Review of the Research:

Nine Components of Effective Professional Development

Prepared

for

Texas Instruments Educational and Productivity Solutions Division

by

The Institute for the Advancement of Research in Education at AEL

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EXECUTIVE SUMMARY

The Professional Development Services group of Texas Instruments' (TI's) Educational and Productivity Solutions (E & PS) Division offers a variety of professional development services to teachers and districts, including face-to-face institutes and online courses. Professional development supported by scientifically based research (SBR) is of particular interest to TI's E & PS Division since state and local entities make decisions about which products and services to adopt or purchase based on the No Child Left Behind (NCLB) legislation. The NCLB legislation emphasizes that effective professional development should (1) improve teachers' knowledge in their content area; (2) be ongoing, hands-on, and of high quality; and (3) give teachers the knowledge and skills they need to improve their instructional practices such that student achievement will be impacted.

This review of the research literature is organized around nine components of professional development that were identified as a result of the document reviews and E & PS staff interviews. The review of literature concerning best practices for delivering professional development was conducted with particular attention to the three sources listed below:

1. *Providing Professional Development for Effective Technology Use*, a critical issue Web site produced by the North Central Regional Educational Laboratory (NCREL) (http://www.ncrel.org/sdrs/areas/issues/methods/technlgy/te1000.htm). On this site, NCREL identifies 14 essential components of professional development.

2. Eight principles of professional development—identified from research as well as literature and best practice—on the Knowledge Loom Web site (http://www.knowledgeloom.org/pd/).

3. The National Staff Development Council's 12 standards for staff development, revised in 2001.

In addition, interviews with E & PS staff were conducted to identify characteristics of the professional development services offered by E & PS. The nine components are: (1) it addresses student-learning needs; (2) it incorporates hands-on technology use; (3) it is job-embedded; (4) it has application to specific curricula; (5) it addresses knowledge, skills, and beliefs; (6) it occurs over time; (7) it occurs with colleagues; (8) it provides technical assistance and support to teachers; and (9) it incorporates evaluation.

For this review, the best available evidence in each of the nine areas was identified and obtained. Each piece of evidence was evaluated in terms of the extent to which it aligned with the principles of SBR, as defined by Section 9101 of NCLB (2002) and by the National Research Council (Shavelson & Towne, 2002). Initially, a total of 92 abstracts, issue reports, journal articles, policy briefs, project reports, research reports, technical reports, and textbooks were reviewed. Of these 92, 14 met minimal SBR

standards: 2 could be deemed experimental studies and 12 were some type of quasi-experimental study (e.g., non-equivalent control group, time series).

In short, evidence supporting the effectiveness of the nine components of professional development was found, though there was more evidence supporting some of the components than of others. These findings are summarized in Table 1 below.

Table 1.
Breakout of Studies (N=14) Providing Evidence of Effectivness to Support Specific Components of Professional Development.

Professional Development Components *	**Experimental Studies with Supporting Evidence**	**Quasi-experimental Studies with Supporting Evidence**
Addresses Student-Learning Needs	2	12
Incorporates Hands-on Technology Use	0	2
Is Job-Embedded	2	12
Has Application to Specific Curricula	2	12
Addresses Knowledge, Skills, and Beliefs	2	11
Occurs Over Time	0	3
Occurs with Colleagues	0	2
Provides Technical Assistance & Support to Teachers	1	2
Incorporates Evaluation	2	10

*Any one particular study may, and often does, address multiple professional development components.

Based on the review of the available research literature regarding the nine components of professional development, the following recommendations are made. TI's E & PS Division should:

- Continue its efforts to address all nine components of professional development when delivering in-person and online professional development. Although the circumstances associated with a particular professional development activity may prevent one or more of the components from being present, the available evidence does not provide sufficient guidance as to which, if any, of the components is more or less important than another.

- Make every effort to evaluate the effectiveness of its professional development services through a comprehensive evaluation of student learning outcomes, participants' use of new knowledge, the degree and/or change (if any) in organizational support of the professional development, participants' learning, and participants' reactions. This evaluation should be focused on the four attributes of evaluation developed by the Joint Committee on Standards for Educational Evaluation: (1) utility, (2) feasibility, (3) propriety, and (4) accuracy.

- Consider conducting randomized controlled trials that randomly assign individuals to experimental and control groups in order to empirically ascertain the effectiveness the professional development program provides.

INTRODUCTION

Texas Instruments' (TI's) Educational and Productivity Solutions (E & PS) Division contracted with the Institute for the Advancement of Research in Education (IARE) at AEL in February 2004 to review the research literature regarding best available evidence relative to components of professional development and their associated effectiveness.

