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What Makes Professional Development Effective? Results From a National Sample of Teachers

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This study uses a national probability sample of 1,027 mathematics and science teachers to provide the first large-scale empirical comparison of effects of different characteristics of professional development on teachers' learning. Results, based on ordinary least squares regression, indicate three

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core features of professional development activities that have significant, positive effects on teachers' self-reported increases in knowledge and skills and changes in classroom practice: (a) focus on content knowledge; (b) opportunities for active learning; and (c) coherence with other learning activities. It is primarily through these core features that the following structural features significantly affect teacher learning: (a) the form of the activity (e.g., workshop vs. study group); (b) collective participation of teachers from the same school, grade, or subject; and (c) the duration of the activity.

In recent years, national, state, and local policymakers and educators have launched efforts to improve education by creating a fundamental shift in what children learn and how they are taught. If children are to achieve at levels demanded by the high standards that states and districts have adopted, however, teachers will have to help them do so. Teachers are necessarily at the center of reform, for they must carry out the demands of high standards in the classroom (Cuban, 1990). Thus, the success of ambitious education reform initiatives hinges, in large part, on the qualifications and effectiveness of teachers. As a result, teacher professional development is a major focus of systemic reform initiatives (Corcoran, 1995; Corcoran, Shields, & Zucker, 1998).

To carry out the demands of education reform, teachers must be immersed in the subjects they teach, and have the ability both to communicate basic knowledge and to develop advanced thinking and problem-solving skills among their students (Loucks-Horsley, Hewson, Love, & Stiles, 1998; National Commission on Teaching and America's Future, 1996). The central elements of systemic reform—high standards, curriculum frameworks, and new approaches to assessment aligned to those standards—generate new expectations for teachers' classroom behaviors, as well as for student performance (Bybee, 1993; National Council of Teachers of Mathematics, 1991; National Research Council, 1996; Webb & Romberg, 1994).

However, although teachers generally support high standards for teaching and learning, many teachers are not prepared to implement teaching practices based on high standards (Cohen, 1990; Elmore & Burney, 1996; Elmore, Peterson, & McCarthey, 1996; Grant, Peterson, & Shojgreen-Downer, 1996; Sizer, 1992). Many teachers learned to teach using a model of teaching and learning that focuses heavily on memorizing facts, without also emphasizing deeper understanding of subject knowledge (Cohen, McLaughlin, & Talbert, 1993; Darling-Hammond & McLaughlin, 1995; Porter & Brophy, 1988). Shifting to a more balanced approach to teaching, which places more emphasis on understanding subject matter, means that teachers must learn more about the subjects they teach, and how students learn these subjects. The continual deepening of knowledge and skills is an integral part of any profession. Teaching is no exception (Shulman & Sparks, 1992; National Board for Professional Teaching Standards, 1989).

Defining High-Quality Professional Development

During the past decade, a considerable body of literature has emerged on professional development, teacher learning, and teacher change.[1] The research literature contains a mix of large- and small-scale studies, including intensive case studies of classroom teaching, evaluations of specific approaches to improving teaching and learning, and surveys of teachers about their preservice preparation and in-service professional development experiences.[2] In addition, there is a large literature describing "best practices" in professional development, drawing on expert experiences. Despite the size of the body of literature, however, relatively little systematic research has been conducted on the effects of professional development on improvements in teaching or on student outcomes.

Although relatively little research has been conducted on the effects of alternative forms of professional development, the research that has been conducted, along with the experience of expert practitioners, provides some preliminary guidance about the characteristics of high-quality professional development (see, in particular, Loucks-Horsley, Hewson, Love, & Stiles, 1998). For example, James Hiebert, in a review of the research on mathematics teaching and learning conducted for the National Council of Teachers of Mathematics, calls attention to the importance of high standards, content focus, and in-depth learning opportunities for teachers. According to Hiebert,

> Research on teacher learning shows that fruitful opportunities to learn new teaching methods share several core features: (a) ongoing (measured in years) collaboration of teachers for purposes of planning with (b) the explicit goal of improving students' achievement of clear learning goals, (c) anchored by attention to students' thinking, the curriculum, and pedagogy, with (d) access to alternative ideas and methods and opportunities to observe these in action and to reflect on the reasons for their effectiveness . . . (1999, p. 15)

Although lists of characteristics such as these commonly appear in the literature on effective professional development, there is little direct evidence on the extent to which these characteristics relate to positive outcomes for teachers and students. Some studies conducted over the past decade suggest that professional development experiences that share all or most of these characteristics can have a substantial, positive influence on teachers' classroom practice and student achievement.[3] Several recent studies have begun to examine the importance of specific characteristics of professional development. For example, a number of recent studies suggest that the duration of professional development is related to the depth of teacher change (Shields, Marsh, & Adelman, 1998; Weiss, Montgomery, Ridgway, & Bond, 1998). Furthermore, there is some indication that professional development that focuses on specific mathematics and science content and the ways students learn such content is especially helpful, particularly for

instruction designed to improve students' conceptual understanding (Cohen & Hill, 1998; Fennema et al., 1996). However, although some researchers are beginning to examine the effects of professional development on teaching and learning, few studies have explicitly compared the effects of different characteristics of professional development.[4]

Thus, there is a clear need tor new, systematic research on the effectiveness of alternative strategies for professional development. The National Research Council, for example, in a review of recent research on the cognitive sciences. teaching, and learning, argues that

> Research studies are needed to determine the efficacy of various types of professional development activities, including pre-service and in-service seminars, workshops, and summer institutes. Studies should include professional development activities that are extended over time and across broad teacher learning communities in order to identify the processes and mechanisms that contribute to the development of teachers' learning communities. (Bransford, Brown, & Cocking, 1999, p. 240)

Study Design

In this paper we draw on data collected as part of a national evaluation of the Eisenhower Professional Development Program, a federal program which supports professional development for teachers, mainly in mathematics and science. We designed this study to enable us to examine the relationship between features of professional development that have been identified in the literature and self-reported change in teachers' knowledge and skills and classroom teaching practices. We integrated and operationalized the ideas in the literature on "best practices" in professional development to create a set of scales describing the characteristics of activities assisted by the Eisenhower program, then empirically tested these characteristics to examine their effects on teacher outcomes.

Data Sources

For the analyses in this study, we use data from a Teacher Activity Survey conducted as part of the national evaluation of the Eisenhower Professional Development Program. The program, Title II of the Elementary and Secondary Education Act (ESEA), is the federal government's largest investment that is solely focused on developing the knowledge and skills of classroom teachers. Part B of the Eisenhower program, with a 1999 appropriation of about $335 million, provides funds through state education agencies (SEAs) to school districts, and through state agencies for higher education (SAHEs) to grantees: SAHE grantees include institutions of higher education (IHEs) such as universities, 4-year colleges, or 2-year colleges, and not-for-profits (NPOs), which are organizations such as zoos, museums, and libraries.

These funds primarily support professional development in mathematics and science.[5]

The Eisenhower program is a source of funding for professional development activities, not a specific approach to professional development. The program allows support for activities that are wide-ranging and include workshops and conferences, study groups, professional networks and collaboratives, task force work, and peer coaching. Furthermore, Eisenhower funding does not exist in a vacuum. Professional development activities assisted by funding from the Eisenhower program (or "Eisenhower-assisted" activities) also may receive funding through states, school districts, and other federal programs. Therefore, this study about the effects of Eisenhower-assisted activities on teacher outcomes also is applicable to professional development funded through other sources.

