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ABSTRACT

This report, the third in a series of reports from the longitudinal evaluation of the Eisenhower Professional Development Program, examines the effects of professional development on improving classroom teaching practice. The Eisenhower Professional Development Program, Title II of the Elementary and Secondary Education Act, is the federal government's largest investment that focuses solely on developing the classroom teachers' knowledge and skills. Drawing on longitudinal data from approximately 300 teachers, this report discusses the impact of the types of professional development activities supported by the Eisenhower Professional Development Program. Results indicate that professional development focused on specific, higher order teaching strategies increased teachers' uses of these strategies in the classroom. This effect was even stronger when the professional development activity was a reform type, rather than traditional. Teachers in the sample did not consistently receive high quality professional development, and teachers in the same school tended to have quite different professional development experiences. There was little change in overall teaching practice from 1996-99. Despite little average change over time in teaching practice, individual teachers varied in their classroom practices, and moderate variation occurred in the classroom practices of individual teachers from year to year. (SM)

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Executive Summary

Does Professional Development Change Teaching Practice? Results from a Three-Year Study

2000

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Does Professional Development Change Teaching Practice? Results From a Three-Year Study

Executive Summary

October 2000

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EXECUTIVE SUMMARY

DOES PROFESSIONAL DEVELOPMENT CHANGE TEACHING PRACTICE? RESULTS FROM A THREE-YEAR STUDY

What are the characteristics of professional development that improve teaching practice? Are these characteristics common to professional development as it is currently offered? The national Evaluation of the Eisenhower Professional Development Program, conducted by the American Institutes for Research (AIR) under contract with the U.S. Department of Education's Planning and Evaluation Service, addresses these questions. This report, the third in a series of reports from the multi-year Eisenhower evaluation, focuses on the effects of professional development on improving classroom teaching practice.[1] Drawing on longitudinal data from a sample of approximately 300 teachers, this report expands our knowledge about the impact of the types of professional development activities supported by the Eisenhower Professional Development Program.

The Eisenhower Professional Development 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 program, with a FY 2000 appropriation of $335 million, provides funds through state education agencies (SEAs) to school districts and through state agencies for higher education (SAHEs) to institutions of higher education and nonprofit organizations (SAHE grantees). These funds primarily support professional development in mathematics and science, but also in other content areas. The goal of the Eisenhower Professional Development Program is to support professional development experiences for teachers that enhance classroom teaching and, ultimately, improve student learning.

Results in Brief

This report finds that:

- **Professional development focused on specific, higher-order teaching strategies increases teachers' use of those strategies in the classroom. This effect is even stronger when the professional development activity is a reform type (e.g., teacher network or study group) rather than a traditional workshop or conference; provides opportunities for active learning; is coherent or consistent with teachers' goals and other activities; and involves the participation of teachers from the same subject, grade, or school.**

However, we find that teachers in our longitudinal sample do not typically receive consistent high-quality professional development:

- **Teachers experience professional development that varies in quality from one year to the next. Further, teachers in the same school tend to have quite different professional development experiences.**

Perhaps as a result of the variation in the quality of professional development, teaching practice in our longitudinal sample did not change as much as we might have expected:

- **In our longitudinal sample, we find little change in overall teaching practice from 1996 to 1999.**

Further, as with professional development, we find that teachers in the same school have quite different teaching practices:

- **Despite little *average* change over time in teaching practice in our longitudinal sample, individual teachers in our sample do vary in their classroom practices, and moderate variation does occur in the classroom practice of individual teachers from year to year.**

These findings imply that the positive effects of professional development on teaching practice would be increased if districts and schools provided a more coherent, systemic program of high-quality professional development for their teachers. These results and implications are discussed in more detail in the remainder of this Executive Summary.

Background

The national Evaluation of the Eisenhower Program, begun in 1996, includes three strands of data collection, each with unique strengths: the National Profile, the Case Studies, and the Longitudinal Study of Teacher Change. (See Exhibit ES.1 for a description of each strand of data collection.) This report draws heavily on the third of these strands—the Longitudinal Study of Teacher Change (LSTC).

The LSTC was designed to examine the effects of participation in professional development on change over time in teaching practice. The LSTC builds on the results of the first two strands of the Eisenhower evaluation, the National Profile and the Case Studies.

