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ABSTRACT

This chapter presents the results for the Multi-Agency Study of Teacher Enhancement Programs, a study of professional development programs believed to represent best practices in professional development for science teachers. Working through an interagency government task force coordinated by the National Science Foundation (NSF), representatives from six groups, the Departments of Energy, Education, Health and Human Services, the National Aeronautics and Space Administration, NSF, and the Smithsonian Institution conducted the study. The evaluation was designed to document the teaching practices promoted in the selected programs and to examine the impacts of the programs in terms of: (1) effects on classroom practice; (2) differences in effects on classroom practice by type of program; (3) effects on teacher leadership and dissemination of findings; and (4) the importance of supports at the district and school levels. Programs selected were expected to meet most of the following criteria: (1) an instructional approach that emphasizes hands-on/minds-on activities; (2) a standards-based approach that aligns curriculum, instruction, and assessment with local, state, and national standards or frameworks; (3) development activities that extend over time, including follow-up when participants return to their schools; and (4) direct involvement of participants with the scientific process. Additional considerations governing selection were stability, inclusion of teachers who are themselves from traditionally underrepresented populations, and inclusion of programs that were carried out within a systemic reform context. Thirty-four programs were included in the study, which was divided into three phases: programs documentation and description, a mail survey of all participants, and site visits to 13 of the initial 34 programs. Twenty-eight of these programs were characterized as development programs; the remaining six as research programs. Findings confirm the value of well-designed professional development experiences. (Contains 11 references.) (MVL)

3 Findings from the Multi-Agency Study of Teacher Enhancement Programs

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This chapter[1] presents the results for the Multi-Agency Study of Teacher Enhancement Programs, a study of professional development programs believed to represent best practices in professional development for science teachers. Working through an interagency government task force coordinated by the National Science Foundation (NSF), representatives from six groups, the Departments of Energy, Education, Health and Human Services, the National Aeronautics and Space Administration, NSF, and the Smithsonian Institution conducted the study. The evaluation was designed to document the teaching practices promoted in the selected programs and to examine the impacts of the programs in terms of: 1) effects on classroom practice, 2) differences in effects on classroom practice by type of program, 3) effects on teacher leadership and dissemination of findings, and 4) the importance of supports at the district and school levels. Programs selected were expected to meet most of the following criteria: 1) an instructional approach that emphasizes hands-on/minds-on activities; 2) a standards-based approach that aligns curriculum, instruction, and assessment with local, state, and national standards or frameworks; 3) development activities that extend over time, including followup when participants return to their schools; and 4) direct involvement of participants with the scientific process. Additional considerations governing selection were stability, inclusion of teachers who are themselves from traditionally underrepresented populations, and inclusion of programs that were carried out within a systemic reform context Thirty four programs were included in the study, which was divided into three phases: program documentation and description, a mail survey of all participants, and site visits to 13 of the initial 34 programs. Twenty-eight of these programs were characterized as development programs; the remaining six as research programs. Findings confirm the value of well-designed professional development experiences.

[1]This summary of evaluation findings is an update of the document, *Best practice in action: Final report of the multi-agency study of teacher enhancement programs*, Frechtling (1997) published by Westat, Rockville, MD.

> Not only were they seen by participants to be personally and professionally valuable, but also the data show that a teacher's participation has important effects on what happens in the classroom. Second, in the short term, programs that are tied directly to what is desired in the classroom have the most immediate payoff. Third, the school or district context, and the support provided for the application of learning make a big difference in the extent to which changes actually occur. Finally, the linkage between participation in professional development activities and the promotion of teacher leadership and dissemination of benefits is weak. Without explicit supports and direction for such undertakings, they are not likely to occur in any consistent or meaningful way.

The basic goal of professional development programs is to broaden and deepen the disciplinary and pedagogical knowledge of teachers. Attention to issues of professional development has increased since the beginning of this decade, when the President and 50 state Governors included improved professional development for teachers as one of eight national education goals:

> *By the year 2000, the Nation's teaching force will have access to programs for the continued improvement of their professional skills and the opportunity to acquire the knowledge and skills needed to instruct and prepare all American students for the next century.* (National Education Goals Panel, 1993)

Professional development programs in science and mathematics education have been the subject of widespread interest in recent years. This emphasis reflects, in part, the heightened importance of teacher education to systemic educational reform. Essentially, systemic reform calls for coordinated changes in all parts of the educational system to ensure that new and higher standards of achievement in science and mathematics are met by *all* students, regardless of gender or ethnic and linguistic background. Educators agree that the fundamental changes required to produce both academic excellence and equity rest largely on the continued growth and professional development of the Nation's teaching force. Reflecting that understanding, each year thousands of teachers take advantage of the opportunities for professional growth offered through a variety of means ranging from limited teacher workshops during the school year to summer institutes and multi-year programs of study.

These activities, generally known as "professional development programs," share one or more of the following goals:

- Broadening teacher knowledge and skills;
- Helping teachers apply new knowledge and skills in the classroom;
- Increasing teachers' awareness of hands-on and laboratory materials and developing strategies for use in the classroom;
- Increasing teachers' understanding of careers in mathematics and science and the skills needed for them; and
- Fostering teacher leadership.

Within this general framework, two types of more comprehensive programs are generally distinguished.

> *Development programs* are multidisciplinary offerings typically held in classroom settings at local colleges, regional education service centers, county or central/district offices of education, or laboratories. Normally these programs run from 2 to 4 weeks and include presentations, demonstrations, lectures, hands-on activities, cooperative group work, field work, and time for discussion, planning, and reflection. These programs usually focus on encouraging a "hands-on/ minds-on" instructional approach and have a primary goal of changing curriculum, instruction, and assessment.
>
> *Research programs* are similar in many respects, but they tend to be more intense and focused on immersing teachers in the scientific process by carrying out research projects in a university or federal laboratory setting under the guidance of working scientists. As initially developed, these programs were intended to engender a deep understanding of the research process in teachers and increase their knowledge about emergent content areas. Transfer to teaching and the classroom was seen as one byproduct of this increased understanding.

