to social capital in numerous ways. For example, they developed model interventions that were institutionalized after their PWG funding ended. They also built and expanded collaborations among interest groups/professional organizations, school(s) or school district(s), community groups, universities, community colleges,

[2] The title "Program for Women and Girls" changed to "Program for Gender Equity in Science, Mathematics, Engineering and Technology" in November 1998. This change was issued in NSF program announcement 99-25.
[3] There is insufficient data to directly link specific strategies with specific outcomes.

federal government projects, private industry, local government agencies, and museums to provide interventions for girls and women in SMET (73 percent of sample projects). Projects improved the educational infrastructure that supports females in SMET by changing policy and practice in classrooms and providing models for replication.

Human capital refers to an individual's accumulated assets, resources, and sources of strength. All individuals attain a certain stock of human capital primarily developed through education and training. PWG projects reviewed in the study directly served over 31,500 participants, including elementary through graduate level students, kindergarten through 12th-grade teachers and preservice teachers, school counselors, school administrators, university faculty, SMET professionals, and parents. Replications and institutionalizations of these PWG projects have served an additional 15,614 participants (as of June 1999). Eighty-two percent of completed sample projects produced enhanced attitudes and self-confidence regarding SMET study, increased interest and enrollment in SMET courses, mastery of SMET content, interest in SMET careers, and/or awareness and use of gender equity strategies by educators.

PWG project evaluations were reviewed to assess (1) how often sample PWG projects conducted summative evaluations; and, if conducted, (2) the quality of the evaluation methodology used. Twenty-two out of 30 completed sample projects conducted summative evaluations. Nineteen of the 22 evaluation reports were judged to present credible evidence about the effectiveness of project strategies.

In conclusion, the impact study found sample PWG projects made significant contributions to knowledge capital, social capital, and human capital during the years 1993 to 1996. PWG's scope and impact in the field of gender equity and SMET is unmatched by any other privately or publicly funded program. In some areas of the impact study, our conclusions are necessarily based on assumptions about the quality and quantity of the data available. However, the evidence indicates that PWG effected positive, short-term changes in human capital and has also successfully initiated and sustained long-term changes in knowledge capital and social capital resources to improve equity in SMET.

CHAPTER 1. THE IMPACT STUDY OF PWG

I. What is PWG?

The Program for Women and Girls (PWG) is a multi-million dollar program funded by the Directorate for Education and Human Resources (EHR) at the National Science Foundation (NSF) to support activities to increase girls' and women's participation in science, mathematics, engineering, and technology (SMET). Historically, girls and women have been underrepresented in SMET classrooms and professions (see Clewell, Thorpe, and Anderson, 1992; Davis, Ginorio, Hollenshead, Lazarus, and Rayman, 1996; Tobin, Kahle, and Fraser, 1990).[4] Female students are less likely to study SMET and, at most levels, are less likely to perform well on math and science achievement tests than their male peers. Female SMET professionals earn less than their male colleagues, are less likely to hold positions of prestige and authority, and are vastly underrepresented in some key SMET fields (for example, women comprise only 17 percent of engineers).

The low participation level of women in SMET fields—particularly in physical sciences, mathematics, and engineering—is a serious national problem. Several issues of particular concern are:

- the disproportionately high number of girls who lose interest in science during middle and high school;
- the low number of women who enroll in advanced high school science and math courses to prepare for college;
- the disproportionately low number of women with SMET undergraduate majors—particularly those in physical sciences, computer sciences, and engineering;
- the low number of women completing SMET graduate degrees; and
- the slow rate of women's advancement to senior ranks and leadership positions in academic, industry, business, and government SMET careers.

The National Science Foundation's mandate to foster the vitality of the nation's scientific and technical enterprise includes responsibility for the quality, quantity, and composition of the human resource base in SMET. The Program for Women and Girls, created by EHR in 1993, addresses these issues as they relate to opportunities and outcomes for girls and women in formal and informal SMET education. Between fiscal year 1993 and fiscal year 1996, NSF awarded almost $38 million to 119 PWG projects. These projects were classified by PWG guidelines as Experimental, Model, or Information Dissemination projects.[5] This study focuses on a random,

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[4] Clewell, B, Thorpe, M.E., and Anderson, B., 1992, *Breaking the Barriers*, San Francisco: Jossey-Bass. Davis, C.S., Ginorio, A.B., Hollenshead, C.S., Lazarus, B.B., and Rayman, P.M., 1996, *The Equity Equation*, San Francisco: Jossey-Bass. Tobin, K., Kahle, J.B., and Fraser, B.J., eds., 1990, *Windows into Science Classrooms*, New York: Falmer Press.

[5] In addition to these three types of projects, one project funded during this period was labeled a "Special" project and did not fit into any of these categories.

stratified sample[6] of all the Experimental and Model projects funded between 1993 and 1996 (Figure 1). Because the number and percentage of funds represented by Information Dissemination Projects were quite small, they were not included in the study.

The primary purpose of Experimental and Model projects is the creation of interventions that improve access to SMET for girls and women. Experimental projects were intended to affect long-term results by achieving systemic change in the educational infrastructure, while Model projects were intended to contribute to human capital and produce replicable models for local change in the short-term. In fact, a review of the proposals of projects funded between 1993 and 1996 suggests that the two sets of projects were more similar than different, and the impact study shows their effects were also similar. Although Experimental projects focused on long-term change, they also achieved short-term human capital gains; Model projects focused on short-term outcomes for participants, but also achieved longer-term, systemic social capital improvements. Because their similarities are more pronounced than their differences, pooled results for both project types are shown in the tables and figures in this report. Where there are significant differences between project types, those differences are highlighted in the text.

[6] N=40.

Figure 1. Allocation of PWG Funding Fiscal Years 1993-1996

MODEL PROJECTS

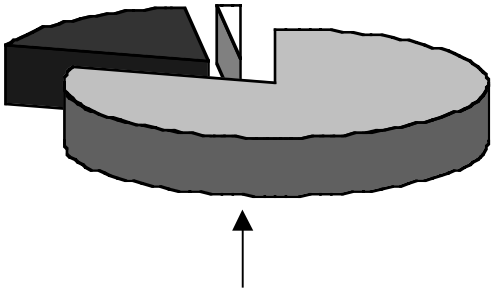
- 18 percent OF PWG FUNDING FY1993-96
- 59 percent OF PROJECTS

Lasted one year with funds up to $100,000; designed to change participant outcomes and create replicable models.

INFORMATION DISSEMINATION PROJECTS

- 2 percent OF PWG FUNDING FY1993-96
- 8 percent OF PROJECTS

Varying durations and funds; designed to produce and disseminate information about girls and women in SMET.



A "typical" PWG Model project received a one-year, $100,000 grant awarded to a university. The project delivered SMET content to middle school or college students. The students participated in hands-on activities in small groups and received information about science or mathematics-related careers. Teachers, faculty, and scientists participated in project activities.

EXPERIMENTAL PROJECTS

- 80 percent OF PWG FUNDING FY1993-96
- 33 percent OF PROJECTS

Lasted three years with annual funds up to $300,000; designed to produce long-term change in infrastructure.

A "typical" PWG Experimental project received a three-year, $800,000 grant awarded to a university. The project delivered services to middle and high school students. Activities were held weekly during the school year and included a summer camp component. The project served the same cohort of girls for three consecutive years, or served three separate cohorts in successive years. K-12 teachers and school administrators received professional development related to achieving gender equity in the classroom. University faculty and scientists served as role models and mentors to students. In addition to serving participants, institutional change was a goal of the project.

II. What Did We Want to Know About PWG?

The study was designed to assess the impact of PWG in three areas:

1. *Knowledge Capital*: the body of existing information about SMET and gender equity (for example, the theoretical or practical understanding of strategies to improve equity in SMET).

2. *Social Capital*: the accumulated store of assets, tangible and intangible, available to members of a community to address common problems and facilitate coordination and cooperation for mutual benefit.

3. *Human Capital*: an individual's accumulated assets, resources, and sources of strength. All individuals attain a certain stock of human capital, primarily developed through education and training.

We focused on these areas because they are useful constructs for organizing data for the PWG Program amd for the Government Performance and Results Act (GPRA) of 1993. The GPRA Act requires NSF (like all federal agencies) to annually monitor program outcomes.[7] Because NSF was interested in the quality and quantity of PWG project-level evaluations—and because project evaluations were an important source of information about knowledge, social, and human capital outcomes—the impact study also included a review of project evaluations.

This summary report of the impact study of PWG briefly describes the process and findings of the two-year study. The technical version of this report, available on the Urban Institute's web site [*http://www.urban.org*] provides further details about the study.

III. How Did We Study PWG?

In order to measure PWG's impact on knowledge capital, social capital, and human capital and assess the strength of PWG project evaluations, we asked the following questions:

On Knowledge Capital

- Did PWG projects contribute to the scholarly body of work regarding gender equity and SMET?
- Are the instructional products that resulted from PWG of high quality and are they effectively disseminated?
- How has PWG led to greater understanding of effective strategies that engage women and girls in SMET?

[7] The impact study was designed to provide EHR and PWG with data useful in GPRA reporting, and was not primarily designed to assess whether PWG met its programmatic goals. However, although there was no requirement included in the PWG program description (NSF 93-126) that projects must affect knowledge capital, social capital, and human capital, *per se,* significant overlap exists between the goals of the program and the impact study research questions.

On Social Capital

- What impact has PWG had on the educational infrastructure?
- What partnerships have been formed and what have they yielded?
- Have PWG project innovations been replicated elsewhere?
- What policies and practices were altered because of PWG?

On Human Capital

- What impact has PWG had on participants or other target audience members?

On Project Evaluations

- What is the frequency, methodological soundness, and quality of project-level evaluations?

We addressed these questions by analyzing data from several sources, including:

1. project evaluations;
2. project reports and other documentation submitted to NSF;
3. interviews with principal investigators, project evaluators, and others involved in the replication and institutionalization of projects;
4. expert review of scholarly articles produced by projects;
5. expert review of instructional products produced by projects; and
6. site visits.

Where possible, data from one source were corroborated with data from another source.

The study focused on a random, stratified sample of 40 PWG projects. The sample included 20 Experimental projects and 20 Model projects. At the time of the study, 30 projects were complete and 10 were ongoing. The sample projects were comparable to all funded projects in terms of location, target population, focus, and predicted outcomes. The available data lent themselves to a qualitative analysis using descriptive, rather than inferential**,** statistics.