Our longitudinal study also builds on the literature on professional development. Over the past decade, a large body of literature has emerged on professional development, teacher learning, and teacher change.[ii] Despite the amount of literature, however, relatively little systematic research has been conducted on the *effects* of professional development on improving teaching or on improving student outcomes. Although a professional consensus has emerged suggesting that particular characteristics of professional development make it "high quality" or "effective," there has been little direct evidence on the extent to which these characteristics are related to better teaching and increased student achievement.[iii, iv]

Exhibit ES.1

Overview of the National Evaluation of the Eisenhower Professional Development Program

Strand of Data Collection	Sample	Contribution to the Study
National Profile	The National Profile collected data in 1997–98 from national probability samples of district Eisenhower coordinators, SAHE-grantee project directors, and teachers who participated in Eisenhower-assisted professional development (i.e., activities sponsored in full or in part by Eisenhower funds).	This component of the evaluation provided data that are generalizable to all districts receiving Eisenhower funds, all teachers who participate in Eisenhower-assisted professional development, and all SAHE-grantee projects.
Case Studies	The Case Studies provided detailed information about how the Eisenhower program operates in 10 schools districts—two school districts in each of five states: Kentucky, New York, Ohio, Texas, and Washington. The case studies were conducted during the 1997–98 school year.	Data from this component provided a detailed context for interpreting the quantitative findings.
Longitudinal Study of Teacher Change	The Longitudinal Study of Teacher Change surveyed all mathematics and science teachers in 30 schools—three schools (one elementary, one middle and one high school) in each of the 10 case-study districts—at three points in time, during 1996–97, 1997–98, and 1998–99 school years.[v]	These data allow us to examine teachers' professional development and teaching practice over time.

We addressed these research gaps in our earlier report, using data from our national probability sample of teachers as well from as our national sample of district Eisenhower coordinators. On the basis of data from our national sample of teachers, we concluded that six key features of professional development are effective in improving teaching practice.

Three are structural features, or characteristics of the structure of the activity:

- the organization of the activity—whether it is a **reform type,** such as a study group or teacher network, in contrast to a traditional workshop or conference;
- the **duration** of the activity, including the total number of contact hours and the span of time over which it extends; and
- the extent to which the activity has **collective participation** of groups of teachers from the same school, department, or grade.

The remaining three features are core features, or characteristics of the substance of the activity:

- the degree to which the activity has **active learning** opportunities for teachers,
- the extent to which the activity has a **content focus** on mathematics or science, and
- 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.[vi]

In addition, on the basis of our national data from district Eisenhower coordinators, we found that there were significant differences between districts in the quality of professional development they provide. We found that district management strategies, including alignment with standards and assessments, frequency of co-funded projects, and commitment to continuous improvement, affected the features of the activities that districts provided—such as active learning, collective participation, and the span of time over which the activities extend. We also found that generally, larger districts are more likely to provide high-quality professional development than are smaller districts.[vii]

Design of the Longitudinal Study of Teacher Change

The Longitudinal Study of Teacher Change (LSTC) was designed to build on the findings from our national, cross-sectional data. The longitudinal data enable us to document teaching practice before and after a professional development activity and to examine the extent to which changes in teaching practice can be attributed to participation in the professional development activity. In the LSTC, we use detailed measures of teaching practice that we collected by surveying teachers at three points in time: the fall of 1997, the spring of 1998, and the spring of 1999. The three waves of the longitudinal survey provide data pertaining to the 1996–97, 1997–98, and 1998–99 school years.

We conducted the LSTC in a purposeful sample of 30 schools, in 10 districts, in 5 states. We considered several factors in choosing the schools. To ensure our ability to examine results by school level, we chose one elementary, one middle, and one high school in each district. In addition, we oversampled high-poverty schools because the Eisenhower program targets teachers in these schools. We also sought schools in which teachers were likely to participate in Eisenhower-assisted activities. Further, we selected states, districts, and schools that had adopted diverse approaches to professional development in addition to traditional workshops and conferences.

We surveyed all the teachers who taught mathematics and science in each of the 30 schools in the sample. Four hundred thirty (430) teachers responded to the 1996–97 survey, 429 teachers responded to the 1997–98 survey, and 452 teachers responded to the 1998–99 survey. For most analyses, we rely on the sample of 287 teachers who responded to all three waves of the survey. The response rate for the first wave was 75 percent; for the second wave, 74 percent; and for the final wave in 1998, 75 percent.

On the survey, we asked teachers to describe a professional development activity that was particularly helpful to the mathematics class that they reported on in the survey. If they did not participate in an activity that fit this category, we asked them to choose any organized professional development activity in which they had participated in the past year. We were able to identify which activities were supported through the district component of the Eisenhower program, but we could not determine which activities were supported through the SAHE component of the program.

Although this was an evaluation of the Eisenhower Professional Development Program, the LSTC uses data on professional development activities that were supported with other sources of funding as well as activities that were funded through the Eisenhower program. . We combined our analysis of professional development activities supported through Eisenhower with our analysis of activities supported with other funding sources because we found that the quality of Eisenhower-assisted activities was not significantly different than the quality of district activities funded with other sources.[viii] Thus, our longitudinal data demonstrate trends and effects that we would expect from district-sponsored Eisenhower-assisted activities, given the common characteristics of activities in our longitudinal sample and Eisenhower-assisted activities nationwide. As a result, although only 21 to 28 percent of the professional development activities described by teachers in our longitudinal sample were funded by the Eisenhower Professional Development Program in 1997, the findings are directly relevant to the Eisenhower program.[ix]

The data in this report are unique in that they provide detailed information on teaching practice and professional development over a three-year period for all teachers of mathematics and science in a school. These data enabled us to analyze relationships between teachers' professional development experiences and classroom practice, while controlling for prior differences in their classroom practice.