Both types of professional development programs may be a single year or multi-year experience and generally include followup sessions during the school year. Both also may provide additional materials or resources for participants to use in their classrooms.

Despite their importance to educational reform, professional development programs, including these more indepth, comprehensive experiences, have until quite recently been the subject of relatively

little comprehensive evaluation. Further, most of the studies reported in the literature have relied solely on teachers' self-reports. The majority of these evaluations looked at participant satisfaction with the programs and examined reported impacts on teacher renewal and enthusiasm for teaching. A much smaller number also looked at application of knowledge to the classroom. These studies typically concluded that most participants feel satisfied with the programs they attend, enjoy the opportunity to network with their peers, use what they have learned once back in their classrooms, share what they have learned with others, and believe that their new teaching behaviors have beneficial effects on their students (Frechtling, Sharp, Carey, & Vaden-Kiernan, 1995).

While such reports are encouraging, direct evidence of changes in classroom practice and resulting improvements in student performance have been sorely lacking. Understanding this situation and recognizing the problems it posed, the Dissemination and Evaluation Working Group (DEWG)—a government body operating under the National Science and Technology Council—coordinated an effort by federal agencies that support professional development projects to undertake an extensive evaluation of their efforts.[2] As a result, a multifaceted study was initiated in 1994. This chapter presents the results of that study.

Study Overview

Working through DEWG, six agencies initiated a study of professional development programs: the Departments of Energy (DOE), Education (ED), and Health and Human Services (HHS), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and the Smithsonian Institution. The work was coordinated by NSF and carried out by three independent research firms—Westat, SRI International, and the National Center for Improving Science Education. In the long term, the evaluation and other efforts of the DEWG were designed to meet two basic goals:

- Identifying those government-supported professional development programs in science, mathematics, and technology that are most effectively implementing and encouraging "best practice," and

[2]The DEWG was an interagency group whose mission was to enhance and expand the evaluation and dissemination of mathematics and science programs.

- Assessing the extent to which these programs are contributing to the national effort to improve science education in the schools.

More immediately, this evaluation was designed to document the teaching practices promoted in the selected professional development programs believed to represent best practice in science education at the time of study initiation. The study examined the impact of these programs on teachers and their teaching, assessed the extent to which dissemination took place, and determined participant satisfaction with the programs and their outcomes. In addition, the study tried to identify the contextual factors that affect a teacher's ability to apply new learning and use new approaches in the classroom setting.

Based on an extensive review of the professional development literature available in 1994, best practice was defined in terms of four elements:

- An instructional approach that emphasizes hands-on/minds-on activities;
- A standards-based approach that aligns curriculum, instruction, and assessment with local, state, or national standards or frameworks;[3]
- Development activities that extend over time, including followup when participants return to their schools; and
- Direct involvement of participants in the scientific process.

Using these and other selection criteria, program officers from each of the six agencies nominated professional development programs that they considered successful in delivering professional development in science teaching. Additional considerations governing selection were 1) stability[4]; 2) inclusion of teachers who themselves were from populations traditionally underrepresented in science or who work with significant numbers of students from those underrepresented groups; and 3) inclusion of programs that were carried out within a systemic reform context.

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[3]See National Council of Teachers of Mathematics (NCTM), National Research Council (NRC), and Project 2061's *Benchmarks* (Listed in References at the end of this chapter) for descriptions of standards-based instruction and professional development.

[4]It is recommended that programs nominated be in at least their second or third year of operation to avoid first-year, startup problems.

Thirty-four programs identified through this process were selected for the evaluation. Twenty-eight of the programs were characterized as development programs and the remaining six as research programs. The evaluation of these combined professional development efforts was carried out in two phases, summarized in Exhibit 1. During Phase I (summer 1994), evaluators made site visits to the 34 professional development programs while they were in progress, documenting program events and practices, reviewing program materials, and interviewing participants and other key players. The purpose of these visits was to document the extent to which programs exhibit the characteristics of best practice.

During Phase II, the evaluators looked at the impacts of participation on teachers when they returned to their classrooms. Two complementary techniques were used: a survey of both 1993 and 1994 program participants from each of the 34 programs; and more indepth analyses (called "case stories") of participants from 13 programs; these programs were selected because of variation in their design and implementation. The survey was used to get a broad picture of teachers' perceptions of the programs and their impacts. The case stories were designed to gather data that would corroborate (or refute) the findings from the surveys, as well as to provide a more indepth picture of program results in a limited number of cases. Detailed reports of the separate components of this study have been presented in a series of reports issued between November 1995 and March 1997.[5]

The Impacts of Professional Development Programs

The multi-agency study provided confirmation of a number of previous findings regarding professional development programs. First, the participants in these programs are not entirely representative of the U.S. science teaching force. While they resemble the overall teaching force in terms of age, number of years teaching, gender, racial/ethnic distribution, and major field of study, as a group they have a higher preponderance of advanced degrees and are more likely to have participated previously in extended professional development

[5]Phase I methodology and findings is presented in Ruskus and Luczak (1995). The findings from the site visits are presented in Westat, Natonal Center for Improving Science Education, and SRI International (1996). The findings from the survey are presented in Carey and Frechtling (1997). The present report summarizes some of these study findings.

Exhibit 1. Study design

Best practices evaluation of professional development (TE) programs		
Phase I. Program Documentation and Description *(Summer 1994)*	Phase II. Participant Followup *(1994-95 School Year)*	
Site visits *34 TE programs exemplifying best practice* • Modeling of best teaching practices • Immersion in "doing science" • Standards-based professional development • Followup activities	Mail (census) survey *All 1993 and 1994 participants from 34 Phase I programs* • Changes in teaching behaviors • Participant satisfaction • Feelings of renewal • Leadership roles/knowledge dissemination • District/school effects on other measures	Site visits *1-2 teachers from 13 of the Phase I programs* • Evidence of best practices transferred from the program • Objective validation of self-report data from survey

programs than the national population (Tables 1, 2, and 3). Thus, the findings reported here, as in other programs that primarily serve volunteer populations, must be interpreted with that caveat in mind.