IV. What Are PWG Projects?

Figure 2. Location of Sample PWG Projects

This section of the report describes characteristics of the 40 sample projects in order to provide context for the findings of the impact study presented in the next chapter. PWG projects are a heterogeneous group. PWG intentionally funded projects that differed according to location, host institution, setting, target population, and strategy. Figure 2 shows the location of each of the 40 sample projects. According to the program description (NSF 93-126), the PWG award competition was open to universities and colleges; nonprofit, nonacademic institutions (including museums, professional associations, and community-based organizations); and state and local governments (including school districts). For-profit organizations could be included as collaborators. Table 1 shows the host institutions of the sample projects.

Table 1. Host Institutions of Sample Projects

Institution Type	All Sample Projects (N=40)	
	Number	Percent
Universities/Colleges	27	68%
Community Colleges	4	10%
Museums/Radio Stations	4	10%
Education Research Organizations	4	10%
Community Groups	1	3%

The majority of sample PWG projects were implemented at four-year colleges and universities (68%). Model projects were more likely to be implemented at colleges and universities (16/20=80%) than were Experimental projects (11/20=55%).

Participants in PWG projects, called “target populations,” included kindergarten through graduate students as well as educators, school administrators, and parents. SMET professionals (such as scientists, doctors, and computer programmers) were also involved in PWG projects as service providers, but did not receive services themselves (Table 2).

Table 2. Target Populations of Sample PWG Projects

Population	Number of Sample Projects Serving This Population (N=40)	
	Number	Percent
High School Students	15	38%
Undergraduate Students	15	38%
K – 12 Teachers	14	35%
Middle School Students	13	33%
Parents	6	15%
Elementary School Students	4	10%
School Counselors	4	10%
University Faculty	3	8%
Graduate Students	2	5%
Pre-Service Teachers	2	5%
School Administrators	1	3%

Most projects served more than one target population. The populations most frequently targeted by PWG projects were high school and undergraduate students (38% each). A slightly smaller proportion of projects served kindergarten through 12th-grade teachers (35%) and middle school students (33%).

Experimental projects were more likely to serve middle school students and educators than were Model projects, which focused more on high school and undergraduate students. While no project denied access to boys, almost all of the sample projects targeted girls and women. As a result, most of the participants in the projects we reviewed were female (over 93%).

PWG projects employed a variety of strategies to increase access to SMET for girls and women. Strategies included internships, discussion groups, mentoring or role modeling, field trips, career workshops, tutoring, extracurricular science or math activities, parent activities, conferences on SMET and gender equity, networking, materials development, professional development for educators, summer camps, in-school coursework, system building, and clearinghouse or resource center development (Table 3).

Table 3. Examples of PWG Strategies

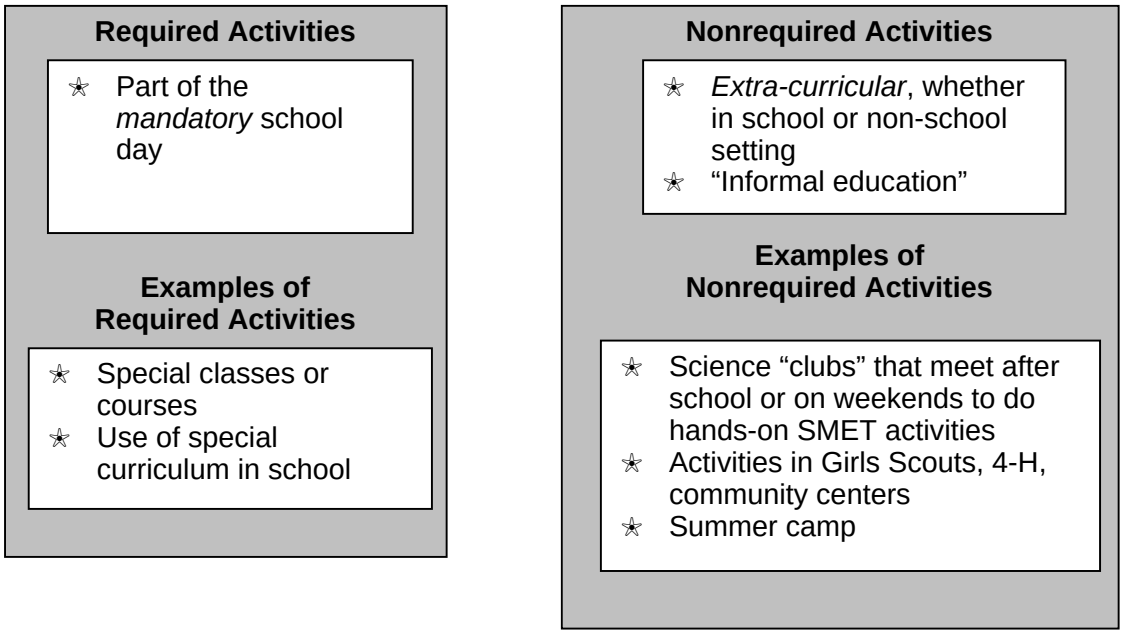
Strategy	Example	Number of Sample Projects Using This Strategy (N=40)
Extracurricular SMET Activities SMET clubs and weekend academies feature hands-on SMET activities.	✯ A weekly Saturday hands-on program for high school girls where participants explore engineering topics.	20
Mentoring/Role Modeling Contact with a representative of a SMET field fostered explicitly to encourage participants to aspire to advanced SMET study or careers.	✯ Undergraduate female SMET majors paired with middle school girls to talk about choices in SMET study.	15
Professional Development for Educators and Leaders Single or ongoing sessions to introduce educators or leaders to concepts of SMET and gender equity and strategies to create a supportive classroom climate for females.	✯ A session for teachers on how to make their classroom management techniques more equitable for girls.	14
Special In-School Coursework New or modified courses, curricula, or classroom activities that are free of gender-bias.	✯ SMET "gate keeping" courses for first year college students are revised to be less threatening to women students.	11
Summer Camp An intense week or more during summer that provides participants with an in-depth educational experience.	✯ A 1 or 2 week educational and recreational program for middle school girls on the campus of a local community college focused on SMET topics.	9
Parent Activities Activities designed for parents to increase awareness of and support for their daughters' SMET interests and potential.	✯ A Saturday workshop for girls and their mothers to engage in hands-on SMET activities.	8
Field Trips Visits to facilities where participants can see SMET professionals at work.	✯ High school girls visit engineering firms, hospitals, and laboratories to explore SMET career options.	5
Internships Placement in a SMET professional setting for a few weeks or months gives participants supervised practical experience in SMET careers or research.	✯ Undergraduate SMET majors assigned to SMET labs to assist in research led by professors or graduate students.	4
Tutoring Extracurricular help with SMET content to improve academic performance.	✯ Undergraduate SMET majors spend time in local high schools to help girls with SMET homework.	4
Discussion Groups Face-to-face or electronic discourse facilitates group consideration of SMET and gender equity.	✯ High school girls participate in an E-discussion with female SMET professionals about opportunities for women in SMET.	3

Most projects used more than one strategy; on average, each used three strategies. Extra-curricular SMET activities and professional development for educators were most frequently employed (50%

and 35%, respectively). Other frequently used strategies included special school coursework (28%) and summer camps (23%). The most substantial difference between Experimental projects and Model projects was their likelihood to engage in professional development for educators (55% of Experimental projects used this strategy, while only 15% of Model projects did so). This is consistent with the target populations of the two types of projects; Experimental projects were more likely to serve educators while Model projects tended to serve students.

PWG strategies were implemented in one of three ways: as required activities in formal school settings, as nonrequired activities in informal settings, or as some combination of both. For example, one project that used a combination of required and nonrequired activities implemented a curriculum change in elementary science classes (formal setting, required activity), accompanied by an extracurricular "science club" for girls (informal setting, nonrequired activity). The majority of projects in our sample delivered interventions in nonrequired, informal settings (70%). Twenty percent of sample PWG projects delivered mixed required and nonrequired activities; 10 percent delivered exclusively required activities in formal settings.

Implementation Strategies: Required versus Nonrequired Activities



The above description of sample project characteristics highlights the heterogeneous nature of PWG projects; location, setting, target population, and strategies vary widely. In the following sections, we present findings about how these elements combined to produce contributions to knowledge capital, social capital, and human capital.

CHAPTER 2. STUDY FINDINGS

I. PWG's Contribution to Knowledge Capital

Knowledge Capital Research Questions:

1. Did PWG projects contribute to the scholarly body of work regarding gender equity and SMET?
2. Are the instructional products that resulted from PWG of high quality and have they been effectively disseminated to other parties?
3. Has PWG led to greater levels of understanding about effective strategies to engage women and girls in SMET?

We looked for three kinds of knowledge capital impact: (A) contributions to the scholarly literature about SMET and gender equity; (B) production and dissemination of instructional products; and (C) data on intervention strategies linked to outcomes for girls and women in SMET.

Knowledge capital is the existing information about SMET and gender equity. For example, knowledge capital is the theoretical or practical understanding of strategies to that improve equity in SMET.

For our analysis of scholarly articles and instructional products, we looked at the entire sample of 40 projects because any project, whether complete or ongoing, could have contributed to the knowledge base by producing articles or products. In our analysis of strategies and outcomes, however, we only looked at completed projects because we rely on summative project evaluations for data. Although 30 of the sample projects were complete at the time of the impact study, only 22 had conducted summative evaluations, 19 of which had methodological rigor sufficient to provide credible evidence of change from pre- to post-intervention. Thus, the data on strategies and outcomes is derived from 19 projects.

A. PWG's Contributions to Scholarly Work

The PWG program guidelines (NSF 93-126) did not require that PWG projects produce scholarly works.[8] Nonetheless, 28 articles, papers, or book chapters from 11 projects were produced by the 40 sample projects. Two projects were particularly productive: one project produced nine pieces of scholarly work and the other produced seven. Together, they account for over 50 percent of all reviewed manuscripts. Two unbiased, expert reviewers rated the quality of each manuscript based on the following criteria: advancing the field, originality, appropriateness of research design, relevance, organization, and soundness of conclusions. Each

I see what there is, and it makes me want to learn more…[about strategies to improve equity in the classroom.]
—Middle School Teacher Participating in PWG Project-Sponsored Professional Development

[8] This refers to published articles, unpublished papers, and book chapters.

manuscript was assigned one of four ratings based on the total number of points given by the reviewers. The reviewers gave 14 of the articles (50%) the highest possible quality rating and eleven articles (39%) received poor ratings.[9]

Table 4. Quantity and Quality of Scholarly Work by Sample PWG Projects

Ratings	Manuscripts from All Sample Projects (N=28)	
	Number	Percent (%)
Highest Quality	14	50
Good Quality	2	7
Fair Quality	1	4
Poor Quality	11	39
Totals	28	100

*Does not sum to 100 percent due to rounding.