Results

We report findings in three areas: (1) the effects of professional development on teaching practice, (2) teachers' participation in professional development, and (3) trends in teaching practice.

The Effects of Professional Development on Teaching Practice

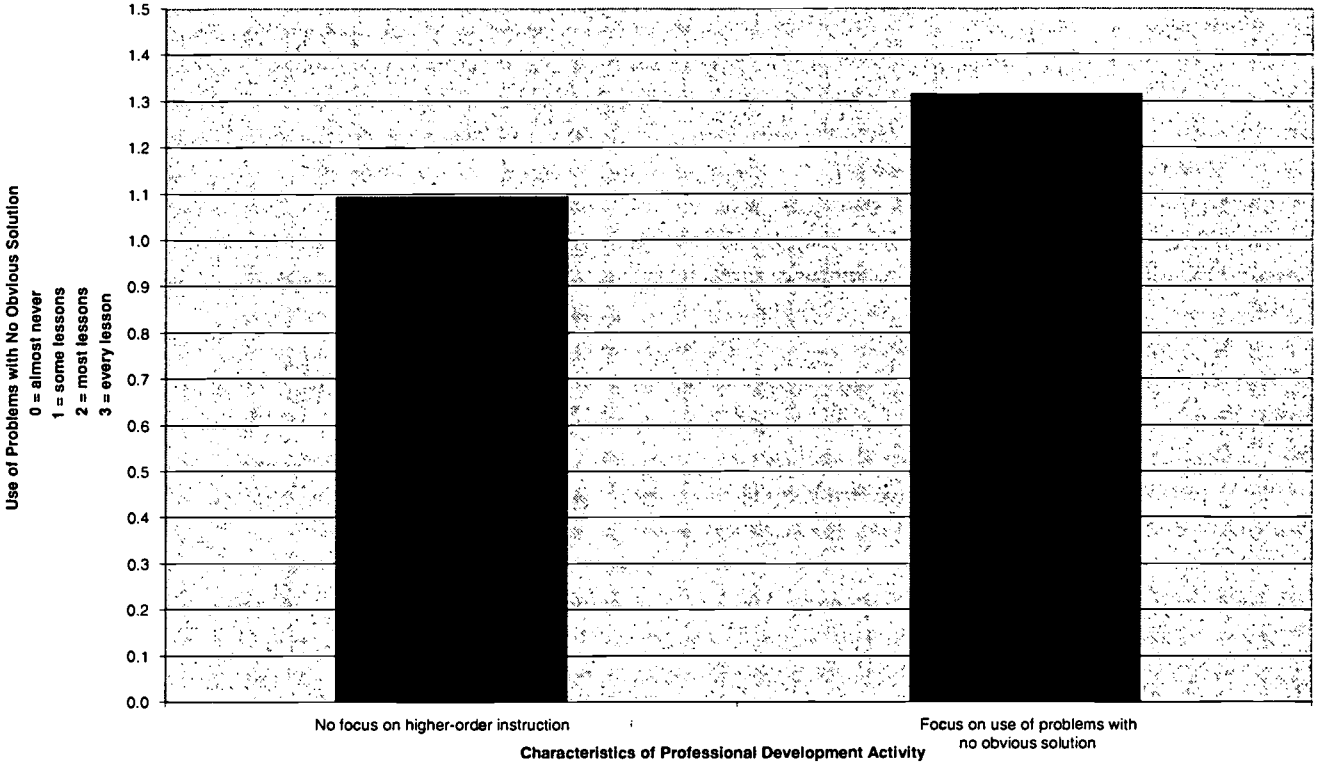
The findings from our longitudinal data reinforce the importance of the six features of professional development identified in the national study—reform type, duration, collective participation, active learning, coherence, and content focus. In addition, the results from our longitudinal study extend our national findings by providing evidence of the link between a focus on specific teaching strategies and/or content in professional development and a teacher's use of those specific strategies and/or content areas in the classroom. In the LSTC, we examined the effects of teaching strategies intended to increase students' higher-order learning in three areas: technology use, instructional methods, and approaches to assessing student work.[x] We found the following:

- **Professional development focused on specific, higher-order teaching strategies increases teachers' use of those strategies in the classroom. This effect is even stronger when the professional development activity has features of high quality (e.g., reform type, active learning, coherence, and collective participation).**

The results of our analyses are clear. First, professional development that focuses on a higher-order teaching strategy—for example, the use of problems with no obvious solution—results in teachers' increasing their use of this strategy in the classroom. Exhibit ES.2 shows that teachers whose professional development focused on using problems with no obvious solution reported increasing their use of this strategy compared with teachers who did not have professional development on this topic.