In the spring, summer, and fall of 1998, we surveyed a nationally representative sample of teachers who had attended Eisenhower-assisted activities over the period from July 1 through December 31, 1997. We carried out the survey by drawing a national probability sample of school districts and SAHE grantees receiving Eisenhower funds. Districts were sampled in proportion to the number of teachers in the district, and SAHE grantees were sampled in proportion to the size of their Eisenhower grant, based on the logic that SAHE grantees with larger grants would serve larger numbers of teachers.[6] For each district and SAHE grantee drawn into the sample, we collected a complete list of all professional development activities conducted with Eisenhower funds over the period from July through December, 1997. We then drew a sample of two activities in each district or SAHE grantee, with probability proportional to the number of teachers attending the activity. We then randomly subsampled two teachers who attended each activity. We received responses from 1,027 teachers, representing activities supported by Eisenhower funds in 358 districts and SAHE grantees. This produced an overall teacher response rate of 72%.[7] The survey asked each teacher to provide detailed information about the specific Eisenhower-assisted professional development activity that we drew in our sampling process and that led the teacher to be selected for our sample. Responses are self-reports of teacher experiences and behavior.

Measures

On the basis of the research on high-quality professional development, our analysis of the characteristics of professional development focuses on "structural features"—characteristics of the structure or design of professional development activities; and "core features"—dimensions of the substance or core of the professional development experience. We include three structural features in our model: (a) the *form* of the activity (i.e., whether it is a reform type, such as a study group or network, in contrast to a traditional workshop or conference); (b) the *duration* of the activity, including the total

number of contact hours that participants spend in the activity, as well as the span of time over which the activity takes place; and (c) the degree to which the activity emphasizes the *collective participation* of groups of teachers from the same school, department, or grade level, as opposed to the participation of individual teachers from many schools. We also examine three core features of professional development activities: (a) the degree to which the activity has a *content focus* (that is, the degree to which the activity is focused on improving and deepening teachers' content knowledge in mathematics and science); (b) the extent to which the activity offers opportunities for *active learning,* such as opportunities for teachers to become actively engaged in the meaningful analysis of teaching and learning (for example, by reviewing student work or obtaining feedback on their teaching); and (c) the degree to which the activity promotes *coherence* in teachers' professional development, by incorporating experiences that are consistent with teachers' goals and aligned with state standards and assessments, and by encouraging continuing professional communication among teachers. The teacher outcomes that we measure are self-reported increases in knowledge and skills in several different areas (e.g., use of technology, instructional methods, approaches to assessment), and changes in classroom practice. Below we briefly review the research in each of these areas, and provide more detailed descriptions of the measures used in our analysis.

Structural Features

Type of activity. Undoubtedly the most common type of professional development, and the form most criticized in the literature, is the "workshop." A workshop is a structured approach to professional development that occurs outside the teacher's own classroom. It generally involves a leader or leaders with special expertise and participants who attend sessions at scheduled times—often after school, on the weekend, or during the summer (Loucks-Horsley, Hewson, Love, & Stiles, 1998, pp. 42–43). Institutes, courses, and conferences are other traditional forms of professional development that share many of the features of workshops, in that they tend to take place outside of the teacher's school or classroom; and they involve a leader or leaders with special expertise and participants who attend at scheduled times.

Although traditional forms of professional development are quite common, they are widely criticized as being ineffective in providing teachers with sufficient time, activities, and content necessary for increasing teacher's knowledge and fostering meaningful changes in their classroom practice (Loucks-Horsley, Hewson, Love, & Stiles, 1998). As a result, there is growing interest in "reform" types of professional development, such as study groups or mentoring and coaching. These reform types differ from traditional professional development in several respects. In particular, reform activities often take place during the regular school day. In fact, some reform activities,

such as mentoring and coaching, take place, at least in part, during the process of classroom instruction or during regularly scheduled teacher planning time. By locating opportunities for professional development within a teacher's regular work day, reform types of professional development may be more likely than traditional forms to make connections with classroom teaching, and they may be easier to sustain over time.

In addition, reform types of activities may be more responsive to how teachers learn (Ball, 1996), and may have more influence on changing teaching practice (Darling-Hammond, 1995, 1996; Hargreaves & Fullan, 1992; Little, 1993; Richardson, 1994; Sparks & Loucks-Horsley, 1989; Stiles, Loucks-Horsley, & Hewson, 1996). Furthermore, Darling-Hammond (1997) argues that these types of activities may be more responsive to teachers' needs and goals.

Some schools have begun to create new models of induction (i.e., support for new teachers) and ongoing professional development for teachers and principals. These models feature mentoring for beginners and veterans: peer observation and coaching; local study groups and networks for developing teaching within specific subject matter areas (e.g., the National Writing Project or the Urban Mathematics Collaboratives); teacher academies that offer ongoing seminars and courses of study tied to practice; school–university partnerships that sponsor collaborative research, interschool visitations; and a variety of formal and informal learning opportunities developed in response to teachers' and principals' felt needs (Darling-Hammond, 1997, p. 325).

In our survey of teachers, we asked each teacher to describe the specified Eisenhower-assisted activity in which the teacher participated, and, as part of the description, we asked the teacher to specify the *type* of activity and offered a choice of 10 categories.[8] We coded the first four categories (within-district workshops, courses for college credit, out-of-district workshops, and out-of-district conferences) as traditional forms of activities, and the remaining six categories (teacher study groups, teacher collaboratives or networks, committees, mentoring, internships, and resource centers) as reform types of activities.[9]

The type of activity may set the context for many other features of the activity's structure and its substance. Because reform activities such as study groups and mentoring often take place during the regular school day, they may enable activities of longer duration than traditional activities; and they may make it easier to encourage the collective participation of groups of teachers from the same school or department. Given the potential importance of activity type as a key structural feature, we contrast traditional and reform activities.

Duration. Almost all of the recent literature on teacher learning and professional development calls for professional development that is sustained over time. The duration of professional development activities is expected to be important in two ways. First, longer activities are more likely to provide an opportunity for in-depth discussion of content, student con-

ceptions and misconceptions, and pedagogical strategies. Second, activities that extend over time are more likely to allow teachers to try out new practices in the classroom and obtain feedback on their teaching.

On our Teacher Activity Survey we asked about two aspects of duration: the total number of *contact hours* spent in the professional development activity, including all components of the activity that were held during the 1-year period from July 1, 1997, through June 30, 1998; and the *span* or period of time, in days, weeks, and months, over which the activity was spread.[10] Although hours and span are correlated (r = .41), they measure different aspects of duration, both of which are potentially important in providing teachers with sufficient opportunities for in-depth study, interaction, and reflection.

Collective participation. There is a growing interest in professional development that is designed for groups of teachers from the same school, department, or grade level. Professional development designed for groups of teachers has a number of potential advantages. First, teachers who work together are more likely to have the opportunity to discuss concepts, skills, and problems that arise during their professional development experiences. Second, teachers who are from the same school, department, or grade are likely to share common curriculum materials, course offerings, and assessment requirements. By engaging in joint professional development, they may be able to integrate what they learn with other aspects of their instructional context. Third, teachers who share the same students can discuss students' needs across classes and grade levels.

Finally, by focusing on a group of teachers from the same school, professional development may help sustain changes in practice over time, as some teachers leave the school's teaching force and other new teachers join the faculty. Professional development may help contribute to a shared professional culture, in which teachers in a school or teachers who teach the same grade or subject develop a common understanding of instructional goals, methods, problems, and solutions. (See, for example, Talbert & McLaughlin, 1993.) Collective participation in the same activity can provide a forum for debate and improving understanding, which increases teachers' capacity to grow (Ball, 1996). Furthermore, Knapp (1997) emphasizes that change in classroom teaching is a problem of individual learning as well as organizational learning, and that organizational routines and establishing a culture supportive of reform instruction can facilitate individual change efforts.