Almost two-thirds of the highest-rated manuscripts, and all of the manuscripts in the "good" and "fair" categories came from the two particularly productive projects. Two of the articles in the "poor" category were also from these projects. All of the articles produced by Model projects were rated "poor." All of the higher-quality articles ("highest quality," "good quality," "fair quality") came from Experimental projects.

The highest-quality manuscripts addressed a number of interesting and important topics regarding SMET and gender equity, including the effect that gender-sensitivity training provided to supervising teachers has on their student teachers. Another explored the ways in which existing theories of adolescent development diverged from the project's findings on girls in rural and urban Appalachia. Using a tool called a "likely story," one manuscript fused research and practitioner knowledge to create a process to help professors, cooperating teachers, and novice teachers explore antecedents and issues related to gender-blind classrooms.

In summary, though PWG did not require projects to develop scholarly products, slightly over one-quarter (28 %) of the projects produced them, and half were of highest quality.

B. Instructional Products Created by Sample PWG Projects

The creation of instructional products was largely a byproduct of other, more primary, project activities. Only three sample projects were funded primarily to develop instructional materials and each produced one product. Overall, 13 of the 40 sample projects created and disseminated one or more instructional products that met our criteria for review (a total of 19 products).[10] The instructional products had various formats including text books, hands-on activity modules,

[9] "Poor quality" articles were not of sufficient scientific rigor to communicate useful information to the education research or practitioner communities.

[10] Review criteria included: (1) product was created with PWG funding; (2) product is available to the public; (3) product can be adopted/adapted by others at new sites; and (4) product was not created primarily to document project activities for NSF. For more detail see the Technical Report.

replication guidebooks, CD ROMS, reference books, and videos.[11] Panels of unbiased, expert reviewers evaluated each product in the following areas: technical quality, usefulness as a reference, ease of replication or implementation, gender equity content, pedagogical content, SMET content, advocacy content, and career information content. The mean rating for all products was in the "good quality" range.

Table 5. Quantity and Quality of Instructional Products

Mean Scores	All Reviewed Products (N=19)	
	Number	Percent (%)
Highest Quality	8	42
Good Quality	3	16
Fair Quality	6	32
Poor Quality	2	11
Totals	19	101*

*Does not sum to 100 percent due to rounding.

As shown in Table 5, eight products (42 Percent of the products produced) were judged to be of the highest quality. These included products from both Experimental and Model projects. Three products (16%) were judged to be of good quality; the remaining products were rated "fair" (32%) or "poor" (11%). The three instructional products produced by projects that were funded for that specific purpose received mixed reviews: one received the highest rating, one received a good rating, and one received a poor rating. Overall, instructional products from Model projects, although fewer, were rated higher than products from Experimental projects.

All of the instructional products were disseminated, although their dissemination was not tracked in any formal way. It was most common for distribution to take place at conferences, over the Internet, and in direct response to requests. Marketing strategies such as television broadcasts, distribution to the membership of a targeted group (for example, a professional society), and word-of-mouth were less common. According to the principal investigators who created instructional products, each product was disseminated to at least 50 people nationally and internationally, with some reaching as many as 700 people. About half of the products came with a user-training component, including e-mail or phone consultation, workshops, week-long training, conferences, guides, and in-school training. One product provided user-training for a fee.

[11] We did not evaluate web sites as products, because there was such extreme variation in the purpose and quality of web sites produced by sample PWG projects.

In sum, although most PWG projects were not intended specifically to produce instructional products, many we reviewed did so. More than half of the products produced by these projects were of "good" or "highest" quality.

C. PWG Evidence about Effective Strategies

As described in chapter 1, PWG projects employed a variety of strategies to improve outcomes for females in SMET. [12] Most of the projects we reviewed measured positive change for participants over the course of the project, which suggests that the strategies they used are effective. These projects added to knowledge capital about "what works" in SMET and gender equity.[13]

Of the 30 completed projects, 19 had credible evidence of outcomes for participants, and it is these projects on which we focus our discussion.

Strategies to Improve Outcomes for Girls and Women In SMET

- Mentoring/Role Modeling
- Extracurricular Activities
- Summer Camps
- Professional Development for Educators
- Activities for Parents

Figure 3 shows the distribution of the most commonly used *and evaluated* strategies among completed sample projects. As noted earlier, projects used more than one strategy and it is impossible to distinguish the separate contributions of each strategy within a project. The outcomes also varied across projects, making it difficult to compare effects across projects with different strategy mixes. Difficulties comparing

Cataloging the Knowledge Capital Contributions of PWG: The Education Development Center CD ROM

Between August 1994 and July 1998, PWG funded "Telementoring Young Women in Engineering and Computing: Providing the Vital Link," a project directed by Margaret Honey and Dorothy Bennett of the Educational Development Center, Inc. (EDC) of New York ($941,085).

The "Telementoring" project created and disseminated a CD ROM cataloging all the PWG projects for researchers, teachers, and other persons interested in learning about strategies to attract females to SMET fields.

The information is compiled from over 100 projects, cross-referencing them by subject area, target population, and strategy. The compilation also includes in-depth descriptions of selected projects. The CD ROM was disseminated among PWG principal investigators in an effort to facilitate the sharing of information about strategies and outcomes.

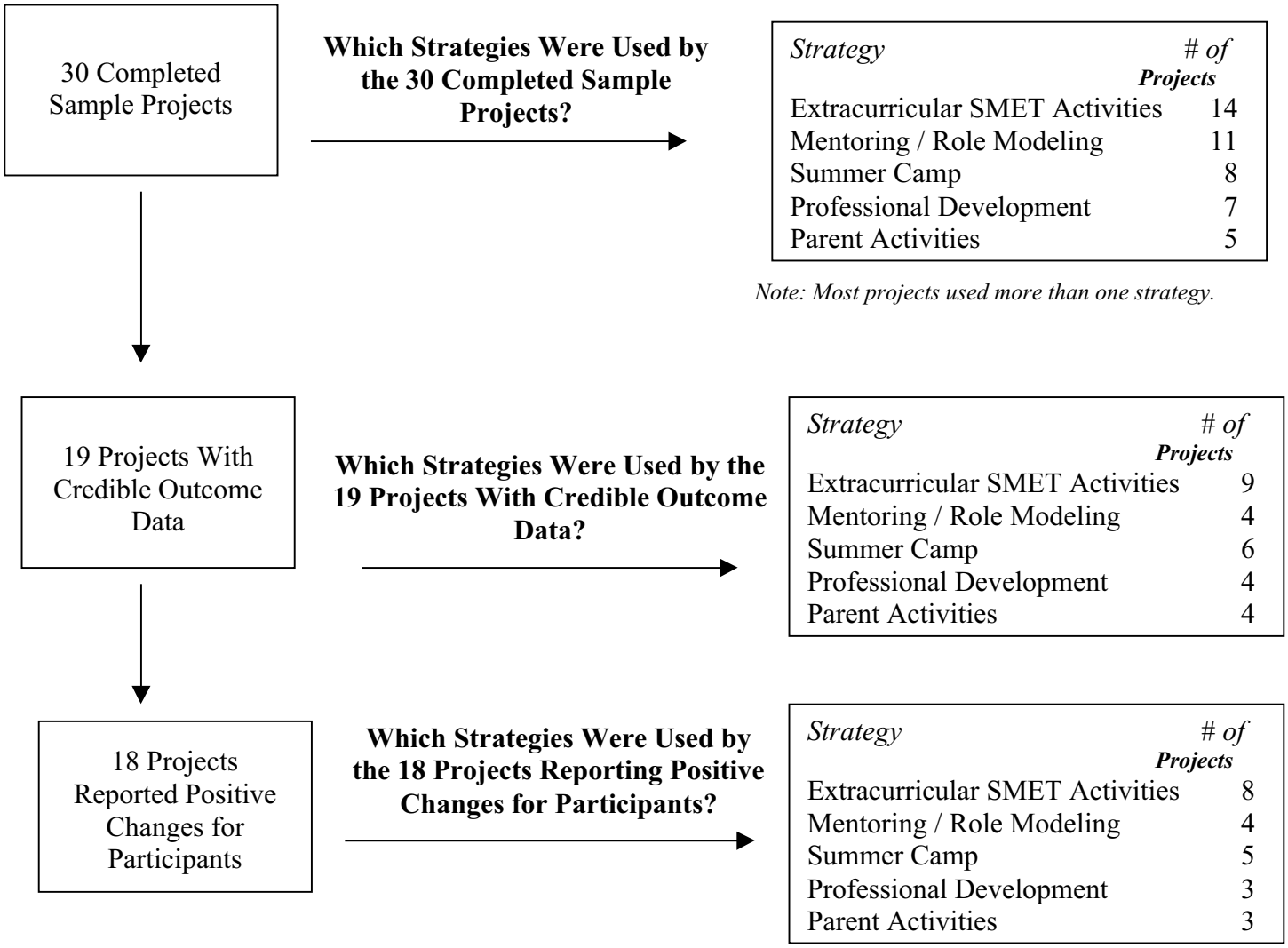
This compilation provides enhanced information about PWG-funded projects through 1997 and features several projects in-depth, as a supplement to other basic information about all the projects which is available to the public on the NSF web site. Copies have been distributed by the Women's Equity Education Act (WEEA) Resource Center at EDC since it became available in summer 1998. The product is also available at www.edc.org/CCT/pwg.

[12] Changes for participants measured pre- to post-intervention included self-confidence in SMET and attitudes toward women and SMET, SMET course-taking outcomes, mastery of SMET content, SMET career plans, and awareness/use of strategies to improve gender equity in SMET classrooms. These outcomes are discussed in more detail in section III.

[13] While we cannot link specific strategies to outcomes with the data we have available, findings of beneficial effects of a number of projects at least suggests that the strategies used by PWG projects can provide important benefits for women and girls.

the relative effectiveness of strategies are compounded because we do not have complete information on such details as how the strategies were implemented in each project or the average number of hours of exposure to the intervention for participants. Our analysis of project evaluations suggests that the most common strategies among projects with credible evidence of benefits include mentoring/role modeling, extracurricular SMET activities, summer camps, professional development for educators, and activities for parents (Figure 3).

Figure 3. SMET Strategies Linked to Positive Change



Changes for participants reported in credible evaluations were largely, but not exclusively, positive. Eighteen of the 19 completed projects with credible project evaluations (95%) reported positive changes for participants.[14] Two projects reported both positive and no change outcomes; these two projects used a mix of services which, between the two, included all five strategies under discussion here. Only one project reported no positive changes at all. This project, which involved a summer camp experience for middle school girls, reported no change in self-efficacy in SMET

[14] Sixteen projects reported *only* positive outcomes.

and negative change in participants' plans to enroll in SMET courses. (These and other outcomes for participants are discussed later in section III, human capital.)