Second, the study affirmed the previous reports that from a personal point of view, participation in summer institutes and followup activities is seen as very valuable and energizing. The following comments from participants in teacher development programs (Carey & Frechtling, 1997) were typical:

Table 1. Percent distributions of teacher development participants, by teacher characteristics and by grade level (n = 1,481)

Teacher Characteristics	All Participants	Grade Level: Elementary 1-6	Middle 7-8	Secondary 9-12
Whole sample	100%	32%	31%	37%
Gender				
Female	65	85	27	41
Male	35	15	73	59
Minority status				
White	83	84	78	87
All other races	17	16	22	13
Advanced degree				
Yes	59	52	60	65
No	41	48	40	35
Major field of study				
Education	59	87	70	26
Science or math	33	6	19	69
Other	7	7	11	5
Number of years teaching				
5 or less	25	23	16	15
6 to 19	52	54	53	52
20 or more	22	22	31	33
Administrative position held in school				
Department chair	18	21	14	20
Curriculum coordinator	10	11	13	6
Other administrator	17	11	15	23
None	55	56	58	51
Attended other science teacher enhancement programs of 40 hours or more in the past 3 years				
Yes	47	39	47	55
No	53	69	53	45

Note. Because of rounding, percents may not add to 100.

Table 2. Percent distributions of research participants, by teacher, school, and target science class characteristics (n=116)

Background characteristic	Percent of teachers
Teacher characteristics	
Gender	
Female	31
Male	69
Minority status	
White	87
All other races	13
Advanced degree	
Yes	82
No	18
Major field of study	
Education	16
Science or math	80
Other	3
Administrative position held in school	
Yes	45
No	55
Attended other science teacher enhancement programs	
Yes	55
No	45
School characteristics	
Metropolitan status	
Central city	30
Urban fringe	32
Town	18
Rural	20
Percent minority enrollment	
Less than 10	52
11 to 50	28
More than 50	20
School reform in science education	
Yes	58
No	42
Target class characteristics	
Instructional level	
Elementary (1-6)	0
Middle (7-8)	15
Secondary (9-12)	85
Ability level of students	
Low ability	2
Average ability	23
High ability	34
Mixed ability	41

Note. Because of rounding, percents may not add to 100.

Table 3. Population statistics for U.S. science teachers

Teacher characteristic	Grade Level		
	Elementary (1-6)	Middle (7-8)	Secondary (9-12)
Gender			
Female	91%	69%	34%
Male	9	31	66
Minority status			
White	88	89	95
All other races	12	12	5
Master's degree			
Yes	34	42	57
No	66	58	43
Major field of study			
Science	2	17	63
Science education	0	2	6
Other education	86	63	22
Other fields	12	18	10
Number of years teaching			
5 or less	23	23	21
6-19	58	53	44
20 or more	19	25	35
Hours of professional development in last 3 years*			
None	43	23	21
Less than 16	51	53	55
16-35	4	16	13
More than 35	3	9	11

*Weiss and colleagues report professional development by hours. Also, elementary grades for these data are 1-4, and middle grades are 5-8.
Note: Because of rounding, percents may not add to 100.
Source: J. Weiss, M. Matti, and P. Smith, Report of the 1993 National Survey of Science and Mathematics Education, Chapel Hill, NC: Horizon Research, Inc., 1994.

Rejuvenation of the desire to teach great science! Ideas, stories, resources and support from everyone resulted in a feeling of power and joy in doing science in the classroom. Confidence in knowing what I wanted to do was right and it would work.

I returned to my school so motivated about teaching that other teachers were aware of my "glow." It was the greatest mood lifter I have had in a very long time.

In addition, the study documented some other outcomes that help us better understand the more far-reaching benefits that well designed programs can provide. These findings are explored in more detail below.

Effects on Classroom Practices

The central question driving the multi-agency study was whether or not evidence can be found that the benefits of professional development programs extend to the classroom and the delivery of instruction. Based on the combined results of the case stories and the surveys, it is our conclusion that the answer is a cautious "yes."

We found considerable evidence that teachers were applying what they had learned about standards-based instruction in science to their classrooms. And, although not all teachers achieved the same level of competency, all groups showed progress and provided evidence of improved teaching. Gains were found for participants in both teacher development and teacher researcher programs.

Instructional impacts were explored through a variety of means. In the case stories, a fundamental question addressed in the classroom observations and interviews was whether or not teachers were using hands-on, inquiry-based methods and whether classroom activities reflected the content, instrumentation, or techniques introduced in the summer programs. The surveys queried teachers about their teaching practices and the frequency with which students engaged in various kinds of activities. Teachers were asked to report on the use of selected teaching strategies both prior to and after their summer experiences.

Taken together, the findings show considerable use of many of the elements of best practice and suggest that teachers' professional development experiences both reinforced and introduced standards-based practices that ultimately were translated into classroom instruction. For example, a participant in one of the teacher

development programs who was observed using hands-on techniques that were partially inquiry-based stated:

> *I have always used hands-on experiences with my students, even before [this program dealing with museum experience].*[6] *The program helped to give me more creative ideas and experiences to use in my science classes....I guess Museum in the Field did not change my teaching style, but enhanced it.*[7]

At another site the observer drew the following conclusions about Susan, a participant in one of the teacher development institutes, focused on space science:

> *At Susan's school, the infusion of space science from K-6 is a direct outcome of the materials that the program provides. The entire elementary science program at this school is built around the ideas of inquiry, exploration, and hands-on experience of the phenomena under study...Susan clearly demonstrated hands-on inquiry-based teaching throughout the 90-minute lesson.*

Finally, corroboration of impact was frequently found in interviews with supervisors and colleagues. Again, in another case story, the following was reported:

> *The principal believes that..."he [the participating teacher] would have left education without this experience. I've seen [teaching] changes this year. He has more confidence that what he's presenting is relevant to students. He stresses relevance in whatever he does. He's more hands-on than any other science teacher, and this is how it should be..."*

This is not to say that all programs prepared teachers to successfully translate what they learned to classroom activities. For example, our research program, rated very valuable in terms of participants' own acquisition of new skills and knowledge, failed the translation test.