EXHIBIT ES.2

Effects of Professional Development on the Use of Problems with No Obvious Solution

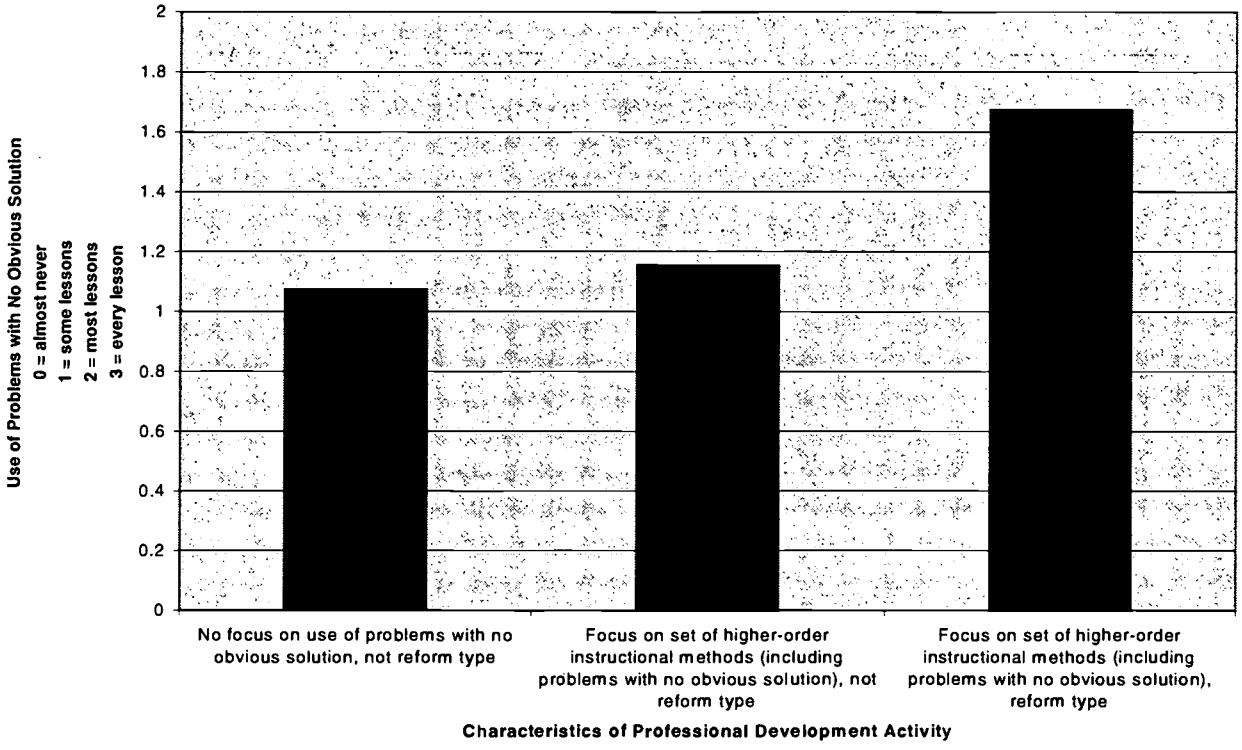


How to read this exhibit: The first bar of Exhibit ES.2 indicates that without professional development that focused on using problems with no obvious solution in 1997–98, on average, teachers reported using this strategy in "some lessons" in 1998–99. (The value of this bar is about 1.1, close to the response value of 1, which equals "some lessons.") If the teachers participated in professional development that focused on this strategy, their use of the strategy in the classroom increased to 1.3—closer to the response category of 2, "most lessons." The analysis controls for subject area, school level, and teachers' use of the strategy in 1996–97, before they participated in the professional development.

Second, professional development that focuses on problems with no obvious solution and also has one or more of the characteristics of high-quality professional development further increases teachers' use of higher-order problem solving in their teaching. For example, Exhibit ES.3 shows that teachers whose professional development focused on higher-order teaching methods and also was structured as a reform-type activity reported greater use of problems with no obvious solution than did teachers whose professional development was not a reform type (i.e., the activity was structured as a traditional workshop or conference).