In short, the nature of the data allow only a crude examination of the link between the strategies employed by PWG projects and outcomes for participants. However, the study found that 95 percent of projects with credible outcome data measured one or more positive changes for participants, and these data suggest that the mix of strategies used by the projects benefited participants. Further, the findings from the impact study add additional evidence to the growing body of literature supporting these strategies as effective interventions for girls and women in SMET.

Expanding Knowledge Capital by Filling a Crucial Gap

"Training Mentors: A Transportable Model to Improve Retention of Women in Science and Engineering" was an Experimental project partially funded by PWG ($100,084) and directed by Dr. Suzanne Brainard at the University of Washington (UW) from August 1995 through September 1998. The premise of the project was that although the literature, and many ongoing intervention projects, recognize mentoring to be an effective strategy to attract and retain women in nontraditional SMET fields, good mentoring is not an intuitive skill. Furthermore, no printed information existed to tell mentors how to mentor successfully. The project filled this gap in the knowledge base by designing, pilot-testing, and disseminating a curriculum to educate mentors.

The mentoring curriculum provides an administrator's guide, handbooks for participants, a bibliography of resources, an evaluation module, a training video of scenarios depicting mentoring relationships, and a guidebook for facilitating group discussions. The guide also highlights potential cross-gender and cross-racial barriers which impede the success of a mentoring relationship. At UW, where the project was initially developed, the retention rate for female engineering students who receive professional mentoring is 97 percent, compared to the mean retention rate of 55 percent for women in science and engineering programs nationwide.

Although originally designed specifically for engineers and female engineering students, the mentor training materials have been widely circulated and adapted for use in other fields where women are underrepresented. The National Park Service has made a grant to Dr. Brainard to adapt the materials for use within several branches of NPS facing high employee attrition rates. The materials have also been adopted in the UW School of Public Health, in the Department of Bio-Engineering, and in other divisions of the engineering and physical science departments. More than 200 other institutions have purchased the mentor training guide.

For her contribution to the field through this project, Dr. Brainard won a 1998 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring.

II. PWG's Contribution to Social Capital

To assess PWG's contribution to social capital, we studied the impact projects have on the educational infrastructure that is likely to promote the involvement of women and girls in SMET. Impacts on infrastructure include: A) funding that advances gender equity efforts in SMET; B) institutionalization of PWG strategies; C) fruitful and lasting partnerships and collaborations; D) alterations in policies and practices resulting from PWG projects; and E) replication of PWG models. Unlike human capital outcomes that can typically be quantified with such measures as grades, test scores, course enrollment and graduation rates, impacts on infrastructure are more difficult to measure.

Social Capital Research Questions:

1. What has been PWG's impact on the educational infrastructure?
2. What partnerships have been formed and what have they yielded?
3. What policies and practices were altered because of PWG?
4. Have PWG project innovations been replicated?

Social capital is the accumulated store of assets, tangible and intangible, available to members of a community to address common problems and facilitate coordination and cooperation for mutual benefit.

We looked for evidence of impacts on infrastructure in final reports and project evaluations and in interviews with principal investigators, project evaluators, and persons involved in the replication and institutionalization of PWG models. Thus, for our analysis of every kind of social capital contribution (except funding), we collected evidence from the 30 completed sample projects. In section A we reference the total amount of PWG funding during the study period, encompassing all funded projects.

A. The Importance of PWG Support for Gender Equity in SMET

With awards of over $37 million between fiscal year 1993 and fiscal year 1996, PWG is the largest public or private funder of efforts dedicated to improving outcomes for girls and women in SMET. Many federal agencies, foundations, and corporate grant makers support SMET education, but they tend not to exclusively target funds to remedy the underrepresentation of girls and women in SMET. Among federal agencies, only PWG ($9.75 million in FY1999) and the Department of Education's Women's Educational Equity Act ($3 million in FY1999) provide funds exclusively for advancing educational opportunities for girls and women, and WEEA does not target funding in SMET. Other agencies emphasize SMET education and devote some funding to females, but serve other minority populations as well. Thus in the list below the dollar amounts represent funding for all populations served and not only females:

- The Department of Education's Minority Science and Engineering Improvement Program ($7.5 million in FY1999);
- The Department of Defense's Science and Technology Academies Reinforcing Basic Aviation ($5 million in FY1999) and Space Exploration and Science and Engineering Apprentice Programs ($1.4 million in FY1999);

- The National Aeronautics and Space Administration's science engineering, Math and Aerospace Academy ($2 million in FY1999); and
- The Department of Energy's Los Alamos Laboratory Underrepresented Minority and Female Program ($350,000 in FY1999).

Funding for girls' and women's programs totaled slightly over 5 percent of foundation donations in 1997; however, the vast majority of this funding did not target SMET education.[15] Foundations including the Howard Hughes Medical Institute, the GTE Corporation Foundation, the AT&T Foundation, the Monsanto Fund, the Ford Foundation, the Alfred P. Sloan Foundation, the Engineering Information Foundation, the Bush Foundation, Intel Corporation and Foundation, Exxon Corporation and Educational Foundation, NEC Foundation of America and Toshiba America fund some efforts at improving opportunities for girls and women in SMET. However, most of these entities do not fund programs exclusively for females. Furthermore, because of their funding reporting it is impossible to identify exactly how much funding went to SMET and girls or women. The available data indicate this figure was significantly less than the funding by PWG over a comparable period.

We also found evidence that funding for gender equity and SMET may be decreasing. Two foundations (the Ford Foundation and the Pfizer Foundation) recently ended programs for girls and women in SMET, making NSF's continued support increasingly important to the field.

B. Institutionalization of PWG Strategies

Institutionalization is ongoing support after PWG funding for one or more major project activities from the host institution's budget.

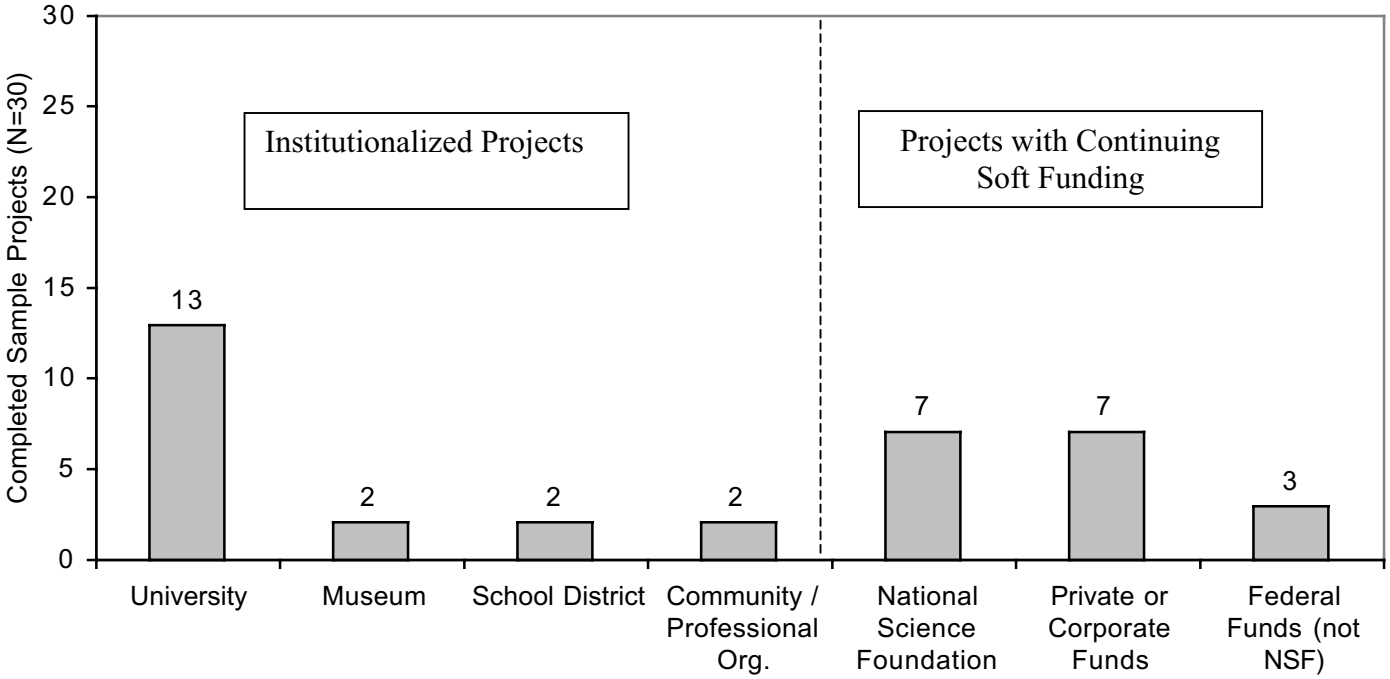
Continuing soft funding is grant money raised by principal investigators after the end of PWG funding.

A second measure of PWG's impact on social capital was the extent to which PWG strategies were institutionalized or sustained with grant money after the end of PWG funding. We focused here on the 30 sample projects for which NSF funding had ended. Twenty-two of the completed sample projects (73 percent of completed projects) were either institutionalized or sustained with soft funding after the end of their PWG grants. Nineteen of these projects (63%) were institutionalized, with permanent, line-item funding from their institutions. Fourteen of the institutionalized projects had some soft funding in addition to institutional funds. Three projects (10%) were sustained entirely on soft funding raised by the principal investigator.

Sources of institutional and continuing funding for the continuing projects varied. Figure 4 describes sources of funding for institutionalized projects and projects receiving continuing soft funding.

[15] Foundation Center, 1999. Trends in 1997 Giving.

Figure 4. Sources of Funding for Institutionalized Sample Projects and Projects with Continuing Funding



Note: 14 projects were both institutionalized and had continuing soft funding.

By the definition of institutionalization, the sources of institutional funding for sample PWG projects are dictated by the types of institutions which originally hosted the projects. For example, Figure 4 shows that 68 percent of institutionalized sample projects (13 of 19) were institutionalized by universities—not surprising since 68 percent of all PWG sample projects were housed at universities to begin with. Museums and school districts also dedicated institutional funds to support the continuation of PWG models. Among projects that received continuing soft funding, 41 percent won subsequent awards from NSF, including:

- Three Model projects were awarded subsequent grants as PWG Experimental projects;
- One Model project was awarded an Information Dissemination Project grant;
- Two Experimental projects were awarded subsequent PWF Information Dissemination grants; and
- One Model project was awarded a NSF Young Scholars grant.