This review of the research literature is organized around nine components that were previously identified by IARE staff (see Institute for the Advancement of Research in Education, 2003 in Appendix B) through document reviews and interviews with key staff from TI's E & PS Division and synthesized from the following three main sources:

1. *Providing Professional Development for Effective Technology Use*, a critical issue Web site produced by the North Central Regional Educational Laboratory (NCREL) (http://www.ncrel.org/sdrs/areas/issues/methods/technlgy/te1000.htm). On this site, NCREL identifies 14 essential components of professional development.

2. Eight principles of professional development—identified from research as well as literature and best practice—on the Knowledge Loom Web site (http://www.knowledgeloom.org/pd/).

3. The National Staff Development Council's 12 standards for staff development, revised in 2001.

Accordingly, this literature review is based on the following nine professional development components: (1) it addresses student-learning needs; (2) it incorporates hands-on technology use; (3) it is job-embedded; (4) it has application to specific curricula; (5) it addresses knowledge, skills, and beliefs; (6) it occurs over time; (7) it occurs with colleagues; (8) it provides technical assistance and support to teachers; and (9) it incorporates evaluation.

Texas Instruments' Educational and Productivity Solutions Division

The Professional Development Services group of TI's E & PS Division offers a variety of professional development services to teachers and districts, including face-to-face institutes and online courses. All instructors of professional development offered by E & PS are current or former classroom teachers who have used TI products (e.g., TI-73, TI-83+, Navigator, Voyager 200, TI-89) with students in classrooms.

Professional development supported by scientifically based research (SBR) is of particular interest to TI's E & PS Division since state and local entities make decisions about which products and services to adopt or purchase based on the No Child Left Behind (NCLB) legislation. This places new demands on educators at all levels,

especially staff development leaders. The accountability requirements under this federal program drastically reshape their roles. Notably, the legislation compels staff development leaders to refocus their perspectives and, in some cases, to revise completely their efforts in the educational improvement process (Guskey, 2003) in order to incorporate methodologies proven effective.

Literature Review Purpose

NCLB strongly emphasizes ensuring that funds are used to support educational practices that are "based on scientific research." As part of an educational technology company, TI's E & PS Division would like evidence to support its claims that the professional development it offers is grounded in SBR. At the outset, it is important to note that research designs employed to assess the impacts of professional development on student learning typically have been qualitative or quasi-experimental in nature rather than experimental.

Criteria for Selection of Studies

At the outset, it is important to note that research designs typically employed to assess the impact of professional development on student learning have been qualitative or quasi-experimental in nature rather than experimental. A total of 92 abstracts, issue reports, journal articles, policy briefs, project reports, research reports, technical reports, and textbooks were initially identified and reviewed. Of these items, selection criteria eliminated sources that did not apply rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to educational activities and programs. Following the eliminations, 14 studies remained that met the above criteria. Two of these were experimental studies and the remaining 12 were quasi-experimental studies.

METHODOLOGY

Using academic databases such as ERIC, FirstSearch, and EBSCO, IARE staff conducted key-word searches to locate research on the nine components of professional development that were being used by TI's E & PS Division. NCLB's definition of SBR draws particular attention to experimental and quasi-experimental designs. Both experimental and quasi-experimental designs employ experimental and comparison groups. The primary difference between experiments and quasi-experiments (Redfield, Sivin-Kachala, & Schneiderman, 2003) is that in experiments, study participants are randomly selected from the population to which results of the study are to be generalized (an external validity issue) and/or randomly assigned to experimental and comparison groups (an internal validity issue and one of the important keys to the determination of cause-effect). Random selection and/or assignment are not features of quasi-experimental designs.

FINDINGS

Results from the review of literature will be summarized in this section. In short, evidence supporting the nine components as characteristics of effective professional develop was found, though there was more evidence supporting some of the components than others (see Table 1). The Appendix contains more in-depth information on each study and related resources.

Effective Professional Development Addresses Student-Learning Needs

All 14 studies selected for review provide evidence that effective professional development addresses student-learning needs. In each instance, the professional development program or experience being studied was targeted to particular desired learning outcomes. In the experimental study of the Student Team Literature program (Killion, 1999; MacIver, Plank, Balfanz, 1997) and the experimental study of Project Legal (Project Legal, 2004) pre-test/post-test knowledge and achievement performance gains were found. In one instance (Killion, 1999; Project Legal, 2004), the law-related knowledge, comprehension, and problem solving skills of students who received instruction from specially trained teachers were significantly better than those of students who received more traditional social studies instruction. The quasi-experimental studies all reported using pre-test/post-test measures of student achievement, usually with some type of comparison group employed to provide a context within which to judge gains (losses). Most of the quasi-experimental studies located for this review focused on professional development related to math and science instruction. Table 2 below summarizes the professional development program being evaluated and its associated content focus for each of the 12 quasi-experimental studies included in this review.