EXHIBIT ES.3

Effects of Professional Development on the Use of Problems with No Obvious Solution, by the Activity's Focus on Problems with No Obvious Solution and Reform-type



How to read this exhibit: The first bar of Exhibit ES.3 shows the effect of professional development that did not focus on problems with no obvious solution and was not a reform type of activity (i.e., the activity was a traditional workshop, course, or conference rather than, for example, a study group, network, or mentoring relationship). This bar indicates that if teachers' professional development did not focus on the use of problems with no obvious solution and was not a reform type of professional development, teachers generally reported using this strategy "in some lessons" (response category of 1). The second bar illustrates the effect of professional development activities that focused on the use of problems with no obvious solution and other related higher-order instructional strategies; but again the professional development activities were not reform types. This second bar indicates that professional development that focused on the set of higher order instructional methods boosted teachers' use of problems for which there is no obvious solution to almost 1.2, indicating that more teachers were using this strategy in "most lessons" (response category of 2). Finally, the third bar of Exhibit ES.3 shows the effect of professional development that was characterized by a focus on higher-order instructional strategies and was a reform type of professional development. This bar shows that reform types of professional development boosted even further the use of problems with no obvious solution to about 1.6. This result indicates that teachers who participated in reform types of professional development that focused on specific higher-order instructional methods used these methods in "most lessons." The analysis controls for subject area, school level, and teachers' use of the strategy in 1996–97, before they participated in the professional development.

These findings are illustrative of the results we obtained for professional development focused on other aspects of teaching. Generally, we find that professional development is effective when it focuses on the following specific higher-order teaching strategies: (1) the use of technology for higher-order learning, (2) the use of instructional methods for higher-order learning, and (3) the use of assessment strategies for higher-order student learning. In addition to the effect of professional development on specific teaching strategies in these three areas, we found that features of quality—specifically reform type, collective participation, active learning, and coherence—strengthened the effect of professional development activities that focus on higher-order teaching strategies.

Participation in Professional Development

Our results suggest that a change in teaching would occur if teachers experienced consistent, high-quality professional development. But we find that most teachers do not experience such activities. On average, the quality of the activities experienced by teachers in our Longitudinal Study of Teacher Change was about the same as the quality of activities experienced by our national sample of teachers in Eisenhower-assisted activities. Our national data indicated the following about district-supported Eisenhower activities: an average of only 23 percent of teachers participating in Eisenhower-assisted professional development were in reform types of professional development; the average time span of a professional development activity was less than a week; the average number of contact hours was 25 and half of the teachers were in activities that lasted 15 hours or less; most activities did not have collective participation or a major emphasis on content; and most activities had limited coherence and a small number of active learning opportunities.[xi] In short, nationwide, the typical professional development experience was not of high quality. Nevertheless, our national data also documented great variation in the quality of teachers' professional development experiences, which indicates that at least some teachers participate in high-quality activities, at least some of the time.

The LSTC expands on these national data on the variation in the quality of professional development. Our longitudinal data indicate that the quality of professional development experiences varies considerably not only across teachers at a single point in time but also over time for the same teachers:

- **Teachers experience professional development that varies in quality from one year to the next. Further, teachers in the same school tend to have quite different professional development experiences.**

We find a substantial amount of year-to-year variation in the quality of the professional development of individual teachers. For example, 79 percent of the variation in the span and 62 percent of the variation in the content focus of a teacher's professional development experience are due to year-to-year variation. This finding indicates that the average teacher's professional development experiences do not add up to a long-term, coherent, high-quality program—the type of program that has the most potential for fostering significant and lasting teacher change.

We find some variation in participation in professional development between schools (e.g., 14 percent of the variation in collective participation and 7 percent of the variation in active learning is due to between-school variation), but most of the variation in the quality of the professional development in which teachers participate lies *within*, not *between*, schools. This finding supports the idea that professional development continues to be an individual teacher experience. Both our

national and our longitudinal data indicate that professional development is more effective when teachers participate with others from their school, grade, or department. Thus, the variation in teachers' professional development experiences within the same school helps explain why professional development is not as effective as it could be.

Trends in Teaching Practice

Perhaps partly as a result of the uneven quality of professional development, we find the following:

- **In our longitudinal sample, we find little change in overall teaching practice from 1996 to 1999.**

Beyond the specific and targeted instructional practices, where we do observe change as a result of professional development, we see little overall change in self-reported teaching practice more generally. Given the usual low quality and inconsistent nature of professional development in which teachers participated, it is perhaps not surprising that we find little change in overall teaching practice over the period of the study. Our data show that teachers' alignment of content with national standards, the goals that teachers have for their students, and their basic pedagogical strategies appear to remain highly stable over time. It may be true that teachers changed on dimensions that we did not measure or that they changed the way they *implemented* certain practices instead of changing their relative emphasis on these practices. However, given the multiple and high-profile efforts of standards-based and school-based reforms to provide professional development to change teachers' practice in desirable ways, we are surprised that teachers, as a group, did not move in the directions in which reforms intend to push them.

Measuring instruction at multiple points over a more extended period of time might increase our ability to capture change in average teaching practice. However, we are confident in our results that at least for the three years of our study, overall, teachers changed little in terms of the content they teach, the pedagogy they use to teach it, and their emphasis on performance goals for students.