Little research is available on the effects of collective approaches to professional development, but there is some evidence that it can be effective in changing teaching practice. Newmann and associates, in a study of 24 "restructuring schools," note that, in the more successful schools:

> Professional development tended to be focused on groups of teachers within the school or the faculty as a whole. Making use of internal as well as external expertise, staff development activities took advantage of local skills and sharing of effective practice. Including internal

> experts as staff developers reinforced teachers' sense of commitment to their school's goals. (Newmann & Associates, 1996)

To measure the construct of "collective participation" in professional development, we asked each teacher in our national sample to indicate whether the activity in which the teacher participated was designed for all teachers in a school or set of schools, or all teachers in the teacher's department or grade level.[11]

Core Features

Focusing on content. Although there is a large body of literature on professional development, surprisingly little attention has been given to what teachers actually learn in professional development activities, that is, their content. In particular, little research has been conducted on the relative efficacy of professional development activities that focus on different types of knowledge, skills, and teaching practices.[12]

The available descriptive research suggests that the content covered during professional development activities varies along at least four dimensions. First, activities vary in the relative emphasis they give to the subject matter that teachers are expected to teach and the teaching methods teachers are expected to employ. Some activities are intended primarily to improve teachers' knowledge of subject-matter content; some are designed to improve general pedagogy or teaching practices, such as classroom management, lesson planning, or grouping methods; and some are intended to improve what Shulman (1987) has termed "pedagogical content knowledge"—teaching practices in specific content domains, such as teaching multidigit addition in elementary mathematics or forces and motion in physics.

Activities also vary in the specificity of the changes in teaching practice that are encouraged. Some activities focus on helping teachers use particular curriculum materials (e.g., new textbooks, science kits, or curriculum replacement units) or prescribed teaching strategies (e.g., specific student questioning strategies). Others focus on general principles, giving less attention to specific curricula or strategies (see Kennedy, 1998, for a discussion of this distinction).

In addition, activities vary in the goals for student learning that they emphasize. Some activities emphasize helping teachers improve student performance in the basic skills; for example, memorizing facts and mastering procedural skills, such as long division or solving linear equations with one unknown. Other activities focus on helping teachers improve students' conceptual understanding; for example, the ability to explain the reasons behind a solution strategy.[13]

Finally, activities vary in the emphasis they give to the *ways students learn* particular subject matter. Some activities give considerable emphasis to improving teachers' understanding of how children learn, by focusing, for

example, on common student preconceptions, misconceptions, and solution strategies in specific subject domains. Other activities focus primarily on new curricula or teaching methods, while giving little attention to the ways students learn.

Although there is little evidence on the relative effectiveness of professional development activities that focus on learning different types of knowledge, skills, and teaching practices, a small literature has begun to emerge focusing on these issues. In particular, an emerging body of work suggests that professional development that focuses on subject-matter content and how children learn it may be an especially important element in changing teaching practice (e.g., Corcoran, 1995). In part, researchers base this argument on the fact that many teachers lack strong content-specific teaching skills. Reynolds, for example, in a review of the knowledge base for elementary school teachers, concluded that "beginning teachers have surprisingly few content-specific pedagogical understandings" (1995, p. 214). Rhine (1998), in a discussion of the role of research in teaching, pointed out that "[r]eform-minded teachers are hungry for continuing education that provides novel ways to address content" (p. 27).

A number of authors argue that professional development requires a dual focus on both knowledge of subject matter content and an understanding of how children learn specific content. Hiebert et al. (1996), for example, argue that teaching for understanding in mathematics requires two forms of knowledge:

> . . . knowledge of the subject to select tasks that encourage students to wrestle with key ideas and knowledge of students' thinking to select tasks that link with students' experience and for which students can see the relevance of the ideas and skills they already possess. (p. 16)

This point of view is bolstered by several recent studies of the effects of professional development on student achievement. Cohen and Hill (1998) conducted a study of mathematics teaching in California, based on data on teachers' professional development experiences and school-level data on student performance on a mathematics test administered statewide. They found that, controlling for the characteristics of students enrolled, average mathematics achievement was higher in schools in which teachers had participated in extensive professional development focusing on teaching specific mathematics content, compared to the achievement in schools where teachers had not. Participation in professional development focusing on general pedagogy, however, was not related to student achievement.

Kennedy (1998) found similar results in a review, commissioned for the national Eisenhower study, of well-designed experimental studies of the relationship between professional development and student achievement in mathematics and science. Kennedy (1998) found that, compared to more general professional development, professional development that focuses on specific content and how students learn that content has larger positive

effects on student achievement outcomes, especially achievement in conceptual understanding.

On the basis of this emerging evidence, we view the degree of content focus as a central dimension of high-quality professional development. To examine the content focus of activities, we asked each teacher in our national sample to indicate the degree of emphasis the activity in which the teacher participated gave to deepening content knowledge in mathematics and science, using a three-point scale (*no emphasis* = 0, *minor emphasis* = 1, *major emphasis* = 2).[14]

Promoting Active Learning

A second core feature of professional development concerns the opportunities provided by the professional development activity for teachers to become actively engaged in meaningful discussion, planning, and practice (see, for example, Lieberman, 1996; Loucks-Horsley, Hewson, Love, & Stiles, 1998). Opportunities for active learning can take a number of forms, including the opportunity to observe expert teachers and to be observed teaching; to plan how new curriculum materials and new teaching methods will be used in the classroom; to review student work in the topic areas being covered; and to lead discussions and engage in written work (Carey & Frechtling, 1997; Darling-Hammond, 1997; Lieberman, 1996).

Although our survey data do not include information on the extent to which a particular strategy was used in an activity nor whether it was used in conjunction with conceptual, in-depth learning, we do have information on the prevalence of several types of learning strategies. We focus in particular on four dimensions of active learning: observing and being observed teaching; planning for classroom implementation; reviewing student work; and presenting, leading, and writing.

Observing and being observed. One element of active learning is the opportunity for teachers to observe expert teachers, be observed teaching in their own classroom, and obtain feedback. These opportunities can take a variety of forms, including providing feedback on videotaped lessons, having teachers visit each others' classrooms to observe lessons, and having activity leaders, lead teachers, mentors, and coaches observe classroom teachers and engage in reflective discussions about the goals of a lesson, the tasks employed, teaching strategies, and student learning.

We asked each teacher in our national sample how the activity helped the teacher use new skills in the classroom. In particular, we asked each teacher whether the teacher received coaching or mentoring in the classroom as part of the professional development activity; whether the teacher's teaching was observed by the activity leader(s) and feedback was provided; and whether the teacher's teaching was observed by other participants and feedback was provided. We also asked whether the activity was evaluated in part based on an observation of the teacher's classroom.

Planning classroom implementation. A second element of active learning involves the opportunity to link the ideas introduced during professional

development experiences to the teaching context in which teachers work. The introduction of new approaches may have different implications depending on the curriculum in place in a teacher's school, the specific textbooks adopted in the teachers' classrooms, and the required assessments in the teachers' districts. Also, the characteristics of the students enrolled in the teachers' classrooms, including the material covered in previous grades and students' expectations for classroom instruction, may affect the implementation of new teaching approaches.

We asked each teacher in our national sample whether, as part of the activity in which the teacher participated, the teacher practiced under simulated conditions, with feedback; met formally with other activity participants to discuss classroom implementation; communicated with the leader(s) of the activity concerning classroom implementation; met informally with other participants to discuss classroom implementation; and developed curricula or lesson plans that other participants or the activity leader reviewed.

Reviewing student work. Another element of active learning is the opportunity to examine and review student work. By examining students' written responses to problems, for example, teachers may gain an understanding of students' assumptions, reasoning and solution strategies (Schifter, 1996; Carpenter, Fennema, Peterson, Chiang, & Loef, 1989). Also, examining and discussing examples of student work may help teachers develop skills in diagnosing student problems and designing lessons at an appropriate level of difficulty.