Table 2.
Summary of the Quasi-experimental Studies Reporting the Effects of Professional Develop on Student Learning Needs.

Content Focus	Professional Development Program	Reference(s) [Primary reference first; secondary, if any, second]
Math (2^{nd} – 5^{th} Grade)	Generalized professional development	Cohen & Hill (1998)
Math (algebra)	Hawaii Algebra Learning Project (HALP)	Young, Dougherty, Lai, & Matsumoto (1998); Killion (1999)
Math (6^{th} & 8^{th} grade) (algebra)	Peoria Urban Mathematics Program (PUMP) for Algebra	Swafford & Thornton (1998); Killion (1999)
Math (middle school)	Middle Grade Mathematics Renaissance	Acquarelli & Mumme (1996); Killion (1999)
Math (general)	University of Illinois at Chicago All Learn Mathematics	University of Illinois at Chicago (1997); Killion (1999)

Content Focus	Professional Development Program	Reference(s) [Primary reference first; secondary, if any, second]
Math (algebra)	Algebra Initiative	Schweingruber, Papakonstantiou, Herbert & Rohr (1998 & 1999); Killion (2002b)
Math/Science	Generalized professional development	(USDE, 2000)
Science	Iowa Chautauqua	Dass & Yager (1997); Killion (1999)
Science	Student Watershed Research Project	Student Watershed Research Project (1997); Killion (1999)
Science (4th & 6th grades)	Science Education Enhancing the Development of Skills (SEEDS)	Killion (2002a)
Reading Readiness	Early Literacy and Learning Model (ELLM)	Wehry (2001); Killion (2002a)
General	Project CRISS: Reading, Writing, & Studying Strategies for Literature and Content	Santa (2004); Killion (1999)

In sum, professional development that is based on analysis of student learning helps teachers close the gap between actual student performance and goals for student learning (Cohen & Hill, 1998; Killion, 2002a; Killion, 2002b).

Effective Professional Development Incorporates Hands-on Technology Use

Only two of the studies selected for review addressed this professional development component; both were quasi-experimental studies (Killion 2002a; Student Watershed Project, 1997).

In the Student Watershed Research Project, teachers received intensive training in watershed research and were provided a model of authentic student performance assessment. Students demonstrated knowledge of data collection and analysis by having their test results compared to duplicate samples analyzed by professional laboratories rather than being required to demonstrate increased performance on a standardized assessment of science knowledge. Student Watershed Research Project staff combined professional laboratory results with the students' data, provided feedback on the data to both the students and teachers, and audited student data. In addition, students wrote their group findings and presented them to a panel of their classroom peers. Annual summits allowed students to display their data on poster-board and give oral presentations. Students also had opportunities to provide information to regulatory agencies regarding the watershed they monitored (Killion 2002a; Student Watershed Project, 1997).

The second study that addressed hands-on technology use was the Science Education Enhancing the Development of Skills or SEEDS program (Killion, 2002a). In this program, teachers regularly used hands-on science activities in addition to cooperative learning groups, discussions, and open-ended questions. As a result of the SEEDS professional development, teachers reported increased pedagogical preparedness for using performance-based assessments, hands-on science, and informal assessments; for helping students take responsibility for their own learning; and for using students' prior knowledge in planning lessons. Annual student performance on the state science proficiency assessment in grades 4 and 6 indicated steady growth and consistently higher performance than students of teachers who did not participate in the SEEDS program.

Thus, the two studies cited above would suggest that incorporating hands-on technology in the professional development process helps teachers develop confidence in their skills. When teachers develop confidence in their skills, they are able to improve their teaching practices, which, in turn, should impact student achievement.

Effective Professional Development is Job-Embedded

All 14 of the experimental and quasi-experimental studies included in the review reported that the professional development program or process being examined was job embedded. The Student Team Literature program (Killion, 1999; MacIver, Plank, Balfanz, 1997) and the Project Legal program (Project Legal, 2004)—both experimental studies—provided the teachers with sustained, on-the-job professional development that included ongoing support from other teachers and/or staff development professionals. The same was found to be true for the quasi-experimental studies though the nature of the job-embeddedness varied from situation to situation. For example, on-site "coaches" were used with ELLM (Killion, 2002a; Wehry, 2001). Another example would be an approach were teachers assume multiple roles (e.g., leader, trainer, curriculum developer) as was done in SEEDS (Killion, 2002a). It seems that the particular strategy is not as important as is the sustained involvement with the professional development focus. Job-embedded professional development appears to improve teacher practice by promoting practical learning. In addition, it takes less time away from the classroom and generally costs less than other professional development strategies (Acquearelli & Mumme, 1996; Cohen & Hill, 1998; Dass & Yager, 1997; Killion, 1999; Killion, 2002b; MacIver, Plank, Balfanz, 1997; Project Legal, 2004; Santa, 2004; Schweingruber et al., 1998 & 1999; Student Watershed Research Project, 1997; Swafford & Thornton, 1998; University of Illinois at Chicago, 1997; USDE, 2000; Wehry, 2001; Young et al., 1998).