- **Despite little *average* change over time in teaching practice in our longitudinal sample, individual teachers in our sample do vary in their classroom practices, and moderate variation does occur in the classroom practice of individual teachers from year to year.**

Although in our longitudinal sample, teachers' practice did not change on average, individual teachers did make moderate changes in their teaching practice from one year to the next. For example, 30 percent of the variation in alignment and 28 percent of the variation in the use of traditional pedagogy is due to year-to-year variation. This year-to-year variation might be due to teachers' adapting to the ability levels of their students or to other influences related to their students or school.

Further, we find a great deal of variation across teachers in their classroom teaching practice. Most of this variation is between teachers in the same school, not between schools. For example, 40 percent of the variation in teachers' use of the performance goal of generating hypotheses and 31 percent of the variation in teachers' use of discussion-oriented instruction are due to variation between teachers in the same school. A substantial amount of variation between schools might suggest a coherent, organized school-fostered system of instruction. Instead, we find that individual

teachers in the same school have very different teaching practices. This finding only adds support to the concept that both teaching and professional development are typically individual experiences.

Implications for Policy and Practice

In sum, we find that high-quality professional development that focuses on specific teaching strategies does affect self-reported teaching practice. Furthermore, this effect is stronger if the professional development has the six dimensions of quality identified in the analysis of our national sample of teachers—the professional development is a reform rather than traditional type, is sustained over time, involves groups of teachers from the same school, provides opportunities for active learning, is coherent with other reforms and teachers' activities, and is focused on specific content and teaching strategies. However, teachers generally do not experience consistent, high-quality professional development. Professional development remains an experience that varies substantially from one teacher to the next, and even from one year to the next for a given teacher. Districts and schools face several challenges in providing high-quality professional development to all their teachers.

First, districts and schools often must choose between serving larger numbers of teachers with less focused and sustained professional development or providing higher-quality activities for fewer teachers. As we noted in the report of our national data, good professional development requires substantial resources.[xii] Re-allocating resources and combining funding sources can be effective in increasing funds for professional development. However, in the absence of increased resources, the federal government, states, districts, and schools still have to make difficult choices. They must decide whether to sponsor shorter, less in-depth professional development that serves a large number of teachers or to support more effective, focused, and sustained professional development for a smaller number of teachers. The Eisenhower legislation encourages the idea of sustained, intensive professional development. The results of this study support that notion. If districts and schools must choose how to allocate scarce resources, districts and schools would do better to focus professional development on fewer teachers in order to provide the type of high-quality activities that are effective in changing teaching practice.

Second, many districts and schools have limited capacity to translate into practice the knowledge about effective professional development. This evaluation has shown that professional development is most effective when it has the six features of quality that we identified earlier—reform type, duration, collective participation, active learning, coherence, and content focus.[xiii] As we stated in our last report, more information is needed on the characteristics and conditions that give some districts the capacity to provide this type of high-quality professional development. States and district could benefit from more detailed information and guidance from the federal government about how to use the Eisenhower program to design and provide professional development that has the specific high-quality features that make it effective for teachers.

Third, districts and schools often do not have the infrastructure to be able to manage and implement effective professional development. Improving the quality of professional development is an ambitious undertaking. The analysis of data from our national probability sample of district Eisenhower coordinators showed that planning that includes system alignment (e.g., the alignment of professional development with standards and assessments), funding coordination, and continuous improvement efforts significantly improves the quality of professional development activities that districts provide. [xiv] Case data from our 10 districts and data from both our national and our longitudinal studies indicate that some of this planning exists but that it is not systematic or

widespread. Our longitudinal study indicates that much of the variation in professional development and teaching practice is between individual teachers within schools, rather than between schools. This finding provides evidence that schools generally do not have a coherent, coordinated approach to professional development and instruction, at least not an approach that is effective in building consistency among their teachers. Participation in professional development is largely an individual teacher's decision; in many districts, teachers select the professional development in which they will participate from a number of options available from a highly disparate set of providers. An increased emphasis by the Eisenhower program on the importance of systematic planning for professional development may encourage both districts and schools to focus professional development activities more coherently and strategically.