Other projects with continuing soft funding had money from private foundations or private industry or other U.S. government agencies (41 % and 18 %, respectively).

You create a service that fills a gap, then they don't quite understand how they got by without it.—PWG Principal Investigator

Projects that demonstrated positive outcomes for participants were more likely to be institutionalized or to receive soft funding than projects that did not demonstrate positive outcomes. Of the projects which continued beyond their PWG grants, over 68 percent had demonstrated positive outcomes (15 of 22). In other terms, 88 percent of the projects we reviewed that demonstrated positive outcomes (16 of 18) were institutionalized or sustained with grants raised by the principal investigators after their PWG grant expired.

Enhancing Social Capital for Female Scientists: Stony Brook's WISE Women

"Stony Brook's Women in Science Experimental Project (WISE)" was directed by Dr. Wendy Katkin, from September 1994 through December 1998. WISE is an ongoing collaboration of SUNY Stony Brook and Brookhaven National Laboratory.

The project provides monthly after-school hands-on research opportunities for high school students and an intense social and academic support program for first year women interested in SMET majors. In the interim project evaluation, beneficial outcomes were documented for participating students (10^{th} grade and first year college students), project staff, and university faculty. High school participants show enhanced self-confidence and increased knowledge of SMET disciplines and careers. College participants take more SMET courses, earn higher grades, and are more likely to graduate with a SMET degree than non-participants.

WISE also creates a more supportive university climate for women in SMET. SMET faculty, both male and female, describe enhanced social and academic support for female students, successful recruiting of top-quality female students, opportunities for networking, and high-level institutional exposure for women staff and faculty as byproducts of a project that mobilized a strong and vital community committed to gender equity.

The greatest testimonial of the project's success is its institutionalization after the end of the PWG grant ($1,137,030). The project is now a highly-regarded, permanent feature of the campus.

C. Partnerships and Collaborations

Collaborations are partnerships in which each member contributes tangibly to project implementation, including commitment of human, physical, and/or financial resources.

A third way PWG projects contributed to social capital was in the formation of partnerships and collaborations. Collaborations contribute to social capital by increasing the collective resources available to address gender equity in SMET.

PWG awarded funds to individual institutions, but the program description (NSF 93-126) specified that Experimental projects should utilize collaboration building to leverage each institution's own social, political, and financial capital in order to more effectively achieve change. There was no comparable charge to Model projects. In spite of this, some Model projects did involve collaboration-building activities. In all, 22 completed projects in the sample (10 Experimental and 12 Model) reported collaborative activities, including capitalizing on existing collaborations and forming new collaborations. Five of these new collaborations continued beyond the PWG grant, indicating long-term impact on social capital. Collaborations continued to seek grants, lobby for institutional and school district funds, and in many cases institutionalize PWG activities. Partners and collaborators in PWG projects included: interest groups or professional organizations, schools or school districts, community groups, universities, community colleges, the federal government, industry, local government agencies, museums, and radio or television stations.

Some projects reported their partnerships and collaborations contributed to social capital in specific ways, including encouraging networking among individuals, engaging in system building, and building collections of gender equity-oriented resources. Sixteen of the completed sample projects (53 %) promoted at least one of these social capital-building activities: two projects reported facilitating formal networking activities; five projects developed clearinghouses or resource centers of information about SMET and gender equity; and nine projects engaged in explicit system building activities.

Networking is linking individuals from different institutions to create a supportive environment for sharing information.

System building is linking institutions for mutual growth and cooperation in the area of SMET and gender equity.

Resource gathering is creating a clearinghouse or resource center for information and resources on gender equity and SMET.

D. Impacts on Policy and Practice

PWG projects also contributed to social capital by introducing and supporting equitable policies and practices in formal and informal educational settings in the institutions in which they were implemented. They include modifications in teaching practice, creation of new courses or revision of existing courses to provide more opportunities for gender equity in SMET classrooms, introduction of new instructional materials free from gender-bias, and inclusion of high school and undergraduate students in laboratory and field research opportunities usually reserved for graduate students. The frequency of these impacts on policy and practice is described in Table 6.

Table 6. Effects of PWG on Policy and Practice

Changes	All Completed Sample Projects (N=30)	
	Number	Percent
Introduction of New Instructional Materials	16	53%
Creation/Modification of Courses	7	23%
Changes in Pedagogical Practices	4	13%
Broadening of Research Opportunities for Students	3	10 %

More than half of the completed sample projects (16 projects or 53 percent, predominantly in pre-college settings) created new instructional materials for both formal (classroom) settings and informal (extracurricular) settings. Nearly one-quarter of sample projects (7 projects or 23 percent, mostly at the post-secondary level) created new courses or modified existing courses to improve opportunities for girls and women in SMET classrooms. For example, two of the courses targeted preservice teachers, augmenting the traditional curriculum to provide training in pedagogical strategies associated with improving outcomes for girls. Three projects modified existing undergraduate SMET "gate-keeping" courses to create a more supportive environment for female students. Two projects created new courses to encourage students to explore the scientific method or opportunities to employ science in community service projects. A small number of Experimental projects (4 projects or 13%) provided professional development to educators to encourage them to use classroom strategies to achieve gender equity. Three projects (10%) opened opportunities for participation in laboratory or field research to students for whom these opportunities were previously unavailable. All of these changes in policy and practice were intended to broaden opportunities for *all students* and eliminate gender-biased policies and practices that discourage girls and women from pursuing SMET study.

Emerging Themes on PWG's Contributions to the Climate for Females in SMET

The term "climate" describes characteristics of a professional or educational setting, including the existence of material and human resources and the actions and attitudes of stakeholders. Traditionally, the climate in SMET fields has been perceived as hostile to females, thereby limiting females' opportunities in both educational and professional venues. Positive changes in social capital, however, encourage positive changes in climate and increase opportunities. In the literature, contributions to social capital including increased funding, replication and institutionalization of effective intervention models, collaboration among individuals and institutions, changes in policy and practice, and the creation of resource centers and clearinghouses are reported to improve the climate for girls and women by increasing material and human resources available to support females in SMET.[16] The impact study collected anecdotal information about PWG's impact on the climate for women and girls in SMET reflecting these findings in the literature. These themes emerged in interviews with principal investigators.

Principal investigators identified a number of positive changes in the SMET climate that occurred over the course of their projects. For example, one university showed an increased number of women faculty in the physics department. This change resulted from efforts to recruit more women. The increase in women in the department, and the subsequent increase in access of female faculty to department resources, led to a greater number of female physics students involved in laboratory research. This change in turn also affected the climate, reducing the isolation previously felt by female students and making the department more welcoming to future female students.

Another principal investigator reported positive climate change resulting from project efforts to increase networking among and collective action by female faculty. The project drew attention to the efforts and achievements of female SMET faculty, and as a result the dean learned the names of some newer faculty members who had previously been "invisible" to the administration. Being known to and recognized by the dean was perceived as advantageous to the young professors.

A third kind of climate change occurring in both universities and in K-12 settings was the "winning over" of other educators outside the circle of participants directly involved in PWG projects. Several principal investigators reported that their PWG projects raised awareness of and support for gender equity among their non-participating peers. K-12 teachers and university faculty interviewed during site visits reported that even educators who were not initially involved in PWG projects became interested in gender equity issues and strategies after seeing new pedagogical methods used by project participants.

Many principal investigators echoed these and similar themes about changes in climate. Although these changes, some subtle, and some overt, are not readily quantifiable, they are important indicators of the nature and scope of PWG's contributions to social capital.

[16]Hall, R.M. et al. (1982) *The Classroom Climate: A Chilly One for Women?*. Washington, D.C.: Association of American Colleges. Hall, R.M. and B.R. Sandler (1984) "*Out of the Classroom: A Chilly Campus Climate for Women*." Washington, D.C.: Project on the Status and Education of Women of the Association of American Colleges.

E. Replication of PWG Models

A fifth way in which PWG projects affected social capital was by producing replicable models for intervention with girls and women in SMET. In order to assess the frequency of replication, persons involved in the replication of PWG models were identified by the principal investigators and interviewed by the impact study staff. By this method, we found that five of the completed sample projects (17%) were replicated. However, it is likely that replications of PWG models are undercounted in this impact study. The nature of replication—achieved through the purposefully wide dissemination of project materials—makes it likely that some replications of PWG models were undertaken without the knowledge of the original principal investigators. Thus, we likely undercounted the true number of replicated PWG models.

Replication is the adoption and/or adaptation of some or all major project activities by an organization not originally associated with the PWG project.

As described above, PWG contributes to social capital by providing substantial funding to increase the access of girls and women to SMET. In addition, the PWG projects we examined appear to have contributed to the development of a supportive infrastructure for the advancement of girls and women in SMET in a variety of ways. They developed strategies which were institutionalized, established and enriched partnerships and collaborations, changed policy and practice in educational institutions, and provided models for replication. According to the gender equity literature, all of these changes contribute to a climate that encourages girls and women to persist and succeed in SMET.

III. PWG's Contribution to Human Capital

Evidence of impact on human capital was derived from a number of sources. It came from interviews with the principal investigators of all 40 sample projects about the number of participants served. It was also drawn from a review of outcomes for participants in the 19 projects for which credible outcome information exists and on corroborating interviews with principal investigators and project evaluators.

Human capital is an individual's accumulated assets, resources, and sources of strength. All individuals attain a certain stock of human capital, developed primarily through education and training.

Human Capital Research Question:

What impact has PWG had on participants or other target audience members?

The data indicate PWG projects had positive, short-term impacts on human capital by 1) directly serving thousands of participants; 2) producing positive outcomes for project participants;[16] and 3) producing beneficial impacts on the principal investigators of PWG projects.