We asked each teacher in our national sample whether the teacher reviewed student work or scored assessments as part of the activity; whether other activity participants or the activity leader reviewed work completed by students in the teacher's classroom; and whether student outcomes were examined as part of an evaluation of the activity.

Presenting, leading, and writing. Apart from opportunities to observe teaching, plan classroom implementation, and review student work, professional development activities may also offer teachers the opportunity to give presentations, lead discussions, and produce written work. Active participation of this kind may improve outcomes by permitting teachers to delve more deeply into the substantive issues introduced.

We asked each teacher in our national sample whether, as part of the activity, the teacher gave a lecture or presentation; conducted a demonstration of a lesson, unit, or skill; led a whole-group discussion; led a small group discussion; or wrote a paper, report, or plan.

Overall index of active learning. To examine the effect of active learning opportunities provided in the activities in which our national sample of teachers participated, we created a composite index, summing all of the types of active learning. Because our survey included four items to measure opportunities for observation, five for planning, four for reviewing student work, and five for presenting/writing, simply summing the 18 types of opportunities included would give more weight to planning and presenting/writing than to observing and reviewing student work. Thus, in computing

the index, we weighted each of the four items pertaining to observation and the four items pertaining to student work by 1.25. This produces an index that runs from 0 (no opportunities were provided for active learning) to 20 (all types of active learning were provided).

Fostering Coherence

A third core feature of professional development concerns the extent to which professional development activities are perceived by teachers to be a part of a coherent program of teacher learning. Professional development for teachers is frequently criticized on the ground that the activities are disconnected from one another—in other words, individual activities do not form part of a coherent program of teacher learning and development. A professional development activity is more likely to be effective in improving teachers' knowledge and skills if it forms a coherent part of a wider set of opportunities for teacher learning and development. We assessed the coherence of a teacher's professional development in three ways: the extent to which it builds on what teachers have already learned; emphasizes content and pedagogy aligned with national, state and local standards, frameworks, and assessments; and supports teachers in developing sustained, ongoing professional communication with other teachers who are trying to change their teaching in similar ways.

Connections with goals and other activities. One way to assess whether a professional development activity is part of a coherent program of teacher learning is to ask whether the activity builds on earlier activities and is followed up with later, more advanced work. To address this issue, we asked each teacher in our national sample to report the extent to which the activity the teacher attended was consistent with the teacher's goals for professional development; based explicitly on what the teacher had learned in earlier professional development experiences; and followed up with activities that built upon what was learned in this professional development activity. Teachers responded on a scale from 1 to 5, where 1 = *not at all* and 5 = *to a great extent.*

Alignment with state and district standards and assessments. A second aspect of coherence concerns the alignment of the content and pedagogy emphasized in the activities with national, state, and local frameworks, standards, and assessments. Teachers receive guidance about what to teach and how to teach it from multiple sources, such as material covered in formal professional development, preservice education, textbooks, national standards, state and local policies and assessments, and the professional literature (Cohen & Spillane, 1992). If these sources provide a coherent set of goals, they can facilitate teachers' efforts to improve teaching practice, but if they conflict they may create tensions that impede teacher efforts to develop their teaching in a consistent direction (Grant, Peterson, & Shojgreen-Downer, 1996).

Efforts to align professional development with state and district frameworks, standards, and assessments offer one approach to increasing the coherence of the instructional guidance teachers receive. The process of aligning professional development with state and district standards and other policies can take a number of forms. For example, professional development activities can be chosen to reflect the topics emphasized in state and district standards. Or, professional development activities can focus on the goals for student learning emphasized in state assessments or the pedagogical methods emphasized in state curriculum frameworks (Webb, 1998).

To measure the alignment of the professional development activity with state and district standards, we asked each teacher in our national sample to indicate the extent to which the activity was aligned with state or district standards and curriculum frameworks, and with state and district assessments. Teachers were asked to respond using a 5-point scale, from 1 = *not aligned at all* to 5 = *aligned to a great extent.*

Communication with others. The third dimension of coherence concerns the ways in which professional development activities encourage professional communication among teachers who are engaged in efforts to reform their teaching in similar ways. An ongoing discussion among teachers who confront similar issues can facilitate change by encouraging the sharing of solutions to problems, as well as by reinforcing the sense that, with time, improvement is possible. There is some evidence, for example, that networks of teachers involved in change can help sustain motivation (Lieberman & McLaughlin, 1992). In addition, by sharing methods, discussing written work, and reflecting on problems and solutions, teachers may foster a better understanding of the goals for student learning that proposed changes in teaching imply.

To measure the extent to which teachers in our national sample were encouraged to establish professional communication as part of the Eisenhower-assisted activities in which they participated, we asked the teachers whether they had discussed what they learned with other teachers in their school or department *who did not attend* the activity; whether they had discussed or shared what they learned with *administrators* (e.g., principal or department chair); and whether they had communicated, outside of formal meetings held as part of the activity, with participants in the activity who teach in other schools.

Overall Index of Coherence. To provide a composite measure of the overall extent to which Eisenhower-assisted activities are a part of a coherent program of professional development, we combined the items that comprise our three specific dimensions of coherence. The composite sums the items concerning connections to teachers' goals and other professional development experiences; alignment; and professional communication. Because three items are available for the first and third of these dimensions, while only two items are available for the second, we weighted the items for the second dimension by 1.5. This produces a scale that runs from 0 (*the activity*

did not include any of the types of coherence we measured) to 9 (*the activity provided all of the forms we measured*).

Teacher Outcomes

Teacher knowledge and skills. To assess the effects of participation on teachers' knowledge and skills, we asked each teacher in our national sample to indicate the degree to which his or her knowledge and skills were enhanced as a result of participation in the specific Eisenhower-assisted activity that drew the teacher into the sample. We asked each teacher to indicate the extent to which knowledge and skills had been enhanced in each of the following areas: (a) curriculum (e.g., units, texts, standards); (b) instructional methods; (c) approaches to assessment; (d) use of technology in instruction (e.g., computers, graphing calculators); (e) strategies for teaching diverse student populations (e.g., with disabilities, from underrepresented populations, economically disadvantaged, limited English proficient, range of abilities); and (f) deepening knowledge of mathematics.

Teachers reported their responses using a 5-point scale, where 1 = *not at all* and 5 = *to a great extent.* We averaged each teacher's responses on these six items to create a composite scale measuring enhanced knowledge and skills.

Change in classroom teaching practice. We asked the teachers in our national sample to what extent they made changes in their teaching practices in each of the following domains, as a result of the professional development activity: (a) the mathematics curriculum content, (b) the cognitive challenge of mathematics classroom activities, (c) the instructional methods employed, (d) the types or mix of assessments used to evaluate students, (e) the ways technology (calculator or computer) is used in instruction, and (f) the approaches taken to student diversity.

Teachers were asked to report responses on a scale from 0 to 3, where 0 = *no change,* 1 = *minor change,* 2 = *moderate change,* and 3 = *significant change.* We averaged each teacher's responses to these six items to create a composite scale measuring change in teaching practice.