> *Steve indicated that he could not use much of the content from the program in his classes...the subject matter is far too esoteric for any high school classroom application.*

[6]In referring to programs, we use the pseudonyms assigned in Ruskus and Luczak, 1995.

[7]Programmatic examples are taken from Westat, National Center for Improving Science Education, and SRI International, 1996.

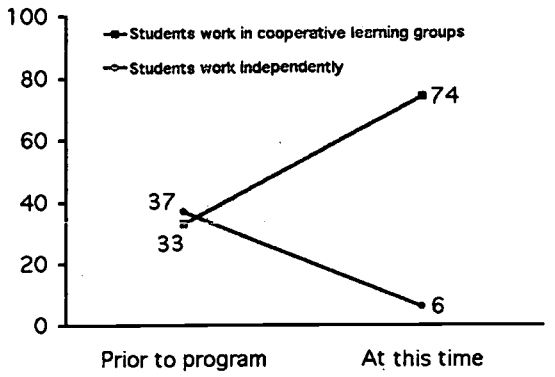
Survey data (Carey & Frechtling, 1997) support the conclusion that program participation impacts classroom instruction. At the same time, however, the data indicate that not all aspects of standards-based instruction were realized with equal strength. For example, while 59 percent of the participants in teacher development programs indicated that they were using new hands-on research projects and 50 percent reported using new explanations or examples in their teaching, only 37 percent indicated that they had made changes in their use of alternative assessments.

Figure 1 shows the reported changes in teacher practices for six specially selected pairs of behavior among teachers attending teacher development programs. One member of each pair represents more traditional teaching practices; while the second represents more current views about best practices. As the exhibit shows, while change in the desired direction occurred for each of the pairs of practices, gains were not uniform, and levels of implementation differed substantially after program participation

An interesting contrast can be found at pairs *a* and *c*. Although the reported prevalence of the two practice choices is roughly the same in *a* and *c* prior to the program participation, the amount of change toward use of best practice is substantially different. Pair *a* contrasted use of cooperative learning with student independent work. There, the use of cooperative learning increased from 33 percent of the participants reporting substantial use to 74 percent selecting this response. The corresponding decrease in student independent work went from 37 percent to 6 percent reporting frequent usage. Pair *c* contrasted indepth study of selected topics with comprehensive coverage of topics at the expense of detail. Indepth coverage increased from 27 percent prior to participation to 48 percent after participation. The corresponding figures for comprehensive coverage were 36 percent to 22 percent. It is easy to see that while both of these changes would be considered positive, the reported adoption of indepth study changes far less and reaches a much lower end level than that of cooperative learning.[8]

[8]This relatively more limited attention to indepth study of topics is confirmed by data from studies such as the Third International Mathematics and Science Study, which indicates that U.S. teachers adopt indepth coverage far less than their international counterparts.

a.



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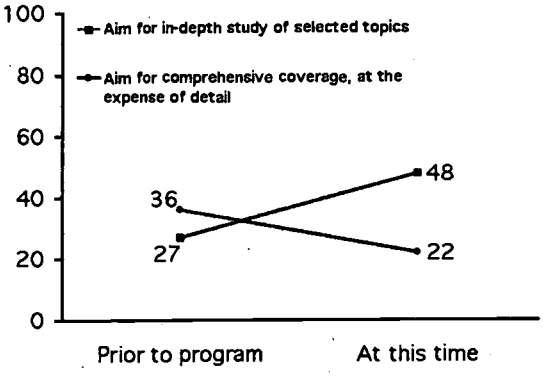

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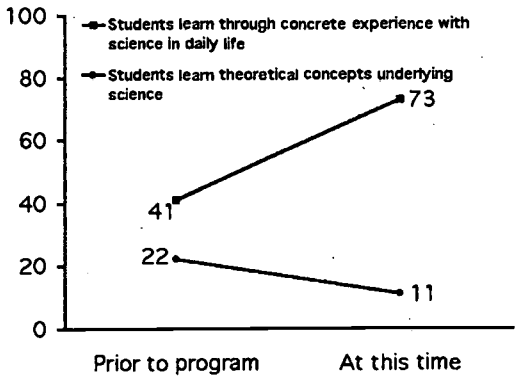
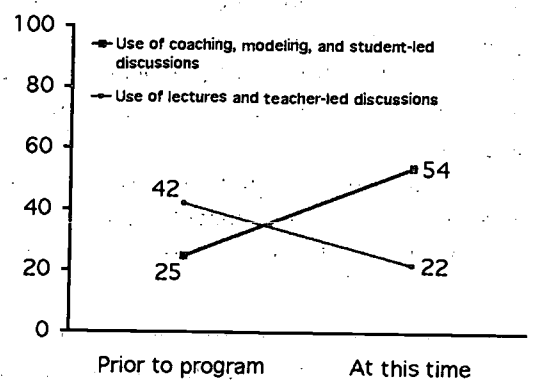


Figure 1.
Percentage of participants reporting change in use of various teaching techniques after participation in teacher development programs*

b.