In sum, our findings show that the most effective professional development is focused on specific higher-order teaching strategies and has features of high quality. Our national data, however, showed that on average, teachers do not experience high-quality professional development. Having a coherent, long-term plan would enable districts and schools to provide both the depth of professional development experiences needed for them to be effective and the breadth of coverage of specific content and teaching strategies that teachers should learn over time. The provision of high-quality programs of professional development by schools and districts may not completely solve the problem of the variation in the quality of professional development, however, since participation in professional development remains primarily the decision of individual teachers. Teachers' discretion in choosing their own professional development activities contributes to the coherence of the teachers' personal goals for professional development, allows teachers to chose the activities that best match their individual needs, and increases teachers' investment in their professional development program. Districts and schools could go a long way in developing high-quality professional development activities by balancing the benefits of teacher choice with the benefits of a coherent district- or schoolwide program of professional development,

To develop meaningful professional development plans, districts and schools would have to overcome challenges to focusing on and setting priorities for professional development activities over time, given limited resources; acquiring knowledge about the features of effective professional development; and building the infrastructure to design and implement the types of activities that teachers need to improve student learning. The Eisenhower Professional Development Program and other sources of funding could continue to play an important role in helping districts and schools overcome these challenges and develop high-quality professional development experiences that will lead to better teaching and better learning.

[i] The first report was based on six exploratory case studies of school districts conducted at the beginning of the evaluation, in the spring of 1997. See *The Eisenhower Professional Development Program: Emerging Themes from Six Districts*, by B. F. Birman, A. L. Reeve, and C. L. Sattler, 1998, Washington, DC: U.S. Department of Education. The purpose of that report was to obtain an initial description of the Eisenhower program and the issues that it faced in different local contexts. The second report described the status of the program on several

dimensions, such as features of quality and management and implementation; the report also linked these dimensions to characteristics of the professional development and to teachers' self-reported outcomes. It was based primarily on data from three national probability samples: (1) district Eisenhower coordinators, (2) Eisenhower project directors in SAHE grantees (i.e., the institutions of higher education and nonprofit organizations supported through the SAHE component of the program), and (3) teachers participating in Eisenhower-assisted professional development (i.e., professional development that was sponsored, at least in part, by Eisenhower funds). In addition, the second report drew on data from 10 in-depth case studies in five states. See *Designing Effective Professional Development: Lessons from the Eisenhower Program*, by M. Garet, B. Birman, A. Porter, L. Desimone, and R. Herman, R. with K. Suk Yoon, 1999, Washington, DC: U.S. Department of Education.

[ii] See "Teacher Change," by V. Richardson and P. Placier, in *Handbook of Research on Teaching* (4th ed.), edited by V. Richardson, in press, New York: Macmillan, for a comprehensive review of the literature on teacher learning and professional development. For a recent intensive case study of change in mathematics teaching, see "A Revolution in One Classroom: The Case of Mrs. Oublier," by D. K. Cohen, 1990, *Educational Evaluation and Policy Analysis, 12*(3), 311–329. For a program evaluation of exemplary professional activities in science, see *Best Practice in Action: Follow-up Survey on Teacher Enhancement Programs*, by N. Carey and J. Frechtling, 1997, Arlington, VA: National Science Foundation. For a national survey of teachers focused on teacher preparation and qualifications, see *Teacher Quality: A Report on the Preparation and Qualifications of Public School Teachers* (NCES 1999-080), from the U.S. Department of Education, National Center for Education Statistics, 1999, Washington, DC: Author. For an experimental study examining the effects of Cognitively Guided Instruction, an intervention in elementary school mathematics, see "A Longitudinal Study of Learning to Use Children's Thinking in Mathematics Instruction," by E. Fennema, T. P. Carpenter, M. L. Franke, L. Levi, V. R. Jacobs, and S. B. Empson, 1996, *Journal for Research in Mathematics Education, 27*(4), 403–434. For an intensive case study of two teachers who participated in the Summer Math program, see *Changing Visions and Changing Practices: Patchworks in Learning to Teach Mathematics for Understanding* (Research Report 91-2), by S. M. Wilson and D. Lowewenberg, 1991, East Lansing, MI: The National Center for Research on Teacher Education, and *Instructional Policy and Classroom Performance: The Mathematics Reform in California* (RR-39), by D. K. Cohen and H. C. Hill, 1998, Philadelphia: Consortium for Policy Research in Education, which describes the relationship among participation in professional development, teaching practice, and student achievement, using survey data from California. For a review of available randomized studies examining the effects of teacher professional development on student achievement in mathematics and science, see *Form and Substance in In-Service Teacher Education* (Research monograph no. 13), by M. M. Kennedy, 1998, Arlington, VA: National Science Foundation. For a recent examination of the effects of the National Science Foundation (NSF) Statewide Systemic Initiatives (SSIs) on classroom practice in mathematics and science, see *Evaluation of NSF's Statewide Systemic Initiatives (SSI) Program: The SSIs' Impacts on Classroom Practice*, by P. M. Shields, J. A. Marsh, and N. E. Adelman,1998, Menlo Park, CA: SRI. For an examination of the effects of the NSF Local Systemic Change (LSC) initiatives, see *Local Systemic Change through Teacher Enhancement: Year Three Cross-Site Report*, by I. R. Weiss, D. L. Montgomery, C. J. Ridgway, and S. L. Bond, 1998, Chapel Hill, NC: Horizon Research, Inc. For a description of "best practices" in professional development, see *Designing Professional Development for Teachers of Science and Mathematics*, by S. Loucks-Horsley, P. W. Hewson, N. Love, and K. E. Stiles, 1998, Thousand Oaks, CA: Corwin Press.