Effective Professional Development Has Application to Specific Curricula

All of the studies reviewed indicated that professional development that was grounded in teaching specific content helped teachers become more deeply immersed in subject matter and teaching methods (Acquearelli & Mumme, 1996; Cohen & Hill, 1998; Dass & Yager, 1997; Killion, 1999; Killion, 2002b; MacIver, Plank, Balfanz, 1997; Project Legal, 2004; Santa, 2004; Schweingruber et al., 1998 & 1999; Student Watershed Research Project, 1997; Swafford & Thornton, 1998; University of Illinois at Chicago,

1997; USDE, 2000; Wehry, 2001; Young, Dougherty, Lai, & Matsumoto, 1998). Most of the studies reviewed had mathematics as their focus (Acquarelli & Mumme, 1996; University of Illinois at Chicago, 1997; Cohen & Hill, 1998; Killion, 1999; Swafford & Thornton, 1998; Schweingruber et al., 1999). A few of the studies focused on science (Dass & Yager, 1997; Killion, 1999; Killion, 2002b; Student Watershed Research Project, 1997) or both mathematics and science (USDE, 2000). Only one of the professional development programs reviewed did not have a specific content focus (Killion, 1999; Santa, 2004).

Effective Professional Development Addresses Knowledge, Skills, and Beliefs

All but one of the 14 studies reviewed supported the idea that professional development should provide opportunities to engage in creating a theoretical understanding of the knowledge and skills to be learned (Acquearelli & Mumme, 1996;; Dass & Yager, 1997; Killion, 1999; Killion, 2002b; MacIver, Plank, Balfanz, 1997; Project Legal, 2004; Santa, 2004; Schweingruber, Papakonstantiou, Herbert, & Rohr, 1998 & 1999; Student Watershed Research Project, 1997; Swafford & Thornton, 1998; University of Illinois at Chicago, 1997; USDE, 2000; Wehry, 2001; Young, Dougherty, Lai, & Matsumoto, 1998). The studies concurred that teacher thinking and classroom behavior are influenced by teacher knowledge and beliefs; therefore, an important component of their professional development needs to be the expansion of their professional knowledge base. As the various studies demonstrate, improving teacher knowledge and skills is related to increasing student performance and ensuring their success.

Effective Professional Development Occurs Over Time

Three of the quasi-experimental studies reported evidence that high-quality professional development occurs over time and should be seen as an ongoing process (Cohen & Hill, 1998; Killion, 1999; Santa, 2004; USDE, 2000). By participating in ongoing professional development, teachers are made aware of changing expectations and new teaching methods. They are given opportunities to implement methods and procedures suggested by the professional development program and to receive feedback on those implementation efforts. By sustaining the professional development implementation effort over time, the potential to impact student achievement increases.

Effective Professional Development Occurs with Colleagues

Two of the quasi-experimental studies reported data related to professional development occurring with colleagues. The evidence from these two studies clearly points to the notion that the most effective professional development sessions are those that give teachers time to collaborate with one another and to discuss their professional development experience (Cohen & Hill, 1998; USDE, 2000). These two studies indicate that when teachers collaborate with colleagues, there is a positive impact on instructional practices and, therefore, on student achievement.

Effective Professional Development Provides Technical Assistance and Support to Teachers

Three of the studies reviewed, one experimental and two quasi-experimental, reported findings that addressed the provision of technical assistance and support to teachers (Acquarelli & Mumme, 1996; Killion, 1999; Project Legal, 2004; USDE, 2000). The evidence from these three studies indicates that, without continuous technical assistance and support, effective, long-lasting professional development will not result. Teachers indicated being more successful in implementing new instructional strategies and techniques when they received ongoing technical assistance and support after receiving professional development.

Effective Professional Development Incorporates Evaluation

NCLB requires schools to show that the professional development being provided to teachers is effective and produces positive results. The issue is not whether teachers are satisfied with a particular professional development experience—but rather what effect professional development has on student achievement (Guskey, 2000). Both of the experimental studies reviewed and 10 of the 12 quasi-experimental studies examined reported findings related to assessing student performance changes as a result of the teachers' professional development that the students' teacher had experienced (Acquearelli & Mumme, 1996; Dass & Yager, 1997; Killion, 1999; Killion, 2002b; MacIver, Plank, Balfanz, 1997; Project Legal, 2004; Santa, 2004; Schweingruber et al., 1998 & 1999; Student Watershed Research Project, 1997; Swafford & Thornton, 1998; University of Illinois at Chicago, 1997; Wehry, 2001; Young et al., 1998). In general, evidence of increases in student achievement was found in each instance. A summary of the evaluation tools used to assess student performance for each of the 12 studies reporting such information is provided in Table 3 below.