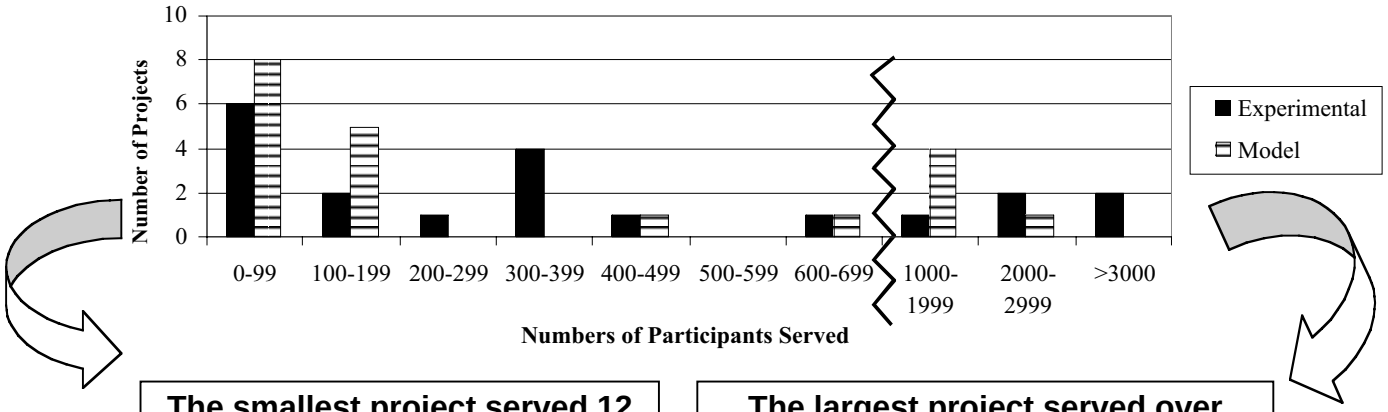
A. Number of Participants Served

The primary purpose of PWG is to develop and disseminate model interventions, not to provide direct services. As such, aggregating the number of participants served directly by the projects may undercount the total impact the program has had via replication and institutionalization. However, the 40 PWG projects we examined did directly serve nearly 32,000 participants. Participants in PWG projects included: students in kindergarten through 12th-grade, teachers, counselors, and administrators; undergraduate and graduate students; university faculty; SMET professionals, parents, and adult (noneducator) leaders of children's activities. For school-aged populations, the categorization of children as students—elementary, middle, or high school—included children of those approximate ages served in nonschool settings (for example, by

[17] PWG's long-term impact cannot be assessed until enough time has elapsed to measure outcomes such as choice of college major, enrollment in SMET graduate study, and entry into SMET careers. For most of the funded projects in our sample, insufficent time has elapsed to determine long-term impacts.

projects targeting girl scouts or other nonschool groups). Vast variation existed in the number of participants served by individual projects; the smallest served 12 and the largest served 8,261 (Figure 5).

Figure 5. Number Served Ranges In 40 Sample PWG Projects



The smallest project served 12 participants…

A Model project operated for one year ($74,521) at a four-year college to encourage women to promote entrance and retention in computer science majors. The project included: recruitment efforts targeting women, mentoring activities for female computer science majors; formal preparation for cooperative education work assignments; and workshops for computer science faculty and business representatives on gender-related issues in computer science.

The largest project served over 8,000 participants…

An Experimental project operated for three years ($1,282,962) under a collaboration between a regional Girl Scout Council and a science museum. It employed a "Training the Trainer" model to (1) develop and disseminate hands-on science activities for Girl Scouts and (2) train Girl Scout leaders to use materials with their troops to help the girls earn science-oriented merit badges. Over the three-year period, more than1,000 leaders participated in the training (and over-night camp-ins at the science museum) and used the activity kits with their scouts.

Ninety percent of all participants were kindergarten through graduate students. The remaining 10 percent were adults. The largest group of participants served by sample PWG projects were middle school students (43 percent of all participants), followed by high school students (28%) and undergraduates (10). [17] The literature on SMET gender equity identifies these as appropriate targets for intervention because they are junctures in the SMET "pipeline" at which female students tend to leave the field.

Reaching a Broad Audience: Bridging the Gap

"Bridging The Gap" (BTG) is an experimental project directed by Marilynn Sikes of the Discovery Place, Inc. Science Museum and collaborators at the Hornets' Nest Council of the Girl Scouts of the USA located in Charlotte, NC ($1,282,962). The project began in August 1994 and is scheduled to be completed in July 2000. BTG makes science, mathematics, and engineering more accessible to girls and women by incorporating SMET activities leading to merit and interest badges intoGirl /scout programming. Its enormous reach is unique; it has the capacity to impact thousands of individuals before its PWG funding ends.

The Project Director built BTG around the theory that if presented with opportunities, girls will engage in SMET activities, preparing them to pursue prestigious, high-paid careers in technical fields. However, she was concerned that Girl Scout leaders were not always comfortable guiding their troops through SMET activities. Thus, the first step in the dissemination of BTG "Nosebag Science" activities is the training and support for adult leaders. In addition, the "Nosebag Science" kits are packed ready-to-go, with all necessary materials and instructions. The training and leader-friendly product format encourage leaders to use the materials with their girls.

BTG dissemination was designed to take advantage of the pyramid structure of the Council of the Girl Scouts. The Council staff collaborated with Discovery Place, Inc. scientists to develop the activities. The Council then disseminated the activities through training at 25 smaller service units, which then disseminated the materials to their component troops of Daisy, Brownie, Junior, Cadette and Senior Girl Scouts. Because the structure was in place to permit wide-scale dissemination, BTG has been able to maximize its impact on young women in North Carolina. In the Hornets' Nest Council alone, 7,361 girls and 900 adult leaders have been exposed to BTG activities. Project staff held a national conference to train 60 other Girl Scout Councils to use BTG materials, and post-conference dissemination has increased the audience to a total of 141 councils currently using BTG materials.

To date, 147 Girl Scout Councils around the country have requested BTG materials. Future plans are to distribute the materials for use by Girl Scouts everywhere in the U.S.—potentially an audience of 2.6 million girls. In 1998, BTG was cited in testimony to the U.S. House of Representative's Committee on Science. In May 1999, the National Center for Children and Technology cited Bridging The Gap as one of the 12 best science education programs in the country.

[18] We estimate that all Experimental and Model projects funded between 1993 and 1996 served nearly 85,000 participants.

B. Outcomes for Participants

Predicted Outcomes are described in proposals as project aims.

Measured Outcomes are changes in participants' knowledge, attitudes, and behavior measured after intervention and documented in credible project evaluations.

Participant outcomes discussed in this report include: affective enhancement for SMET study (see definition in Figure 6); increased SMET course-taking; mastery of SMET content; interest in, and entry into, SMET careers; and use of gender equity strategies in SMET classrooms. These categories were constructed by identifying every predicted outcome in each proposal and every measured outcome in each project evaluation. The measured outcomes were drawn from the 19 projects with credible project evaluations identified earlier in this report. These outcomes related to change (positive, negative, and none) in participants' knowledge, attitudes, or behavior upon completion of the project. [18] Most projects predicted more than one type of human capital outcome.

Figure 6. Predicted Outcomes for PWG Project Participants

	Outcome	Definition
Student Outcomes	**Affective enhancement for SMET study** ▪ Self-confidence in SMET ▪ Attitudes towards SMET and females in SMET	Changes in attitude regarding competence in SMET from pre- to post-intervention.
	SMET course-taking ▪ Enrollment in SMET courses ▪ Interest in, or plans for, SMET study ▪ SMET majors in college ▪ Retention in SMET study ▪ Pursuit of SMET graduate study	Students' enrollment in SMET courses and changes in intentions to pursue SMET study from pre- to post-intervention.
	Mastery of SMET content	Students' knowledge of SMET content from pre- to post-intervention.
	SMET career plans ▪ Plans to pursue a SMET career ▪ Entry into a SMET career field	Students' entry into a SMET career post-intervention or change in intention to pursue career from pre- to post-intervention.
Adult Outcomes	**Awareness and use of gender equity strategies** ▪ Awareness of gender equity issues ▪ Use of gender equity strategies	Change in educators' or leaders' knowledge of gender equity issues in SMET settings and change in use of specific strategies to create an equitable environment for all students from pre- to post-intervention.

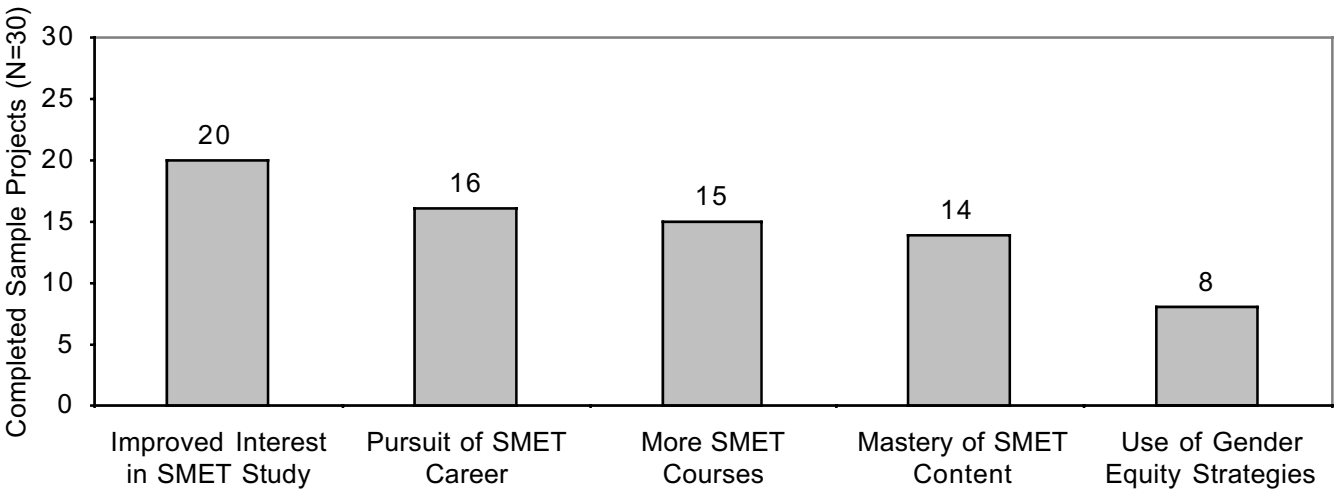
[19] Many projects also collected anecdotal information about outcomes for participants: stories about the participants' later progress in SMET classes, choice of SMET majors, etc. While this information is interesting and demonstrates an impact on individual participants, it is not quantifiable because it is not methodically measured. Therefore, these anecdotal data are omitted.

Nothing's going to hold her back. That's what this program has done for her.

—Parent of PWG Project Participant

Figure 7 shows the percent of completed sample projects that predicted change for participants in each of the five outcome categories described in Figure 6.

Figure 7. Predicted Change for Participants



Most projects predicted more than one kind of change for participants. Sixty percent of all the completed sample projects predicted they would enhance students' interest in SMET study. About half predicted they would increase SMET course taking or plans for SMET course taking, promote mastery of SMET content, or positively influence SMET career plans (53% , 50%, and 47%, respectively). Fewer projects predicted they would increase adults' awareness and use of gender equity strategies (27%).