Estimation Methods

To examine the effects of the structural and core features of professional development on teacher outcomes, we estimated a formal causal model, using data from our national sample of teachers. Because it is possible that teachers in different types of schools or teachers with different characteristics may experience different types of professional development, we included *school and teacher* characteristics as control variables in our model. The model includes two characteristics of the schools in which the participating teachers teach: the percent of students eligible for free and reduced-price lunch, and the percent of minority enrollment. The model also includes five characteristics of the participating teachers: gender, subject of the teacher's

professional development experience (mathematics or science); grade level (elementary, middle, or high school); whether the teacher is certified in his or her main teaching field; and the teacher's teaching experience, in years.[15] In addition, we also included the sponsorship of the activity as a variable in the model (coded 1 = *SAHE grantee,* 0 = *district*).[16,17]

We have characterized professional development activities in terms of structural and core features. We view the three structural features—activity type (reform versus traditional), duration, and collective participation—as structural elements that set the context in which a professional development activity takes place. We view the three core features—content focus, active learning, and coherence—as characteristics of the professional development processes and experiences that take place during an activity. Given this framework, we expect the structural features of professional development to play an important role in determining the substance or core of the professional development experienced by teachers; and we expect the core features of the professional development experienced to contribute to teacher outcomes, including enhanced knowledge and skills and changes in teaching practice. We estimate this implied model using ordinary least squares (OLS) regression.[18]

Our data are cross-sectional, so we cannot rule out alternative causal interpretations. We can, however, identify the strength and direction of relationships among variables. Our path model suggests a logical ordering of the design and outcomes of professional development activities, but our model should not be considered to exclude the possibility of two-way effects or an alternative temporal ordering.

Results

Table 1 shows the regression coefficients, significance levels, and standard errors of the predictors in the model, Table 2 gives these statistics for the control variables in the model, and Figure 1 displays the causal model represented by the results of our analyses. The appendix lists the means and standard deviations of all the variables in the model and the correlations between them. The results shown in Figure 1 are expressed as standardized path coefficients. All paths shown are statistically significant at the .05 level.

To interpret the results, we begin by discussing the effects of the three structural features (form, duration, and collective participation) and proceed to discuss the core features (content focus, active learning opportunities, and coherence) and teacher outcomes. The results indicate that activity type has an important influence on duration: reform activities tend to span longer periods (.21) and to involve greater numbers of contact hours (.10) than traditional activities. Our results also show a modest direct effect of activity type on enhanced knowledge and skills (.05), indicating that reform activities have slightly more positive outcomes when all of the design features and quality characteristics in our model are included.

Our two measures of duration—time span and contact hours—exert a substantial influence on the core features of professional development ex-

Table 1

The Relationships of Features of Professional Development to Teacher Outcomes

Predictors	Dependent variables[a]							
	Span	Contact hours	Collective participation	Focus on content knowledge	Active learning	Coherence	Enhanced knowledge and skills	Change in teaching practice
Sponsor (1 = *district,* 2 = *SAHE grantee*)	.27***	.27***	−.13***	.15***	.08**	.01	.02	−.01
	1.25	26.27	−.36	.40	.15	.02	.04	−.02
	(.15)	(3.27)	(.10)	(.09)	(.05)	(.06)	(.06)	(.06)
Type (1 = *traditional,* 2 = *reform*)	.21***	.10**	.04	.01	.02	.02	.05*	.04
	.88	9.29	.11	.02	.03	.03	.11	.08
	(.14)	(2.98)	(.09)	(.08)	(.05)	(.06)	(.05)	(.05)
Span (1 = *<a day . . . 9 = > a year*)				.08*	.30***	.26***	.02	.02
				.05	.12	.11	.01	.01
				(.02)	(.01)	(.01)	(.01)	(.01)
Contact hours				.10**	.31***	.16***	.03	.09**
				.00	.01	.00	.00	.00
				(.00)	(.00)	(.00)	(.00)	(.00)
Collective participation				.06	.13***	.08**	.03	.02
				.05	.08	.06	.02	.00
				(.02)	(.02)	(.02)	(.02)	(.00)
Focus on content knowledge							.33***	−.11***
							.29	−.08
							(.02)	(.02)
Active learning							.14***	.03
							.18	.04
							(.04)	(.04)
Coherence							.42***	0.21***
							.51	0.22
							(.03)	(.04)
Enhanced knowledge and skills (EKS)								.44***
								.39
								(.03)
R^2 (in percentage)	12.3	10.5	6.1	11.3	34.9	19.6	51.7	41.6

[a]For each dependent variable, standardized regression coefficient (β) is shown on the first line; unstandardized regression coefficient (b) is shown on the second line; standard error (in parentheses) is shown on the third line. Sponsor and type were considered exogenous variables in the model.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2

The Relationship of Control Variables to Features of Professional Development and Teacher Outcomes

	Dependent variables[a]									
Control variables	Sponsor	Type	Span	Contact hours	Collective participation	Focus on content knowledge	Active learning	Coherence	Enhanced knowledge and skills	Changes in teaching practice
School, percent of students in poverty	−.08*	.06	−.02	−.07	.04	.03	−.02	.03	.02	.02
	.00	.00	.00	−.11	.00	.00	.00	.00	.00	.00
	(.00)	(.00)	(.00)	(.06)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
School, percent of minority students	.00	.03	.06	.16***	.04	.07	.04	.02	.02	−.04
	.00	.00	.00	.20	.00	.00	.00	.00	.00	.00
	(.00)	(.00)	(.00)	(.05)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
Teacher's gender (1 = *female*, 2 = *male*)	.02	.04	.02	.02	−.02	.05	−.01	−.07*	−.03	−.01
	.02	−.04	.07	2.54	−.05	.13	−.02	−.14	−.07	−.03
	(.04)	(.04)	(.16)	(3.52)	(.10)	(.09)	(.06)	(.07)	(.06)	(.06)
Subject (1 = *math*, 2 = *science*)	−.06	−.02	.00	.07*	.03	.11***	.05	−.03	.02	.04
	−.04	−.02	.00	5.50	.07	.22	.07	−.05	.04	.06
	(.03)	(.03)	(.12)	(2.50)	(.07)	(.07)	(.04)	(.05)	(.04)	(.04)
Grade level (1 = *elementary*, 2 = *middle*, 3 = *high*)	.13***	−.01	−.13***	−.07	−.13	−.18***	−.12***	−.15***	.04	−.12
	.06	.00	−.28	−3.17	−.17	−.23	−.10	−.13	.04	−.11
	(.02)	(.02)	(.08)	(1.64)	(.05)	(.04)	(.03)	(.03)	(.03)	(.03)
In-field certification (0 = *no*, 1 = *yes*)	−.14***	−.03	.04	.00	.01	.04	.04	.10**	.01	−.07**
	−.11	−.03	.17	−.28	.03	.09	.06	.16	.03	−.12
	(.03)	(.03)	(.12)	(2.69)	(.08)	(.07)	(.04)	(.05)	(.05)	(.05)
Teaching experience (in years)	−.03	−.01	.03	−.03	.10**	.00	−.08	.02	−.03	.05*
	.00	.00	.01	−.13	.01	.00	.00	.00	.00	.00
	(.00)	(.00)	(.01)	(.14)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)

[a]For each dependent variable, standardized regression coefficient (β) is shown on the first line; unstandardized regression coefficient (b) is shown on the second line; standard error (in parentheses) is shown on the third line.

*$p < .05$. **$p < .01$. ***$p < .001$.