Table 3.
Summary of Evaluation Tools Used to Assess Student Achievement Changes as the Result of a Particular Program of Professional Development for Teachers.

Professional Development Program	Student Performance Evaluation Tool (Area)	Reference [Primary reference first; secondary, if any, second]
Project CRISS: Reading, Writing, & Studying Strategies for Literature and Content	Standardized Free-recall (General)	Santa (2004); Killion (1999)
Early Literacy and Learning Model (ELLM)	Tera – 2 (Reading Readiness)	Wehry (2001); Killion (2002a)

Professional Development Program	Student Performance Evaluation Tool (Area)	Reference
Science Education Enhancing the Development of Skills (SEEDS)	Ohio state science proficiency tests (Science – 4th & 6th grades)	Killion (2002a)
Student Team Literature Program	Stanford 9 Achievement Test (Reading Comprehension)	MacIver, Plank, Balfanz (1997); Killion (1999)
Project Legal	Criterion-referenced tests	Project Legal (2004); Killion (1999)
Algebra Initiative	Algebra I End-of-Course Exam (Math – algebra)	Schweingruber, Papakonstantiou, Herbert, & Rohr (1998 & 1999); Killion (2002b)
University of Illinois at Chicago All Learn Mathematics	Iowa Test of Basic Skills (Math – general)	All Learn Mathematics Annual Report (1997); Killion (1999)
Hawaii Algebra Learning Project (HALP)	GOALS: A Performance-Based Measure of Achievement (Math – algebra)	Young, Dougherty, Lai, & Matsumoto (1998); Killion (1999)
Iowa Chautauqua	Multiple-choice tests (Science)	Dass & Yager (1997); Killion (1999)
Peoria Urban Mathematics Program (PUMP) for Algebra	Illinois Goal Assessment Program (Math)	Swafford & Thornton (1998); Killion (1999)
Middle Grade Mathematics Renaissance	New Standards Reference Exam (Math – middle school)	Acquarelli & Mumme (1996); Killion (1999)
Student Watershed Research Project	Student data samples (Science)	Student Watershed Research Project (1997); Killion (1999)

Summary

NCLB places a premium on professional development that (1) improves teachers' knowledge of the subjects they teach; (2) is an integral part of schoolwide educational improvement plans; (3) gives teachers and other school personnel the knowledge and skills they need to help students meet challenging standards; (4) is high-quality, sustained, intensive, and classroom-focused to have a positive and lasting effect on classroom instruction and teachers' performance in the classroom; and (5) advances teachers' understandings of effective instructional strategies that are based on scientifically based research and align with and are directly related to academic content standards, academic achievement standards, and assessments. The best evidence available points to the fact that the Professional Development Services group TI's E & PS

Division will provide effective professional development if nine components are incorporated into their professional development activities. It has not been empirically established whether all nine components must be present or whether a particular subset is crucial. Only through continued rigorous research will this be established.

RECOMMENDATIONS FOR NEXT STEPS

The Professional Development Services group of TI's E & PS Division offers a variety of professional development services to teachers and districts. NCLB emphasizes that effective professional development should (1) improve teachers' knowledge in their content area; (2) be ongoing, hands-on, and of high quality; and (3) give teachers the knowledge and skills they need to improve their instructional practices such that student achievement will be impacted. To address these issues, TI's E & PS Division should:

- Continue its efforts to address all nine components of professional development when delivering in-person and online professional development. Although the circumstances associated with a particular professional development activity may prevent one or more of the components from being present, the available evidence does not provide sufficient guidance as to which, if any, of the components is more or less important than another.

- Make every effort to evaluate the effectiveness of its professional development services through a comprehensive evaluation of student learning outcomes, participants' use of new knowledge, the degree and/or change (if any) in organizational support of the professional development, participants' learning, and participants' reactions. This evaluation should be focused on the four attributes of evaluation developed by the Joint Committee on Standards for Educational Evaluation: (1) utility, (2) feasibility, (3) propriety, and (4) accuracy.

- Consider conducting randomized controlled trials that randomly assign individuals to experimental and control groups in order to empirically ascertain the effectiveness the professional development program provides.

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APPENDIX A

Literature Checklist

Author(s): Santa, C. M.

Title: *Project CRISS: Evidence of effectiveness*

Source: Retrieved from http://www.nsdc.org/midbook/index.cfm

Publication Date: 2004 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a non-equivalent control group design)

Data Collected: Data were collected through a standardized free-recall approach using text appropriate to the reading level of the students.