As discussed above, 19 of the 30 completed sample projects produced credible outcome data about change for participants. These data show that sample projects were very successful at achieving predicted human capital change. Figure 8 shows that almost all measured change for participants was positive.

Figure 8. Outcomes Measured by All Completed Sample Projects

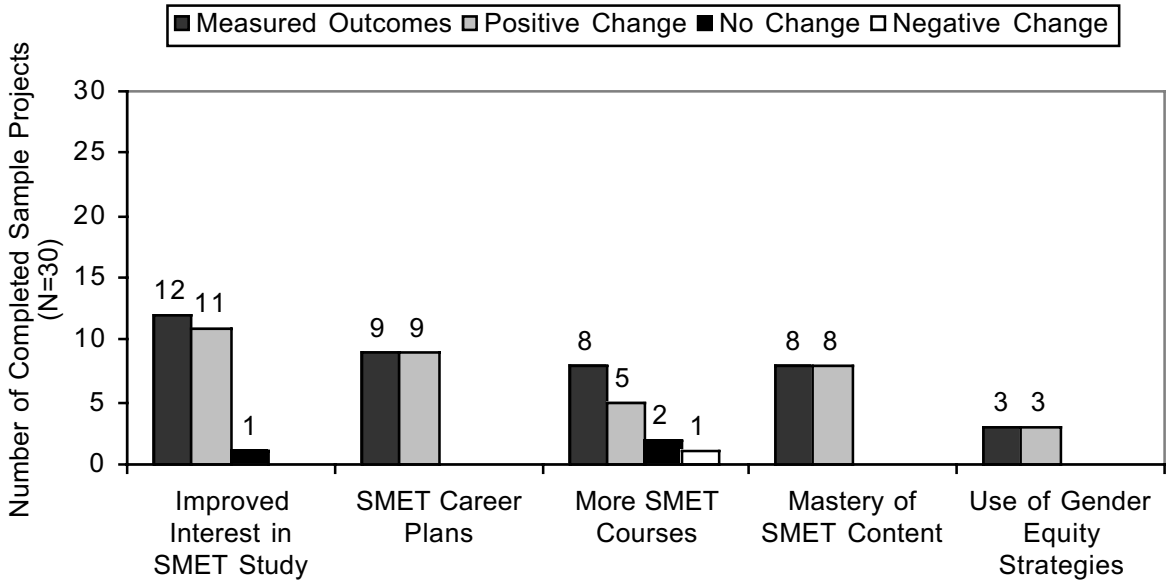


Figure 8 shows that almost all of the data from the 19 credible PWG project evaluations show benefits for over 10,000 total participants. Only one project measured a negative change: a decrease in students' interest in pursuing SMET courses in high school. Three projects measured "no change" after the project, one in interest in SMET study and two in course taking plans.

In sum, where projects did (credibly) measure and report outcome data, the data show the projects were almost universally successful in achieving predicted change. Evidence from the impact study shows that projects did not always measure change for participants they predicted would occur. It appeared that in some cases, unmeasured outcomes resulted from the fact that predicted outcomes were related to education and career decisions to be made in future years. Projects funded for 12 to 36 month periods did not have the resources to collect long-term data. Also, many sample projects were completed only recently, and will not be able to observe long-term effects for several years.

Demonstrating Human Capital Impacts for Students, Educators, and Parents: The Dr. C.D. Turnage Scholars Program

The "Dr. C.D. Turnage Science, Math and Technology Scholars Program", an experimental project funded from June, 1996 through May, 2000 ($888,916), is operated by a collaboration of Elizabeth City State University and the Roanoke River Valley Consortium under the direction of Dr. Deborah C. Fontaine, Ms. Patricia Dobbin, Dr. Cheryl Lewis, Dr. Joseph Nelson, Dr. Shirley Turnage, Ms. Sandra Hardy, and Dr. James McLean. The project serves five rural, economically disadvantaged, predominantly African-American school districts in North Carolina.

The project encourages eighth-grade girls to pursue SMET study by providing hands-on activities, field trips, and a SMET oriented summer camp held at a college. Teachers, counselors, and school staff are engaged in professional development centered on equitable instructional delivery practices. Parents are also included in activities and discussions of gender equity issues.

Interim evaluations show quantitative and qualitative gains for participating students in math and science grades and attitudes and interest in SMET. Measurements of teachers' attitudes and practices show gains in awareness and use of gender equity strategies in the classroom pre- to post-intervention. Surveys of parent participants reveal they feel more confident about their daughters' abilities and more willing to support girls' pursuit of science and math education and careers.

C. Outcomes for Principal Investigators

Most projects focused on outcomes for participants; none of the sample projects monitored the impact of the project on the principal investigators. However, in interviews about the impact on their professional and personal activities and interests, principal investigators of the 40 sample projects reported many ways in which they had been affected by PWG. Respondent reports include: positive personal and professional change; enhancement of networking and contacts; promotion; institutional, community, and national recognition; tenure; and awards resulting at least in part from their PWG projects. For many principal investigators, work on PWG projects led to subsequent grants (both from PWG and from other sources) to further explore issues of gender equity and SMET (Table 7).

Table 7. Effects on Principal Investigators

Impact on Principal Investigators	All Completed Sample Projects (N=30)	
	Number	Percent
Academic Tenure	7	23%
New Position	14	47%
Promotion	18	60%
Awards	8	27%
Additional Funding	18	60%

The majority of sample projects resulted in benefits for the principal investigators, although these gains were not the explicit purpose of the projects. Because most projects had female principal investigators, PWG resulted in a cadre of women earning promotions and academic tenure, being selected for new positions, winning regional and national recognition for their efforts, and successfully competing for subsequent funding for their work.

In summary, PWG projects contributed to human capital by directly serving thousands of participants, and by benefiting participants and principal investigators in concrete ways.

IV. PWG Project Evaluations

Evaluation Review Research Question:

What are the frequency, methodological soundness, and quality of project-level evaluations?

Because NSF was interested in the frequency and quality of project-level evaluations, and because we relied on them as a major source of data for the impact study, a systematic review of all project evaluations was conducted. We were primarily interested in summative evaluations, that is, evaluations of project outcomes and impact. Many projects also conducted (or only conducted) formative evaluations: evaluations collecting participants' feedback on various aspects of project implementation.

Although these process evaluations are key in helping project staff refine the delivery of project services, we were more interested in evaluations that provided outcome data.

As described in earlier sections of this report, 22 of the 30 completed projects conducted summative evaluations. The evaluations varied significantly in terms of design, sources for outcome data, and measures used.

Sources of Outcome Data

- Surveys
- Participants' Journals
- Interviews
- School and University Course Enrollment and Graduation data
- Standardized Test Scores
- Structured Observations
- Skills Tests

The practice of good evaluation suggests the following are critical aspects in a strong evaluation:

- A well-established theoretical link between the interventions to be delivered and the outcomes to be achieved;
- A cogent means of measuring outcomes;
- High-quality data;
- Appropriate analytical techniques and inferences;
- Overall scientific integrity.

We had no difficulty assessing the PWG evaluations on the first point. In order to be funded, projects had to be based on existing theory and research on gender equity in SMET. Proposals that did not explicitly link interventions and outcomes with theory were rejected by the reviewers and not funded by the program. To judge the evaluations on points two, three, and five we developed a set of objective criteria, described below in Table 8 to assess the credibility of each evaluation.[19] To assess point four, the degree to which analytical techniques and inferences are appropriate, we used our subjective judgment based on the context of the projects and our knowledge of the field of gender equity in SMET.

[20] The criteria do not capture every aspect of determining the quality of data and overall scientific integrity but they include the considerations we felt were most important.

Table 8. Assessment of Project Evaluations

Strength of Evaluation Evidence	Characteristics of Evaluation	Number of Evaluations	Percent of All Projects with Evaluations (N=22)	Percent of All Completed Sample Projects (N=30)
Clear and Convincing Evidence	☑ Sufficient Sample Size (N≥10) ☑ Means of Measuring the Outcome(s) Identified and Appropriate ☑ Pre-Post, No-Treatment Control, or Comparison Design ☑ One or More Data Collection Points ☑ Sufficient Description of Evaluation Design ☑ Appropriate Analytical Techniques and Inferences	11	50%	37%
Possible or Probable Evidence	☑ Sufficient Sample Size (N≥10) ☑ Means of Measuring the Outcome(s) Identified and Appropriate ☐ Pre-Post, No-Treatment Control, or Comparison Design ☑ One or More Data Collection Points ☑ Sufficient Description of Evaluation Design ☑ Appropriate Analytical Techniques and Inferences	8	36%	27%
No Credible Evidence	☐ Sufficient Sample Size (N≥10) ☐ Means of Measuring the Outcome(s) Identified and Appropriate ☐ Pre-Post, No-Treatment Control, or Comparison Design ☐ One or More Data Collection Points ☐ Sufficient Description of Evaluation Design ☐ Appropriate Analytical Techniques and Inferences	3	14%	10%

Table 8 shows that of the 22 project evaluations, 19 were of sufficient strength to provide clear and convincing or possible/probable evidence about project effectiveness. This group of credible evaluations includes 86 percent of all evaluated projects, but only 64 percent of all completed sample projects.

PWG project evaluations were conducted by either internal evaluators, usually the principal investigator or co-principal investigator (12 projects) or external evaluators (10 projects). In general, external evaluators produced methodologically stronger evaluations than internal evaluators in terms of data collection methods, sample size, and measurement of change. In addition, external evaluators more clearly described the evaluation design, data collection and analysis methods, and statistical justification for conclusions drawn about positive impacts. These

externally produced reports were also more likely to discuss weaknesses in the evaluation design or execution that threatened the robustness of results.

The PWG project evaluations varied in their design. Nearly half of completed projects (9 projects or 47%) employed a pre- and post-intervention design to measure change in participants. Five projects (26%) adopted a more rigorous quasi-experimental design. One project compared project outcomes with historical data. Five project evaluations featured a post-intervention design, relying on participants to retrospectively self-report change attributed to project participation. Three projects produced evaluations for which the design was so poorly described that it is impossible to determine if evaluation results are credible or not.

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The 22 reviewed evaluations employed a variety of data sources. Most evaluations used more than one source of information, which included: surveys; journals; interviews; school and university course enrollment; grades, testing and graduation data; and structured observations. The most frequent means of data collection was participant surveys, used by 74 percent of evaluated projects. Most projects employing surveys developed the instruments themselves. Four of the projects reported using established, widely validated instruments (the Fennema Scales, Kahle's Perceptions of Science and Scientist, Meyer's Science Attitude Scale, Erb's Women in Science Scale, Sadker and Sadker's Classroom Observation Scale for Gender Equity, and Aiken's Revised Mathematics Scale). Only one of the evaluators who reported using project-developed surveys described the process used to field-test and revise instruments to ensure reliability and validity. The remaining nine evaluations that employed surveys provided no detail about the internal validity or reliability of the instruments used. Twenty-six percent of evaluated projects used school or university-based data, including course enrollment, graduation rates, degrees earned, grades, or standardized achievement test scores.