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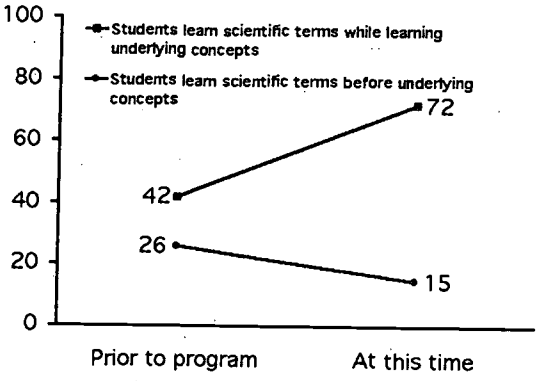

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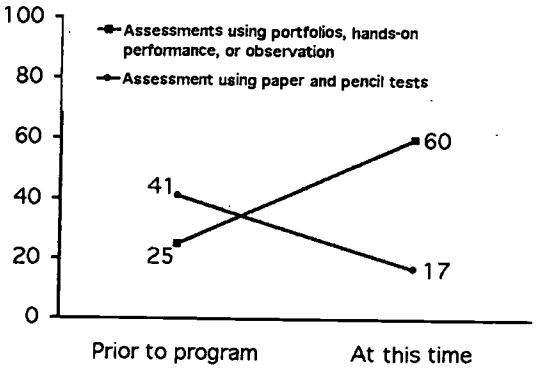

*Exhibit contrasts those reporting high usage—4 or 5 on a 5-point scale—with those reporting low usage—1 or 2 on a 5-point scale.

Differences were also found when the data for the teacher researcher programs were examined (Figure 2). Again, while change was in the right direction for all pairs of practices examined, changes were uneven and differed sharply in some cases from the teacher development programs.

The study also found some important differences in extent of classroom application when teacher characteristics were considered.[9] Characteristics associated with fuller translation to the classroom included

- initial level of use of standards-based techniques—those who already used standards-based instruction before program participation were more likely to show more use of these practices after program participation;
- school level—teachers who were at the elementary/middle level were more likely to report using instruction reflective of best practices than were high school teachers; and
- autonomy—teachers who had a greater sense of control over their environments reported greater changes than those who felt they had less control.

However, one of the most important findings was that there was no difference in the benefits received by teachers from different racial/ethnic groups or teachers who taught different types of students. Although the data from the case stories suggest that certain environments pose greater challenges than others, and in absolute terms standards-based instruction was found to be less prevalent in the central city and urban fringe schools than in the suburbs, the benefits of professional development were in evidence across the board. Thus, it appears to be important to encourage teachers working with urban populations to participate as fully as possible in high-quality professional development programs. Clearly, policymakers would be well advised to consider ways of providing incentives for such teachers, and for the programs that serve them.

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[9]These analyses of differential effectiveness for different types of teachers were only carried out for those participating in the teacher development programs. Because of the relatively smaller sample of participants in the researcher programs, these more fine-grained analyses could not be carried out. This issue is considered further in the next section on characteristics of the most effective programs.

Effects of Program Characteristics

A second question of central interest was whether or not we could identify programs that appeared to be most effective in promoting change in classroom practices and, if we could, what the characteristics of the more effective programs might be. The results of the study indicated that teacher development programs that provided experience with the "model science classroom" had the most immediate impact on classroom practice. For the teachers in the development programs, experiences related to research and the research process showed relatively less classroom impact.

What does it mean to provide experience with the model science classroom? Although there is no one way to do this, the general notion is that these programs provided direct experience in using and developing the kinds of instructional practices that it is hoped the teachers will eventually incorporate into their day-to-day teaching. This contrasts with programs that placed greater emphasis on the scientific experience, on doing, learning about, or observing scientific research. Characteristics of these more effective programs include

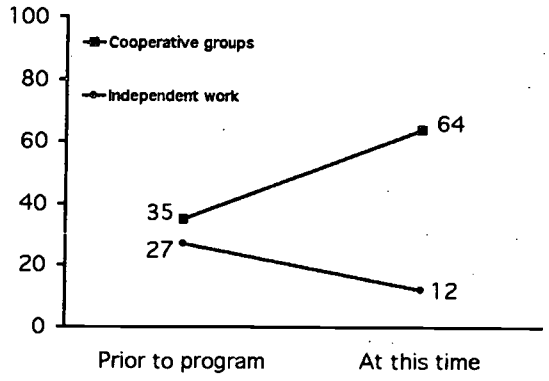
- participating in hands-on activities for use in the classroom,
- planning how information could be used in the classroom,
- developing curriculum units,
- engaging in challenging problem solving,
- collaborating with scientists or other staff, and
- interacting with program participants.

While the results for the teacher development programs were relatively clear, the picture for the teacher researcher programs was not. Because of sample size limitations, we do not know from this study what the relative impacts of well-implemented teacher researcher programs might be compared to other approaches, and the potential benefits of the research experience require further examination.

We did find, however, that the two types of professional development programs attracted different types of teachers. Participant differences can be classified into three general categories: personal, school, and classroom characteristics.

1. Personal characteristics: Relative to participants in teacher development programs, those in research programs

a.



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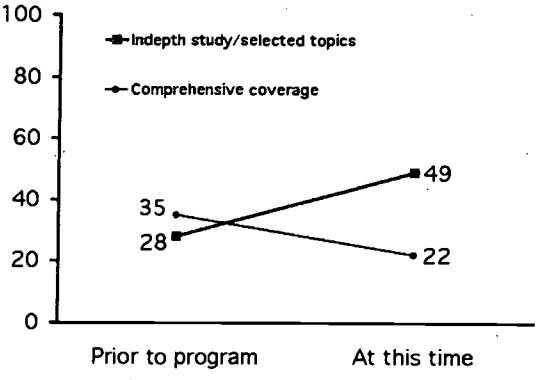