Population: The evaluation of Project CRISS was conducted in 1991-1992 with eight pre- and post-comparison groups at the development site and two replication sites (Montana, Florida, and Virginia). In subsequent studies in 1994-1995, similar results occurred in two other sites (Colorado and Washington).

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	*
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

Students who were taught Project CRISS strategies demonstrated significantly greater gains ($p < .001$) in the retention of subject-specific information than comparable students who did not participate in the program. The evaluation of Project CRISS was conducted in 1991-92 with eight pre- and post-comparison groups at the development site and two replication sites (Montana, Florida, and Virginia) using intact classroom groups of

students in grades 4, 6, 8, and 11. Teachers, rather than students, were randomly assigned to the treatment and comparison groups.

Information retention was assessed through a standardized free-recall approach using text appropriate to the reading level of the students. Both pre- and post-test data were collected using procedures that closely resembled actual classroom and learning situations. Measures to ensure reliability of the process were employed. Data were then analyzed using statistical processes to explore differing effects of the implementation of Project CRISS across both the pre- and post-tests. Students at all three sites outperformed the nontreatment group at significant levels even when accounting for naturally occurring gains of students. In subsequent studies in 1994-95, similar results were found in two other sites (Colorado and Washington).

Conclusions

Students of teachers who participated in Project CRISS training, which was sustained and job-embedded, outperformed the nontreatment group at significant levels even when accounting for naturally occurring gains of students at all three evaluation sites. At the middle school level, students in the treatment group recalled more than twice as much content-area knowledge as their comparison groups. For teachers of all the content areas this program was deemed beneficial. When teacher interdisciplinary teams used similar learning strategies across content areas, students' application of the skills was reinforced and their learning increased.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

Literature Checklist

Author(s): Wehry, S.

Title: *The early literacy and learning model (ELLM) initiative: Making a difference 1999/2000 & 2000/2001*

Source: Florida Institute of Education at the University of North Florida

Publication Date: 2001 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a non-equivalent group design)

Data Collected: Data were collected via reading readiness tests, program-developed tests, and teacher interviews.

Population: The Early Literacy and Learning Model (ELLM) was used in five Northeast Florida Counties, including Jacksonville, with children from predominantly high-poverty, low-achieving urban schools and centers that served mostly African American students and their families. The program was implemented in 89 sites including faith-based child care; Head Start; subsidized pre-kindergarten early intervention; pre-kindergarten handicapped special education; and bilingual, kindergarten, and 1st-grade classrooms.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

ELLM contributed to the improvement of children's reading readiness. Using non-random but equivalent group pre- and post-test design with a control setting, ELLM has enabled children to demonstrate significant gains in reading readiness when compared to

both national norms and the control site on the TERA - 2 and an alphabet recognition test. These results occurred for three cohort groups consisting of 4- and 5-year-olds in child care; 5- and 6-year-olds in kindergarten; and 6- and 7-year-olds in 1st grade. Furthermore, the ELLM students represented high-needs urban students, and they performed in the national "average" category as defined by TERA - 2.

ELLM students in the 4- to 5-year-old and 5- to 6 - year-old cohorts demonstrated significant improvement in the alphabet recognition assessment, outperforming the national sample of kindergarteners tested as a part of America's Kindergarteners: Early Childhood Longitudinal Study (ECLS). Of ECLS students, 66% demonstrated reading proficiency while 81% of the ELLM kindergarten students and 56% of the ELLM pre-kindergarten demonstrated proficiency.

Teachers seemed to view themselves as learners and reported increased confidence in their own reading skills, deeper understanding of reading instruction, more knowledge about reading resources, and greater appreciation for the strategies they were using.

Conclusions

ELLM provides the foundation for successful readers. Addressing the specific needs of high-poverty, low-achieving students, this program offered teachers intensive, ongoing support to provide literacy instruction. The staff development model depended largely on literacy coaches who worked directly with teachers in their classrooms as they applied what they were learning and made adaptations to address the varied learning needs of their students.

Related Resource

Killion, J. (2002). *What works in the elementary school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/connect/projects/elwhatworks.pdf

Literature Checklist

Author(s): Killion, J.

Title: *Science education enhancing the development of skills*

Source: *What works in elementary school: Results-based staff development*, National Staff Development Council

Publication Date: 2002 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a non-equivalent control group design)

Data Collected: Data were collected from the Ohio state science proficiency tests, program-specific teacher surveys, and classroom observations.

Population: More than 1,000 teachers from rural, urban, and suburban communities in six towns and three private schools in Stark County, Ohio were involved in this project.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	*
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

Annual student performance on the Ohio state science proficiency assessment in grades 4 and 6 indicated steady growth and consistently higher performance by Stark County students than other students across the state. The test required higher level thinking; more than factual recall of data; and assessed the strands of nature of science, physical science, earth and space science, and life science. From the beginning of the project in 1995, 4th-grade student achievement has rose from 44% of students passing the state assessment to 76% of the students passing in 2002. The 6th-grade passing rate went from

47% to 71%. In all cases, the state's average scores were lower, and sometimes by as much as 10%.