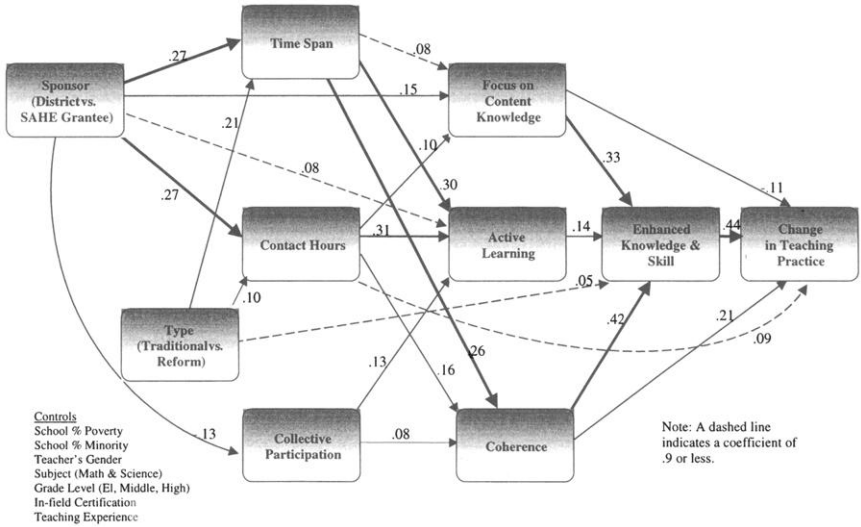

Figure 1. **The relationship of features of professional development to teacher outcomes.**

periences. Time span and contact hours have a substantial positive influence on opportunities for active learning (.30 and .31) and coherence (.26 and .16). Longer activities tend to include substantially more opportunities for active learning, such as the opportunity to plan for classroom implementation, observe and be observed teaching, review students' work, and give presentations and demonstrations. Longer activities also tend to promote coherence including connections to a teacher's goals and experiences, alignment with standards, and professional communication with other teachers. Time span and contact hours also have a moderately positive influence on the emphasis given to content knowledge (.08 and .10); activities that span a longer period and last more hours are more likely to focus on mathematics and science content.

The fact that both time span and contact hours have independent effects on our measures of core features suggests that both dimensions of duration are important. Professional development is likely to be of higher quality if it is both sustained over time and involves a substantial number of hours.

All three of our measures of the core features of activities have a positive influence on enhanced knowledge and skills, as reported by the teachers in our sample. Both content focus and coherence have substantial positive effects on enhanced knowledge and skills (.33 and .42), indicating that activities that give greater emphasis to content and that are better connected to teachers' other professional development experiences and other reform efforts are more likely to produce enhanced knowledge and skills. Active learning also is related to enhanced knowledge and skills (.14), but the effect

is less strong. Activities that are content focused, but do not increase teachers' knowledge and skills, have a negative association with changes in teacher practice (−.11).

Finally, enhanced knowledge and skills have a substantial positive influence on change in teaching practice (.44); teachers who report enhanced knowledge and skills are likely to report changing their teaching practices as well. In addition, the coherence of professional development activities has an important positive influence on change in teaching practice (.21), over and above the effects of knowledge and skills. This suggests that compared to teachers whose professional development is not coherent, teachers who experience professional development that is coherent—that is, connected to their other professional development experiences, aligned with standards and assessments, and fosters professional communication—are more likely to change their practice. This positive effect for teachers whose professional development is coherent is true even compared to teachers who have gained the same underlying knowledge and skills as a result of their professional development experiences.

Our data also provide information about how prevalent these characteristics are in a teacher's professional development activities. The data indicate that most Eisenhower-assisted activities are traditional in form. Overall, 79% of teachers participating in district activities participated in traditional types of activities, including 52% in in-district workshops, 4% in college courses, 15% in out-of-district workshops or institutes, and 8% in conferences. Similarly, 74% of teachers participating in SAHE grantee professional development activities (i.e., sponsored by institutions of higher education and nonprofit organizations) participated in traditional types. Some teachers report that the activities in which they participated were reform types, including collaboratives and networks, internships, mentoring, resource centers, committees and task forces, and study groups, but the overall percent of teachers participating in reform activities is relatively small.

Although most teachers participate in traditional forms of professional development, there is a considerable amount of overlap between traditional and reform types of professional development on the other structural and core features of these activities. For example, the average length of reform activities is 35 hours, compared with 23 hours for traditional activities. But there are some traditional activities that last over 120 hours, and some reform activities that last fewer than 20 hours. Similarly, 62% of teachers report that traditional activities last 2–4 days or less, but 18% participate in traditional activities that span 9 months or more; and whereas 29% of teachers participate in reform activities that span 9 months or more, 34% are in reform activities that span 2–4 days or less.

There also is substantial variation on the core features for both reform and traditional activities. Half or more of teachers in both reform (54%) and traditional activities (50%) report that the activities have a major emphasis on mathematics and science content knowledge. Furthermore, although the

mean number of active learning opportunities is higher for reform activities (4.4) than for traditional activities (3.4), many traditional activities offer between 12 and 16 types of active learning, and many reform types offer only 1 or 2 types of active learning. Similarly, although reform activities score higher on average on coherence than traditional activities (6.3 compared with 5.9), both forms of activities sometimes have no or few characteristics of coherence, and sometimes have as many as nine types of coherence.

Variation also exists across reform and traditional types in teacher reports of enhancement of knowledge and skills and changes in classroom practice. On a scale of 0–5, where 0 = *no enhancement* and 5 = *great enhancement,* teachers report a mean of 3.1 for traditional activities and 3.4 for reform activities. For both types of activities, however, teachers report varying degrees of enhanced knowledge and skills, from 1 to 5.

Similarly, teachers report changing practice more as a result of reform activities than traditional activities (1.4 compared to 1.2, where 0 = *no change* and 3 = *the highest degree of change*), but scores for both types of activities range across the entire distribution—from no change to the highest degree of change.

It is clear from these data that many professional development activities do not have features of high quality, whether they are structured as reform or traditional. There may be several reasons why some activities lack high-quality features. First, providing activities with multiple high-quality features is challenging, and requires a substantial amount of lead time and planning, which schools and districts may not always have. Second, providing activities with these high-quality features is expensive. We estimate that it costs an average of $512 per teacher to provide a high-quality professional development experience. This is more than twice the amount of money that districts typically spend.

Discussion and Implications

These results suggest several ways for improving professional development. First, they provide empirical confirmation on a national probability sample of the assumptions in the literature on "best practice" in professional development. For example, our results indicate that sustained and intensive professional development is more likely to have an impact, as reported by teachers, than is shorter professional development. Our results also indicate that professional development that focuses on academic subject matter (content), gives teachers opportunities for "hands-on" work (active learning), and is integrated into the daily life of the school (coherence), is more likely to produce enhanced knowledge and skills.[19]

Our results also extend the literature on "best practice" in several ways. For example, although we find distinctions between the effects of traditional and reform activities, they generally are not direct effects on teacher outcomes. Rather, the effect of reform versus traditional professional development activities operates indirectly through the other design features and dimensions of quality identified above. That is, reform activities tend to

produce better outcomes primarily because they tend to be of longer duration. Traditional and reform activities of the same duration tend to have the same effects on reported outcomes, and there is considerable overlap in span and contact hours for these two forms of activities. Thus, to improve professional development, it is more important to focus on the duration, collective participation, and the core features (i.e., content, active learning, and coherence) than type.

In addition, our results provide support for previous speculation about the importance of collective participation and the coherence of professional development activities. Activities that are linked to teachers' other experiences, aligned with other reform efforts, and encouraging of professional communication among teachers appear to support change in teaching practice, even after the effects of enhanced knowledge and skills are taken into account. Such coherence has been hypothesized as important, but with little direct empirical support in the literature to date. Similarly, our data provide empirical support that the collective participation of groups of teachers from the same school, subject, or grade is related both to coherence and active learning opportunities, which in turn are related to improvements in teacher knowledge and skill and changes in classroom practice.

Finally, along with several recent papers (Cohen & Hill, 1998; Kennedy, 1998), our results confirm the importance of professional development that focuses on mathematics and science content. Much of the literature on professional development focuses on the process and delivery system; our results give renewed emphasis to the profound importance of subject-matter focus in designing high-quality professional development.