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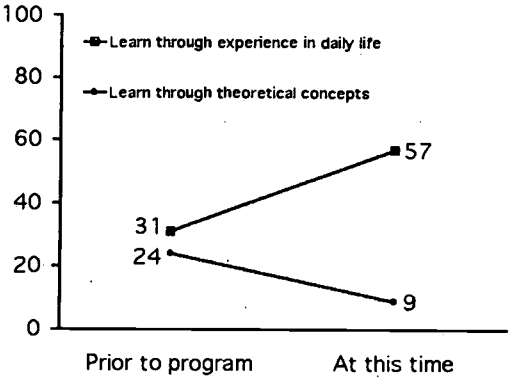
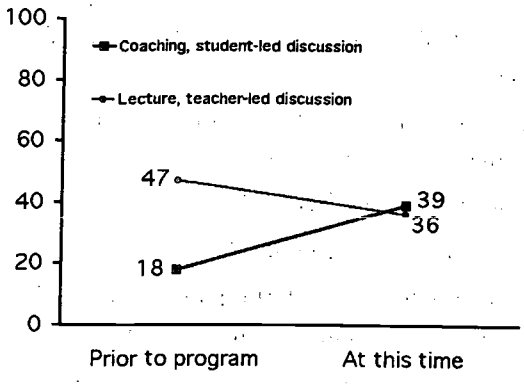
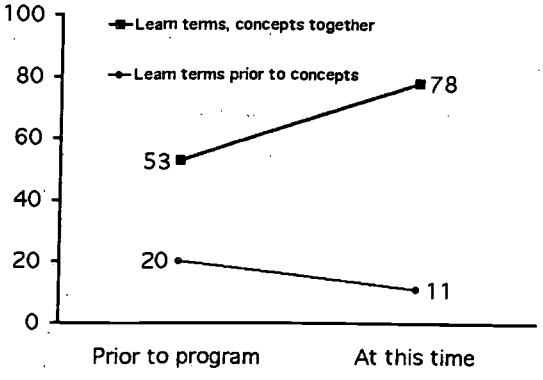


Figure 2.
Percentage of participants reporting change in use of various teaching techniques after participating in research programs*

b.



d.



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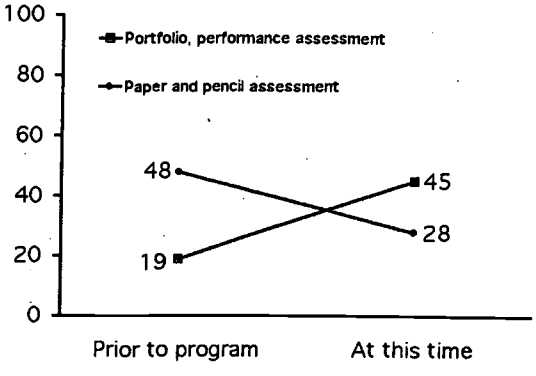

*Exhibit contrasts those reporting high usage—4 or 5 on a 5-point scale—with those reporting low usage—1 or 2 on a 5-point scale.

- were more likely to be male (69 versus 32 percent), and
- more often had degrees above a bachelor's (82 versus 57 percent).

2. School characteristics: Participants in research programs taught in schools that were more often
   - secondary (85 versus 32), and
   - private (14 versus 5 percent).
3. Classroom characteristics: Participants in research programs taught science classes that were more likely to
   - meet for 5 or more hours per week (65 versus 37 percent), and
   - be composed of higher ability students (34 versus 16 percent).

While we cannot say what would have happened to the teacher researcher participants had they attended teacher development institutes (and statements about relative gain cannot be derived from the study), it is clear from Figure 2 that overall, the research participants gained skills and knowledge that were associated with changes in classroom practice. This suggests that changes in practice can be attained in a variety of ways. The model classroom may be a very effective, but not the only effective, way to promote changes in classroom instruction. More attention needs to be given to developing an understanding of the benefits of different strategies for different teachers or for teachers at different points in their careers.

Teacher Leadership and Dissemination of Findings

A commonly held belief is that teachers who participate in summer institutes and other extended professional development efforts will not only change their own classroom practices, but they also will work with other teachers in their schools or districts to bring about more widespread change. The belief, or hope, is that by investing resources in the training of one or two teachers, many more teachers will be reached.

Findings from the study suggest, however, that this belief is not readily substantiated. Granted, teacher leadership was not an explicit goal for the majority of programs, and strategies for dissemination were covered lightly, if at all. However, many of the programs cited

dissemination as a desired benefit, and dissemination of new practices is frequently mentioned as a general goal of professional development activities.

Both the case stories and survey data strongly indicate that formal dissemination of knowledge and practice was a relatively rare event. Figures 3 and 4 present responses from the teacher development and teacher researcher participants regarding their dissemination activities. These data show that in general, little direct dissemination of knowledge and skills resulted from program exposure.

However, in our program where leadership was a major focus, a somewhat more positive picture emerged. The case story found:

> *All the teachers interviewed, with the exception of one who worked primarily alone, had shared what they had learned in the program with others. They had done so through holding demonstrations in their own classrooms for other teachers to observe, conducting workshops for their colleagues at different times, guiding teachers through FOSS kits, and working closely with the program's mathematics representatives or science representatives at different grade levels. Most of their activities were confined to their own buildings unless they were teacher leaders who had responsibilities at other schools. Their formal contacts with teacher-participants in schools other than their own were limited primarily to their regular institute sessions. The amount of sharing varies by building.*

This relative lack of leadership in dissemination among the majority of participants is especially noteworthy as a number of other indicators suggest that the teachers who participate in summer institutes are among the more outgoing and may already have held leadership positions in their schools or districts. While one reason may be the lack of formal emphasis on dissemination in most of the programs, another is probably the lack of time and/or support when the teachers return to their schools. This latter issue, and the overall role of the school or district context, is discussed in more detail below.