In addition to improved student performance on state assessments, teacher classroom practices changed. Teachers more regularly used hands-on science activities, cooperative learning groups, discussion, and open-ended questions. Teachers reported increased pedagogical preparedness for using performance-based assessments, hands-on science, informal assessments, helping students take responsibility for their own learning, and using students' prior knowledge in planning lessons.

Conclusions

The combination of strong curriculum and hands-on professional development, as was evident in Science Education Enhancing the Development of Skills, improved students' performance and teachers' classroom practices. The opportunity for teachers to assume multiple roles as leaders, trainers, coaches, curriculum developers, and facilitators was a strength of the staff development design for this program. Teachers deepened their understanding of science, science pedagogy, and leadership through the project's professional development.

Literature Checklist

Author(s): MacIver, D. J., Plank, S. B., & Balfanz, R.

Title: *Working together to become proficient readers: Early impact of the talent development middle school's Student Team Literature Program.* (Report No. 15)

Source: Center for Research on the Education of Students Placed At Risk

Publication Date: 1997 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Experimental (a matched control group, pre-test/post-test design)

Data Collected: Data were collected from the Stanford 9 Achievement Test.

Population: The project was implemented in 1995-1996 in 21 classrooms in sixth through eighth grades at Central East Middle School in Philadelphia. More than 85% of the students were from low-income families and the student population at Central East Middle School included a large percentage of second language learners and minority students.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

Teachers involved in this staff development program received comprehensive, sustained professional development and worked in collaborative groups throughout the school year.

A matched control group, pre-test/post-test design was used to evaluate effects of Student Team Literature (STL) on students' end-of-the-year reading comprehension scale scores on the Stanford 9. Researchers used hierarchical linear models to estimate the differences between experimental classrooms (21) and control classrooms (25) in reading comprehension, while controlling for prior achievement and current grade level. Additional measures were used to estimate the difference in the effectiveness of peer assistance in increasing reading comprehension in experimental and control classrooms.

While the results from the Student Team Literature were based on one school's use, earlier research on the Student Team Reading (the first version of the Student Team Literature) was extensive. It demonstrated significant improvement ($p<.05$) in the California Achievement Test Total Reading for 1,223 urban sixth-grade students in six middle schools when compared to control classrooms where traditional reading instruction was provided using basal and isolated skill instruction. In addition, a second study of the Student Team Reading Program paired with the Student Team Writing Program in sixth-, seventh-, and eighth-grade classrooms with 3,986 students in the Baltimore City Schools, resulted in significant improvements (at least $p<.05$) in reading comprehension, vocabulary, language mechanics, and language expression on the California Achievement Test when compared to match control schools. These results were obtained even when the control schools had significantly higher pre-test scores ($p<.01$) in Total Reading and Total Language.

Conclusions

Students in the Student Team Literature (STL) classrooms displayed significantly better reading comprehension after the first year of implementation (effect size .51) than did students in the comparison group. The increase in reading comprehension occurred across all levels of prior ability; students with the strongest prior reading skills benefited the most. Peer assistance was found to be more productive and frequent in STL classrooms than in the control classrooms.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

Literature Checklist

Author(s): Project Legal

Title: *Law-related education: Goals for American leadership*

Source: Retrieved from http://www.maxwell.syr.edu/plegal/

Publication Date: 2004 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Experimental

Data Collected: Data were collected through criterion-referenced tests of knowledge and comprehension of legal issues and problem-solving skills related to legal issues.

Population: The original study in 1979 involved 1,718 students in the state of New York in diverse school settings whose teachers were randomly assigned to implement either Project Legal or traditional instructional approaches.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	*
Incorporates Evaluation	*

Findings

Project Legal's first evaluation was conducted during the 1978-1979 school year, and subsequent evaluations have supported the initial findings. The original study used a pre- and post-test control and treatment group design. Students who participated in Project Legal classrooms performed significantly better than those who had more traditional social studies curriculum and instruction.

Criterion-referenced assessments of students' law-related knowledge and comprehension and problem-solving skills in law were designed by the program developers to measure the program's effectiveness. The original study involved 1,718 students in New York state in diverse school settings whose teachers were randomly assigned to implement either Project Legal or traditional instructional approaches. The random assignment of teachers and classrooms to treatment and control groups strengthens the findings of the program evaluation.

Conclusions

The staff development component of this project immersed teachers in professional development where they had support from project staff and other teachers who were implementing the program. Students in Project Legal classrooms in grades 5, 8, and 11 significantly improved their knowledge and comprehension of law-related curriculum and their problem-solving skills related to functioning in the U.S. legal/judicial system when compared to students in traditional U.S. history classrooms.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

Literature Checklist

Author(s): Schweingruber, H., Papakonstantiou, A., Herbert, E., & Rohr, M.