It is important to emphasize that although the data discussed here are cross-sectional, there are a number of strengths to the data set on which our model of effective professional development is estimated. First, the data represent a national probability sample of Eisenhower mathematics and science professional development activities and the teachers who participated in them. Because the Eisenhower program is a funding stream, and therefore can be used for a wide variety of professional development activities, it is reasonable to conclude that this is a representative sample of math and science professional development being offered in the United States. Second, despite the complicated three-stage sampling scheme followed, the response rates were an excellent 72%. Districts and SAHE grantees were sampled to obtain rosters of professional development activities for a 6-month period. Activities were then sampled with probability in proportion to the number of teachers participating. Finally, respondents were randomly sampled from the selected professional development activities. Third, whereas the data are based on teacher self-report, teachers were asked to give an accounting of behaviors, not provide direct judgements of quality that might have been more likely biased in a positive direction. Fourth, the analyses are conducted on between-respondent and between-activity variance. To the extent that teacher self-report is based in a positive direction, this bias may operate uniformly throughout the data set, and if so, does not

affect our estimates in the path analysis. Although there are many strengths to the data described in this paper, longitudinal research clearly is needed, focusing on the relationships among professional development, teacher learning, teacher change, and ultimately, student learning.

Results of our study indicate that if we are serious about using professional development as a mechanism to improve teaching, we need to invest in activities that have the characteristics that research shows foster improvements in teaching. A major challenge to providing this type of high-quality professional development is cost. Schools and districts understandably feel a responsibility to reach large numbers of teachers. But a focus on breadth in terms of number of teachers served comes at the expense of depth in terms of quality of experience. Our results suggest a clear direction for schools and districts: in order to provide useful and effective professional development that has a meaningful effect on teacher learning and fosters improvements in classroom practice, funds should be focused on providing high-quality professional development experiences. This would require schools and districts either to focus resources on fewer teachers, or to invest sufficient resources so that more teachers can benefit from high-quality professional development.

APPENDIX

Sample Design and Response Rates

Designing the sample. We based the district sampling frame for the 1997–1998 Teacher Activity Survey on the Common Core of Data (CCD), maintained by the National Center for Education Statistics. At the time we selected the sample, 1992–1993 was the most recent year for which complete CCD data were available.

Because district size (as measured by the number of teachers) is highly skewed, a simple random sample would contain many small districts representing very few teachers. Thus, we drew the sample of districts with probability proportional to district size, separately within each of the three poverty strata, using the number of teachers employed as the measure of size. Within each stratum, we selected with certainty all districts with 5,000 or more teachers—4 low-poverty districts, 10 medium-poverty districts, and 12 high-poverty districts.

To obtain sufficiently precise estimates of program characteristics, we planned to sample 400 district coordinators. In some large districts, Eisenhower funds are divided among subdistricts. To estimate the number of subdistrict interviews that might be required, we assumed that subdistrict interviews would occur in only very large districts (i.e., the 26 districts with more than 5,000 teachers), and we assumed that one subdistrict interview would be required per 5,000 teachers. These calculations led us to estimate that the 26 certainty districts in our sample might generate 53 interviews altogether—27 more than would be required without subdistricts.

Because we desired an overall sample size of 400 *interviews,* we set a total sample size of 373 *districts,* to accommodate the anticipated 27 additional subdistrict interviews. Because we planned to select 26 districts with certainty, this left 347 districts to be drawn with probability proportional to size. We allocated these 347 districts to the three strata in proportion to each stratum's total number of teachers in districts with fewer than 5,000 teachers. This procedure yielded a sample size of 140 low-poverty districts, 129 medium-poverty districts, and 104 high-poverty districts.

Table A1

Correlations Among Variables

	Mean	Standard deviation	Poverty	Minority	Gender	Subject	Grade	In-field	Teaching experience
School, percent of students in poverty	30.37	23.65	1.00						
School, percent of minority students	29.31	30.12	.50***	1.00					
Teacher's gender	1.18	.38	.00	−.03	1.0)				
Subject	1.50	.50	.02	.06	.13***	1.00			
Grade level	1.70	.82	−.15***	.01	.33***	.02	1.00		
In-field certification	.70	.50	−.10*	−.08*	−.07*	−.02	−.02	1.00	
Teaching experience	13.93	.93	−.03	−.08*	.05	−.04	−.02	.02	1.00
Sponsor	1.23	.42	−.08	−.03	.03	−.07	.12***	−.11***	−.12***
Type	1.20	.40	.06	.07*	−.03	−.04	−.05	−.03	−.04
Span	4.02	1.78	.01	.04	−.01	−.02	−.06	−.04	−.04
Contact hours	34.97	43.84	.01	.12***	.02	.05	−.01	−.06*	−.08*
Collective participation	0	1	.08*	.05	−.09**	.02	−.14***	.03	.10**
Focus on content knowledge	0	1	.08*	.09**	−.03	.12	−.19***	.01	−.04
Active learning	0	.73	.03	.08*	−.09**	.02	−.15***	.03	−.10**
Coherence	−.02	.79	.03	.05	−.20***	−.09	−.21***	.11***	−.02
Enhanced knowledge and skills	3.31	.89	.08*	.11*	−.08*	.04	−.15***	.05	−.08**
Change in teaching practice	1.28	.81	.05	.03	−.15	.00	−.25***	.01	.01

Note. Pairwise correlations are based on *n* values ranging from 901 to 1027. For a list of the questions from the Teacher Activity Survey used in this analysis, see the Technical Appendix in Garet et al. (1999).
*$p < .05$. **$p < .01$. ***$p < .001$.

Sampling activities and teachers. Altogether, we successfully completed interviews in 363 districts and consortia. Within each district in which we completed an interview, we asked the Eisenhower coordinator to provide a complete list of all Eisenhower-assisted activities conducted in the district over the period from July 1 through December 31, 1997. Ten of the 369 districts with completed interviews did not conduct any Eisenhower-assisted activities during this period, leaving 359 from which we potentially could obtain activity lists.

For most districts, we drew two activities at random from the complete list of mathematics and science activities provided, with probability proportional to the number of participants in each activity. For districts with more than 7,500 teachers,

Sponsor	Type	Contact hours	Collective participation	Content focus	Active learning	Coherence	Knowledge and skills	Change in teaching practice
1.00								
.03	1.00							
.30***	.19**							
.29***	.10**	1.00						
−.15***	.02	.01	1.00					
.17***	.05	.18***	.06	1.00				
.26***	.09**	.46***	.14***	.26***	1.00			
.11***	.10**	.23***	.12***	.29***	.49***	1.00		
.19***	.16***	.30***	.11***	.51***	.48***	.62***	1.00	
.10**	.13***	.26***	.13***	.25***	.40***	.54***	.58***	1.00

we drew one activity for each group of 2,500 teachers teaching in the district. Thus, for example, we drew three activities in districts with between 7,500 and 9,999 teachers, and four activities in districts with between 10,000 and 12,249 teachers.

Once the sample of activities was drawn for each district, we asked the district Eisenhower coordinator to provide a list of all teachers participating in each of the sampled activities. We then drew a simple random sample of 2 teachers for each of the selected activities. Of the 359 districts from which we attempted to obtain activity lists and teacher names, we obtained complete activity lists and teacher names from 312, a response rate of 87%. We examined variation in response rates for activity lists and teacher names by district size and poverty. We observed some differences in the response rates for activity lists by district size, but there is no clear pattern. We did not observe any differences in response by poverty.

Response rates for teachers. Altogether, for the 312 districts for which we obtained activity lists and teacher names, we sampled 1,255 teachers. We obtained the

school address for each of these 1,255 teachers from the Eisenhower coordinators, and we mailed either a mathematics or science form of the teacher activity survey, depending on the type of activity attended.