The Importance of Supports at the District and School Levels

Many people strongly believe that the most effective strategies for professional development tie the development directly to the context of a particular district or school and rely on the teachers themselves for

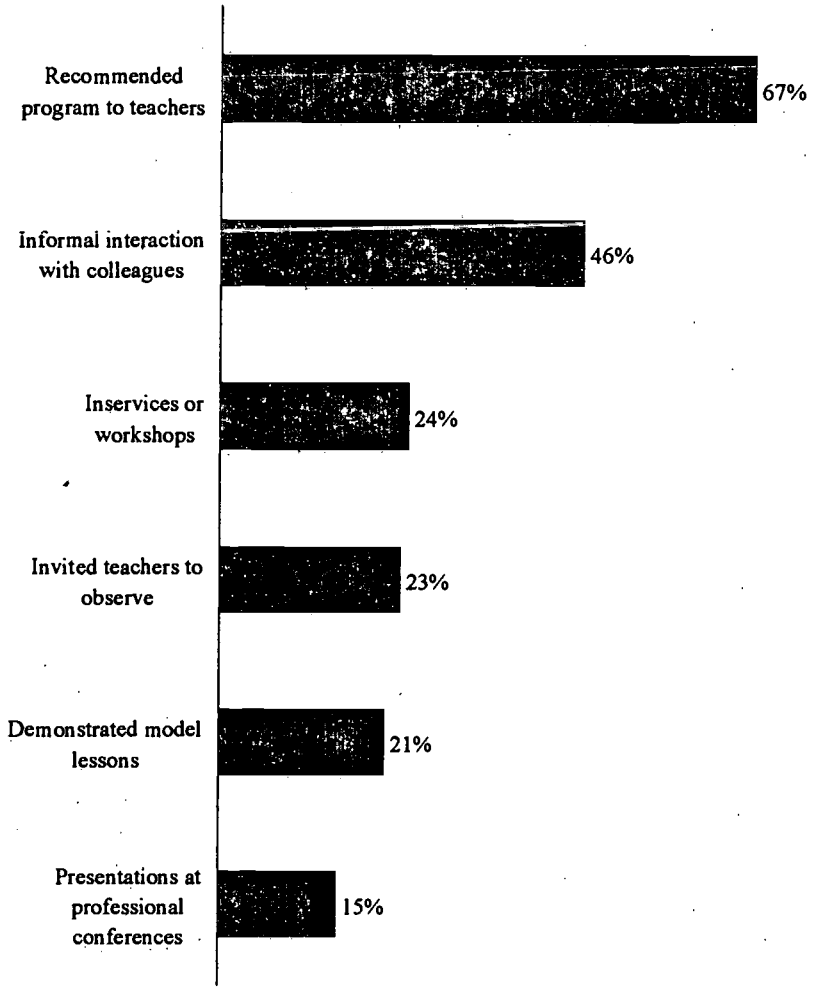

Figure 3
Percent of participants in teacher development programs saying they have shared and disseminated knowledge gained in the program to a great extent

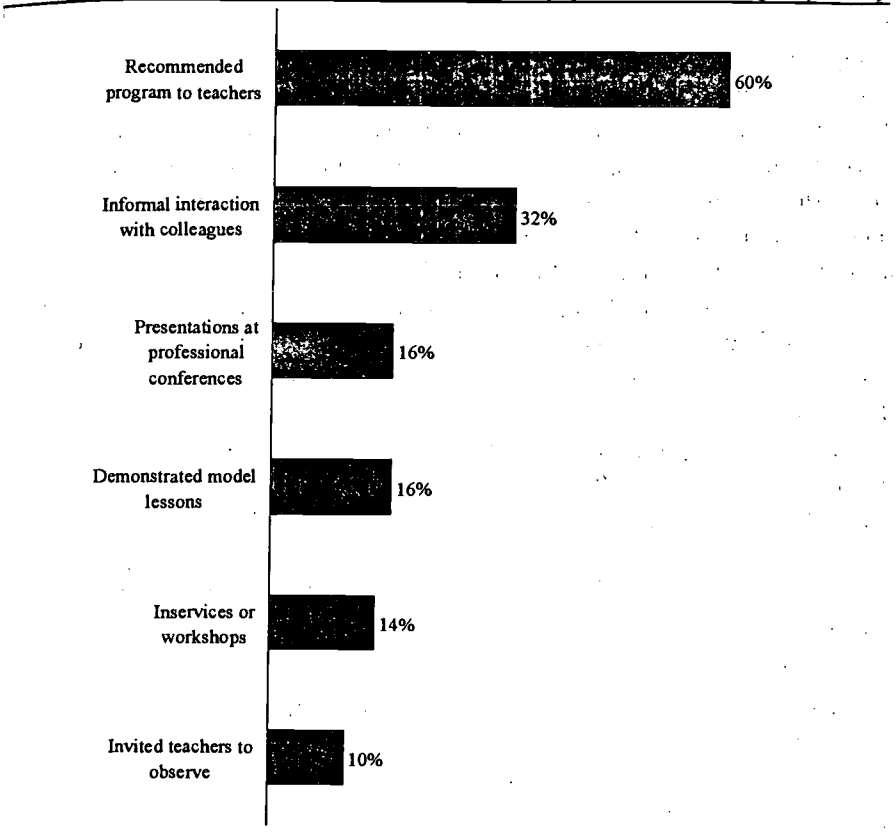

Figure 4
Percent of research participants saying that they have shared and disseminated knowledge gained in the program to a great extent

planning the program and designing (or in some cases providing) its content (Lieberman, 1995; Darling-Hammond, 1995). These researchers advocate models that tie professional development to a particular school and are explicitly linked to reform activities that the school is undertaking.

At the time that the multi-agency study was initiated, the emphasis on the individual school-based model was not as strong as it is today. Rather, the emphasis was on ensuring that professional development efforts were designed as sustained and extended experiences that would be supported by school or district personnel.[10] Ties might be explicit in terms of

[10]This is not to say that teacher input was unimportant. However, this input was sought more frequently in terms of evaluation and feedback rather than planning and direction.

integration with systemic reform efforts or implied through loosely structured agreements with school authorities. For example, many programs required that a teacher's principal sign a letter agreeing to have the teacher participate as a condition of enrollment. Underlying this requirement was the belief (stated or unstated) that this signature served as a proxy for future support to the teacher in using and sharing new skills after program participation.