In the few cases where statistical tests were employed to measure the significance of observed change from pre- to post-intervention, small sample sizes potentially threatened the validity of the t-tests and chi square analyses. Experimental projects, which typically served larger populations by virtue of their three-year time span, were in some cases able to aggregate three years' worth of participant data, yielding larger samples. In any case, only seven evaluations discussed using statistical tests to verify results.

Decreasing response rates from pre- to post-intervention, and from post-intervention to follow-up, also affected sample sizes and raised the risk of biased results. Evaluations that relied on mailed surveys after the intervention frequently had very low response rates. Also, instruments intended to collect data from participants who were not the primary target population (for example, parents)

also frequently had very low response rates. A few projects attempted to increase response rates by offering monetary incentives to participants for completing and returning post-intervention surveys. However, even these methods were not always successful. Three methods surfaced as the most successful for collecting post-intervention or follow-up data: person-to-person contact, telephone interviews, and data collection undertaken during the final project activity or at a subsequent "reunion" event.

In sum, the impact study found that 86 percent of completed evaluations were of acceptable, although varied, quality. Fourteen percent of the completed evaluations did not provide credible information about project outcomes. Over one-quarter of all the completed projects in the sample (27 %) did not complete summative evaluations. Projects with poor quality or missing evaluations did not contribute outcome data to the study. In the following chapter we present recommendations for improving project-level evaluation.

CHAPTER 3. SUMMARY AND RECOMMENDATIONS

As the demand for a workforce with advanced mathematics and science skills grows, the inclusion of women and girls in SMET study and careers becomes an increasingly critical issue. To meet current and future demand, girls must be prepared for, and challenged to pursue SMET study from the time they begin school. PWG was developed by NSF to provide this encouragement, and is responsible for positive outcomes in the areas of knowledge capital, social capital, and human capital for girls and women in SMET.

A. Impact on Knowledge Capital

Summary of Knowledge Capital Findings:

- Eleven sample projects (28% of the sample of 40) contributed to knowledge capital by producing 28 articles, papers, and book chapters sharing information about research, evaluation, and practice in the field of gender equity and SMET.
- Fourteen of the manuscripts (50%) produced by sample projects received the highest quality rating —indicating a high quality contribution to the scholarly literature.
- Thirteen sample projects each created and disseminated one or more instructional products each.
- The mean rating of products produced by sample projects was in the "good quality" range.
- Each of the products had been disseminated to at least 50 people nationally and globally, with some reaching as many as 700 people.

A number of the projects we reviewed had a beneficial impact on knowledge capital. They produced scholarly articles, half of which were judged to be of very high quality. Instructional products created by some sample projects also contributed to the knowledge base about gender equity in SMET. These products were rated on average "good quality."

Many project evaluations suggested that strategies employed by PWG projects, in particular mentoring/role modeling, extracurricular SMET activities, summer camp, activities for parents, and professional development for educators were associated with positive change for girls and women over the course of the projects. This evidence supports the gender equity literature which suggests that these types of interventions have beneficial effects for girls and women.

Requiring projects to report information such as about average hours of exposure to each intervention per participant would improve PWG's capacity to understand the links between strategies and outcomes and expand PWG's contribution to the SMET equity knowledge base.

Dissemination of knowledge is critical for creating permanent change in SMET and maximizing NSF's "bang for the buck." The program should capitalize on opportunities to contribute to

knowledge capital by encouraging dissemination of information about effective strategies (and, equally important, ineffective strategies). Providing funding for dissemination is one tool to accomplish this goal.

Recommendations for monitoring PWG's contributions to knowledge capital and encouraging projects to contribute to knowledge capital:

1. Require projects to report key information such as about average hours of exposure to each intervention per participant.

2. Consider providing funding for dissemination of project findings.

B. Impact on Social Capital

Summary of Social Capital Findings:

- PWG is the largest public or private funder of efforts to increase the access of women and girls to SMET fields.
- Twenty-two PWG-funded models (73% of completed sample projects) received further funding from PWG, other NSF programs, and private and public sources.
- Nineteen sample projects (63%) were institutionalized after the end of their PWG funding with permanent, line-item funding from their institutions. Three other projects (10%) are currently sustained with soft funding.
- Eighty-eight percent of the sample projects that demonstrated positive outcomes were institutionalized or sustained with grants raised by the principal investigators after their PWG funding expired.
- Twenty-two PWG projects (73% of completed sample projects) built and expanded collaborations between interest groups/professional organizations, school(s) or school district(s), community groups, universities, community colleges, federal government projects, private industry, local government agencies, and museums. Many collaborations continued after the end of PWG funding.
- Impacts on educational infrastructure included: improved pedagogical practices used to nurture and challenge females in SMET courses, the creation of new courses or modification of existing courses to provide more opportunities for achieving gender equity in SMET classrooms, the introduction of gender bias-free curricula, and the broadening of SMET research opportunities for students at the high school and university levels.

PWG plays a critical role in the national effort to attract and retain females in SMET fields. NSF, through PWG (now the Program for Gender Equity), devotes more funding targeted to gender equity in SMET than any other public or private entity in the U.S. NSF funding is leveraged through the collaborations and partnerships built by PWG projects and through subsequent replication and institutionalization of PWG models. Social capital impacts of PWG include long-

term, positive changes in educational infrastructure including adoption of pedagogical practices designed to foster equity in the classroom, the creation of new courses to provide more opportunities for gender equity in SMET fields, the introduction of curricula that is free from gender bias, and broadening SMET research opportunities for students traditionally excluded from these opportunities.

Social capital impacts are difficult to measure in quantitative terms and, as a result, are rarely reported in project evaluations. We suggest that PWG explore ways to encourage principal investigators to document these important outcomes, particularly institutionalization and replication of PWG models as this is important information about PWG's impact.

Recommendations for monitoring PWG's contributions to social capital:

1. Encourage projects to track and report institutionalization and replication of PWG models.

2. Encourage projects to think of creative ways to document, and where possible, quantify social capital outcomes such as the building of partnerships and collaborations and changes in policy and practice.

C. Impact on Human Capital

Summary of Human Capital Findings:

- The 40 PWG projects in the study sample directly served over 31,500 participants, including elementary through graduate level students, K-12 teachers and pre-service teachers, school counselors, school administrators, university faculty, SMET professionals, and parents. We estimate that *all* Experimental and Model projects funded between 1993 and 1996 served nearly 85,000 participants.
- Replications and institutionalizations of sample PWG projects have served an additional 15,614 participants (as of June, 1999).
- Participants most frequently targeted by sample PWG projects included students in middle school, high school, and college, settings that are identified in the literature as "critical junctures" for retention in the SMET pipeline.
- All but 1 of the 19 completed projects that produced credible project evaluations documented positive outcomes for participants including increased interest and enrollment in SMET courses, mastery of SMET skills and concepts, interest in SMET careers, and awareness and use of gender equity strategies by educators.

Outcome data from credible project evaluations provide evidence that sample PWG projects produced positive change in human capital in the short-term. These changes include enhanced self-confidence for SMET study, increased interest in SMET study, mastery of SMET content, increased interest in SMET careers, and awareness and use of gender equity strategies in formal and informal educational settings. However, predicted outcomes were not always measured and documented in project evaluations. This is often because predicted outcomes focus on education

and career decisions to be made in future years, and projects funded for 12 to 36 months have no capacity to track long-term change.

One unintended positive by-product of PWG was the positive impact on principal investigators. Interviews with project staff identified a number of positive changes from pre- to post-intervention, including contributions toward earning academic tenure, new positions, promotions, recognition awards, and additional funding. Positive impacts on these (mostly female) principal investigators is an important contribution to the field.

Recommendations for monitoring PWG's contributions to human capital:

1. Provide guidance for projects about how to select appropriate short- and long-term goals for changes in participants' attitudes and behaviors.

2. If PWG projects are to be encouraged to produce long-term change, consider how the program could help projects plan and implement long-term data collection and other follow-up efforts to measure change.

D. PWG Project-Level Evaluation

Summary of Project Evaluation Findings:

- Twenty-two of 30 completed sample projects (73%) conducted summative evaluations.
- Nineteen of the 22 reviewed project evaluation reports (86%) were judged to present credible evidence about the effectiveness of project strategies.

Project evaluation is complicated and, throughout the social sciences, evaluators struggle with common issues about quantifying measures of knowledge capital, social capital, and human capital. Weaknesses identified in some PWG project evaluations are common, and by no means unique to PWG. However, in reviewing the sample projects we found that during the study period between 1993 and 1996, there were not rigorous guidelines in place for project evaluation; further, projects were not held accountable for completing their evaluations as proposed. The FastLane reporting system that NSF has initiated is one means by which the program has addressed these issues since the end of the impact study sample period. Fast Lane requires that annual reports be filed before additional funds are released to the project and that a final report be submitted before the P.I. can receive further grants.

Recommendations for improving PWG project evaluations:

1. Establish specific and comprehensive reporting requirements for number of participants, including disaggregated information about age, grade level, gender, and race or ethnicity.

2. Standardize guidelines for reporting knowledge capital, social capital, and human capital outcomes.
3. Provide technical expertise to principal investigators in evaluation design, statistics, measurement, and methodology.
4. Consider the feasibility of providing resources for at least some projects to collect data on longer-term outcomes.

The guidelines suggested above to improve project evaluation and data reporting could be promulgated by PWG staff in collaboration with the Division of Research, Evaluation and Communication (REC) and disseminated via the PWG web site, program description, and the National Science Foundation's FastLane electronic reporting system. These proposed administrative requirements would assure that in the future, consistent and comprehensive data are available to measure the total impact—long-term and short-term—of PWG projects.

In conclusion, the impact study found sample PWG projects made significant contributions to knowledge capital, social capital, and human capital during the years 1993 to 1996. PWG's scope and impact in the field of gender equity and SMET is unmatched by any other privately or publicly funded program. In some areas of the impact study, our conclusions are necessarily based on assumptions about the quality and quantity of the data available. However, the evidence indicates that PWG effected both positive, short-term changes in human capital and also successfully initiated and sustained long-term changes in knowledge capital and social capital resources to improve equity in SMET.

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