On the basis of a careful effort to locate and contact each nonresponsive sampled teacher by telephone, we concluded that 142 of the 1,255 sampled teachers (or 11%) were out of scope, because they had not attended the sampled activities, or they could not be located, because the address provided by the Eisenhower coordinator was in error and we were unable to obtain a current address. Of the remaining 1,113 potential respondents, we received completed surveys from 783, or just over 70%.

We checked whether teacher response rates differed by district size and poverty, as well as for teachers who received mathematics and science surveys, and for teachers in high- and low-poverty schools. We did not find significant differences for any of these factors.

Sample Design and Response Rates for SAHE Grantee Project Director Interviews and Teacher Activity Survey

Designing the sample. In most respects, the approach we used in sampling institutions of higher education/not-for-profit organizations (IHE/NPO) paralleled the process for districts. The primary difference in our sampling plans for IHE/NPOs and districts is that for IHE/NPOs, we could not use the number of teachers as a basis for selection, because IHE/NPOs are not staffed with teachers, as are school districts, and because information on the number of participants is not available on the full population of IHE/NPOs receiving Eisenhower funds. Hence, we sampled IHE/NPOs based on the size of the Eisenhower award each received, in dollars per year. The correlation between grant size and number of teachers is .6.

For purposes of the sampling plan, we defined the population of IHE/NPOs as all institutions with an Eisenhower grant covering at least part of the 1997–1998 school year, and offering at least one Eisenhower-assisted activity during the period from July 1 through December 31, 1997. To construct a sampling frame of the IHE/NPOs that received funds for the 1997–1998 school year, we contacted the 50 SAHE Eisenhower coordinators and asked them to provide a list of all IHE/NPOs that had been awarded grants, along with information on the size of each grant and the grant period, in months. All states provided appropriate information.

Screening IHE/NPOs and scheduling interviews. We sought a completed sample size of 100 IHE/NPOs. Once the initial sample was drawn, we contacted each sampled institution to request participation in the evaluation. As part of the screening process, we determined whether each sampled institution had offered Eisenhower-assisted activities during the period from July 1 through December 31, 1999. Institutions that did not or that declined to participate were replaced with randomly drawn institutions of similar grant size.

Response rates for IHE/NPOs. We contacted 120 institutions; of these, 12 did not conduct activities in the relevant period and two did not receive Eisenhower funds over the relevant period, although they were included on the list of funded projects provided by their state. Thus, these 14 institutions did not meet the conditions to be included in our sample, and we considered them out of scope. We replaced each out-of-scope SAHE grantee with a randomly drawn SAHE grantee with similar annual dollar grant amount. Of the remaining 106 institutions, 92 completed interviews, producing an overall response rate of 87%.

Sampling activities and teachers. As we did in each sampled district, we asked each sampled IHE/NPOs to provide a complete list of Eisenhower-assisted activities

that the institution had offered over the period from July 1 through December 31, 1997, and, from these lists, we selected activities to be included in our sample. We had intended to follow the plan we used for districts, and sample two activities per SAHE grantee. But as we began to receive activity lists from the IHE/NPOs, we learned that many IHE/NPOs in our sample offered just one activity over the relevant period, and most that offered more than one activity offered a relatively small number. Thus, to maintain the overall desired sample size for activities of about two per district, we decided to sample *all* activities offered by the sampled IHE/NPOs. Then, as we did in our district data collection, we obtained the names of 2 randomly-selected teachers who attended each activity. We were able to obtain teacher names for 81 IHE/NPOs, or 88% of the IHE/NPOs in which we conducted interviews.

Response rates for teachers. Altogether, we obtained the names of 334 teachers. Of these, we excluded 27 from the sampling frame because they reported that they did not attend the sampled activity or because we could not obtain a correct address. Of the remaining 307 teachers, we obtained completed responses from 244, or 80%.

Notes

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[1]See Richardson and Placier (2001) for a comprehensive review of the literature on teacher learning and professional development.

[2]See, for example, Cohen (1990) for a recent intensive case study of change in mathematics teaching; Carey and Frechtling (1997) for an evaluation of exemplary professional development approaches in science; and U.S. Department of Education (1999) for a national survey of teachers focused on teacher preparation and qualifications.

[3]See, for example, Fennema et al. (1996), an experimental study examining the effects of Cognitively Guided Instruction, an intervention in elementary school mathematics; Wilson and Ball (1991), an intensive case study of two teachers who participated in the Summer Math program; and Cohen and Hill (1998), which describes the relationship between participation in professional development, teaching practice, and student achievement, using survey data from California. See Kennedy (1998) for a review of available randomized studies examining the effects of teacher professional development on student achievement in mathematics and science. See Shields, Marsh, and Adelman (1998) for a recent examination of the effects of the National Science Foundation (NSF) State Systemic Initiatives (SSIs) on classroom practice in mathematics and science; and Weiss, Montgomery, Ridgway, and Bond (1998) for an examination of the effects of the NSF Local Systemic Change (LSC) initiatives.

[4]Kennedy (1998) and Cohen and Hill (1998) are among the few examples of studies that compare the relative effectiveness of different forms of professional development. Both studies conclude that professional development focused on the teaching and learning of specific mathematics and science content is more effective than more general professional development.

[5]See Garet et al. (1999) for a more detailed discussion of the Eisenhower program and the results of the evaluation.

[6]The correlation between grant size and number of teachers served is .6.

[7]See Appendix for a more complete discussion of the sampling plan.

[8]The categories draw in part on Loucks-Horsley, Hewson, Love, and Stiles (1998).

[9]The survey included a final category, "other organized forms of professional development." and asked the teacher to describe the form. We reclassified all responses into one of the 10 forms listed.

[10]Teachers who completed their surveys before the end of the 1997–1998 school year were asked to estimate the number of additional hours the activity would last during the remaining months of the school year.

[11]Teachers were also given the following options: teachers as individuals, teachers as representatives of their departments, grade level, or schools, and other configurations. Teachers could check all that applied.

[12]Not all professional development is focused on knowledge and skills. Some activities are designed to increase teachers' awareness of new practices rather than to increase knowledge and skills; others are designed to build or renew teachers' motivation and commitment to teaching, without necessarily changing teaching practices.

[13]See Garet et al. (1999) for a discussion of these performance goals.

[14]We did not ask teachers about other aspects of content-focus; for example, the extent to which the activity emphasized how students learn specific content or the extent to which it focused on methods of teaching specific content. Items on these aspects of content focus are included in a separate component of the Eisenhower study, see Porter et al. (2000).

[15]With few exceptions, we found few systematic differences in Eisenhower professional development experiences for teachers in different types of schools or with different characteristics. One teacher characteristic that has a consistent effect is grade level taught. Teachers in secondary schools tend to report participating in activities with less positive quality (for example, fewer opportunities for active learning and less change in teaching practice). See Table 1.

[16]For the larger evaluation of the Eisenhower Professional Development Program, we were interested in understanding the differences between activities supported by the district component of the program, and those offered by the SAHE component of the program.

[17]See Garet et al. (1999) for more details on the measures.

[18]The significance tests are computed according to the assumptions of conventional simple random sampling. These tests do not take into account the fact that the sample is stratified by poverty, the teacher weights vary to some extent across districts, and the reports of teachers who attended the same activities or activities in the same district are not independent. We reran the analyses incorporating these factors, and the significance test results were nearly identical to those reported here.

[19]When enhancements in knowledge and skills is controlled, content focus has a negative association with changes in classroom practice. We suspect that this result is probably spurious, resulting from the large number of independent variables included in the model predicting change in teaching practice. (The model for change in teaching practice includes all of the structural and core features of professional development, as well as all control variables.) We estimated a model predicting change in teaching practice, but omitted knowledge and skills as an intervening variable, and, in that model, content focus has a positive effect.

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