The present study affirms the importance of support at the school or district level and was critical in assuring application of the lessons of the professional development experience. The impact of the professional development experience—translation to classroom instruction, leadership, dissemination, etc.—was strongly affected by the district or school context already in place. As stated earlier, more translation to the classroom was found where teachers felt they had more control over their schools and classrooms. The case stories also suggest that teachers with a supportive administrator are able to make the most changes. Some contrasting examples are found in one of the case stories.

> *Bob considers his principal to be supportive. He said that the principal seems to have an interest in science. If it's within reason, the principal will give Bob release time to attend a function and will spend money for the classroom....*
>
> *Two participants indicated that they receive much psychological support but little financial support for computers, other equipment and supplies....Another teacher receives no support from his department chair. He was "called on the carpet" by the principal for not having his students use the textbook.*

Another important factor affecting classroom implementation is the availability of materials and equipment. It was clear that many of the new skills and techniques learned at the institutes could not be implemented, or were far more difficult to implement in situations where needed materials and equipment were not available. For example, a case story that focused on the impacts of an institute aimed at enhancing teachers' ability to use computers found the following:

> *The greatest barriers that teachers perceive in their classroom implementation of [a program focusing on computer usage] are ... no money to buy updated computers; lack of access to*

- *computers in the classroom; and lack of available software relevant to the content areas being taught.*

Recognizing this factor, some programs have built materials provision into their programs. In some cases, low-cost, easy-to-access materials are provided to teachers in the "make-and-take" mode. In other cases, traveling vans bring high-end equipment directly to the schools to use for a limited period of time.

However, material and equipment supports are not the only, or even the most important, factor in determining whether changes in practice take place. A more important facilitator is the general reform climate in the school or district and the "readiness for change." The survey data showed that in addition to teachers' previous practices, level of school taught, and sense of autonomy, a major facilitator of transfer was teaching in a school in which there was already some kind of reform being implemented.

These findings, taken together, reinforce the importance of professional development programs having more than a superficial tie to the school and highlight the need for a strong commitment of support if the goal of improved classroom learning is to be widely attained. To a large extent, the findings also lend credence to the importance of school-based programs and suggest that such programs may provide the most immediate effect on changing practices. At its best, the school-based model brings with it a number of characteristics shown by this study to be needed for change to occur—a readiness for change, a supportive administrative structure, a cadre of peers who can support each other, and time for trying out new approaches and introducing new content—all critical supports for change.

The results also indicate that the school- or district-based model is not the only one that can be effective. Many participants in professional development programs with a regional and even national target population were able to make significant changes in their classroom practice. What seems to be most important is making sure that certain predisposing conditions are established in the school or district—a significant challenge in far too many instances.

Conclusions

Taken together, the results from this multi-agency study provide some valuable insights into the effects of participating in professional development programs. First, the findings confirm the value of well-designed professional development experiences for those who

attend. Not only were they seen by participants to be personally and professionally valuable, but the data show that a teacher's participation has important effects on what happens in his/her classroom. Although we cannot say that these experiences result in increased student achievement, we do know that they contribute to establishing the conditions under which improved achievement is likely to occur. Programs that provide teachers increased knowledge about, and practice in, delivering standards-based science instruction result in students being provided pedagogy and broader exposure to relevant and important science content.

Even among this self-selected group of attendees, however, there were some important differences in outcomes. Some practices associated with standards-based instruction were evidenced far less frequently than others. For example, it appears difficult for teachers to change from limited coverage of a wide range of topics to more indepth consideration of a few topics. Some teachers also are resistant to giving up a teacher-centered approach. And, while hands-on, instruction was the most widely observed practice, there were still indications that more progress could be made in assuring that *hands-on* really means *minds-on*, rather than a more superficial adoption of active engagement.

Second, programs that model the ideal science classroom, including participating in hands-on activities for use in the classroom, planning how information could be used in the classroom, developing curriculum units, engaging in challenging problem solving, and collaborating with scientists or other staff, are the most effective in facilitating this transfer. While we cannot be certain that this approach is preferable in the long run, in the short term programs tied directly to what is desired in the classroom have the most immediate payoff.

Third, the school or district context, and the support provided for the application of learning, make a big difference in the extent to which changes actually occur. While it is certainly possible for the lone teacher, unsupported by administrators and colleagues, to make a difference, the chances of this occurring are far less than in a supportive environment. This finding raises some possible dilemmas. Specifically, should teachers be denied access to professional development if the school or district commitment for support is not adequate? And, what are the characteristics of an adequate commitment? Clearly, a signature on a letter of application is not. Materials and equipment support, release time to attend followup

sessions, and work with other teachers are more desirable. Having teams of teachers participate is also a potentially effective strategy. These, plus an explicit tie-in to an ongoing plan for reform, are probably the best. The very difficult question is how far program managers should go in defining and requiring commitment from home schools and districts.

Fourth, the question of moving the high school teacher toward greater reform remains a significant challenge. The good news is that participants who teach at the high school level do make changes; the bad news is that these changes are significantly smaller in magnitude. This is not the first study to note that it is more difficult to change the behavior of high school teachers than teachers in the earlier grades (Cuban & Tyack, 1995). However, how to change this phenomenon remains an open question, and a closer look at the relative efficacy of programs that target this population seems warranted.

Finally, those who are interested in using professional development programs as a way to promote teacher leadership and dissemination of program benefits need to recognize that the link between program participation and sharing of information is not necessarily given or naturally evolving. A variety of factors affect whether or not a teacher is able to share what has been learned with others. While this is no doubt related to the environment of the school, there are a number of ways in which the professional development program can increase the likelihood that such sharing occurs. First, teachers must be made aware that it is an expectation of their program participation. Second, administrators in the schools where participants teach need to make a commitment that they will not only encourage their leadership in information dissemination, but will also provide time and support for it to occur. And, third, professional development programs need to include activities specially designed to build the capacity of teachers to become leaders in the educational change process, helping them to both identify strategies for playing more visible roles and giving the skills needed to promote the acquisition of the new understandings among their peers and colleagues.

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