[iii] See, in particular, *Designing Effective Professional Development: Lessons from the Eisenhower Program*, by M. Garet et al.; "Relationships between Research and the NCTM Standards," by J. Hiebert, 1999, *Journal for Research in Mathematics Education, 30*(1), 3–19; *Designing Professional Development for Teachers of Science and Mathematics*, by S. Loucks-Horsley et al.; *Federal Legislation Enacted in 1994: An Evaluation of Implementation and Impact*, U.S. Department of Education, Office of the Under Secretary, Planning and Evaluation Service, 1999, Washington, DC: Author.

[iv] 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. Several recent studies have begun to examine the relative importance of specific dimensions or characteristics of professional development. For example, a number of recent studies suggest that the intensity or duration of professional development is related to the depth of teacher change: *Evaluation of NSF's Statewide Systemic Initiatives (SSI) Program: The SSIs' Impacts on Classroom Practice*, by P. M. Shields et al.; *Local*

Systemic Change through Teacher Enhancement: Year Three Cross-Site Report, by I. R. Weiss et al. Further, 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: *Instructional Policy and Classroom Performance: The Mathematics Reform in California* (RR-39), by D. K. Cohen and H. C. Hill; "A Longitudinal Study of Learning to Use Children's Thinking in Mathematics Instruction," by E. Fennema et al. However, few studies have explicitly compared the effects of different forms of professional development on teaching and learning. Among the few examples of studies that compare the relative effectiveness of different forms of professional development are *Form and Substance in In-Service Teacher Education* (Research monograph no. 13), by M. M. Kennedyand *Instructional Policy and Classroom Performance: The Mathematics Reform in California* (RR-39), by D. K. Cohen and H. C. Hill. 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.

[v] The Longitudinal Study of Teacher Change also included interviews and classroom observations of teachers in the 30 schools. Results of these data are reported in *Designing Effective Professional Development: Lessons from the Eisenhower Program,* by M. Garet et al.

[vi] See *Designing Effective Professional Development: Lessons from the Eisenhower Program,* by M. Garet et al.

[vii] See *Designing Effective Professional Development: Lessons from the Eisenhower Program,* by M. Garet et al.

[viii] Specifically, we compared the characteristics of Eisenhower-assisted activities in our national sample of districts with the characteristics of the professional development activities reported in the Longitudinal Study of Teacher Change and found that the quality of activities in both samples was about the same.

[ix] Since teachers generally do not know who sponsors the professional development activities in which they participate, we determined sponsorship by matching the list of district activities to the activity that each teacher described. In some cases, activity names were ambiguous, so we calculated both a conservative estimate, comprising activities whose names clearly matched, and a liberal estimate, which included activities that *probably* matched.

[x] To measure the extent to which professional development activities focused on the uses of technology that are linked to higher-order learning, we asked teachers whether the professional development activity in which they participated focused on improving their capacity to use (1) calculators or computers to develop models or simulations; (2) calculators or computers for data collection and analysis; (3) computers to write reports; and (4) computers to access the Internet. Teachers responded yes or no. To measure the extent to which professional development activities emphasized higher-order instructional methods, we asked teachers whether the professional development activity in which they participated focused on developing their capacity to use any of the following six instructional methods with students: (1) work on independent, long-term (at least one week) projects; (2) work on problems with no immediately obvious method or solution; (3) develop technical or mathematical writing skills; (4) use equations, graphs, tables, and text together; (5) work on interdisciplinary lessons (e.g., writing journals in class); and (6) debate ideas or otherwise explain their reasoning. To measure the extent to which professional development emphasized student assessment methods that are associated with higher-order learning, we asked teachers whether the professional development activity focused on developing their capacity to use any of the following six forms of student assessments in their classroom teaching: (1) essay tests; (2) performance tasks or events; (3) systematic observation of students; (4) math/science reports; (5) math/science projects; and (6) portfolios.

[xi] For more details, see *Designing Effective Professional Development: Lessons from the Eisenhower Program,* by M. Garet et al.

[xii] See *Designing Effective Professional Development: Lessons from the Eisenhower Program,* by M. Garet, et al.

[xiii] See also *Instructional Policy and Classroom Performance: The Mathematics Reform in California* (RR-39), by D. K. Cohen and H. C. Hill and *Form and Substance in In-Service Teacher Education* (Research monograph no. 13), by M. M. Kennedy.

[xiv] See *Designing Effective Professional Development: Lessons from the Eisenhower Program,* by M. Garet et al.

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