Title: *High school algebra initiative: Year one report*
High school algebra initiative: Year two report

Source: Rice University School Mathematics Project

Publication Date: 1998 and 1999 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a post-test only with nonequivalent group)

Data Collected: Data were collected from Algebra I End-of Course Exams, classroom observations, project-specific teacher surveys, and project-specific principal surveys.

Population: Project was implemented in all high schools in Houston Independent School District, which served approximately 210,000 students from ethnically and economically diverse backgrounds

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

Over the three years of the Initiative, students' scores on the statewide Algebra I End-of-Course Exam increased from 23% passing to 42% passing. Most encouragingly, after three years of the Initiative, passing rates for African American and Hispanic students in Houston Independent School District were higher than in the state as a whole. Likewise, passing rates for economically disadvantaged students were higher than statewide rates.

In addition to improved scores on state end-of-course tests, teachers and administrators reported positive responses to the Initiative. Other benefits of the Initiative included changes in instruction and corresponding impact on student motivation and attitude; increased collaboration among teachers and strengthened ability to work together; tighter alignment between curriculum and instruction; and more focused discussion of mathematics instruction and content.

Conclusions

This professional development program for Algebra I teachers changed teacher practices, impacted student achievement, and increased alignment between curriculum and instruction.

Related Resource

Killion, J. (2002). *What works in the high school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/connect/projects/hswhatworks.pdf

Literature Checklist

Author(s): University of Illinois at Chicago

Title: *All Learn Mathematics annual report 1996-97*

Source: University of Illinois at Chicago

Publication Date: 1997 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a non-equivalent control group)

Data Collected: Data were collected from the Iowa Test of Basic Skills, project-specific teacher surveys, teacher interviews, and classroom observations.

Population: 600 teachers in more than 44 schools (selection process unknown)

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

For the schools participating in the both the first and second cadre, all improved their mathematics scores. The degree of improvement varied by school, with increases occurring at the lowest-performing as well as at the highest-performing schools. Differences in the numbers of student performing at or above the national norm at 5 of the 6 schools in the first cadre were statistically significant when compared to the control group. In the second cadre, the differences in the numbers of students performing at or above the national norm at 7 of the 18 schools was statistically significant, when compared to the control group. Changes in teachers' practices were also attributed to All Learn Mathematics. Interview and survey results indicate that, as a result of participating in staff development programs, teachers' attitudes about mathematics improved;

classroom instructional practices shifted from lecture or teacher-centered to student-centered and students working in cooperation with each other; and teachers' preparedness to teach mathematics, including their own understanding of mathematics concepts, improved. Teachers felt well-prepared to have students work in cooperative groups, practice computational skills, and engage students in inquiry-oriented activities. They also felt competent to use performance-based assessment and informal questioning, lead a class of students on investigative strategies, and manage students engaged in hands-on or project-based work.

Conclusions

Not only did the University of Illinois at Chicago—All Learn Mathematics (ALM) program increase student achievement in mathematics at all participating schools, it increased teachers' understanding of mathematics and use of appropriate instructional strategies to create student-centered classrooms. As a result of ALM, significant changes in mathematics education were made, and a greater accountability for schools, students, teachers, and administrators was initiated.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

Literature Checklist

Author(s): Cohen, D. K., & Hill, H. C.

Title: *State policy and classroom performance: Mathematics reform in California*

Source: Consortium for Policy Research in Education

Publication Date: January 1998 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a time series design)

Data Collected: Data were collected from the California Learning Assessment System state achievement tests, a one-time project-specific teacher survey, a review of state and district documents, school visits, and interviews of state and district administrators and reformers.

Population: Survey participants included 1,000 teachers, sampled to represent the population of second- through fifth-grade elementary school teachers in California. School visits were conducted at elementary schools and classrooms in three California school districts. The same districts, schools, and classroom teachers were followed for four to five years.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	
Occurs Over Time	*
Occurs with Colleagues	*
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	

Findings

Two thirds of teachers responding to the survey reported participating in at least one of the five mathematics-related professional development sessions in the year prior to the survey. The breadth of these professional development opportunities, however, was not

matched in their depth. Most teachers reported spending only nominal amounts of time in professional development activities. Of the teachers who reported attending one of the workshops in the past year, roughly half indicated they spent one day or less than one day in the mathematics-related activity, and approximately 35% reported spending between two and six days. A smaller fraction of those who attended the workshops, and a very small fraction of the entire sample, attended workshops lasting one week or longer. Few California teachers found rich learning opportunities.

Survey results suggested that teachers' learning opportunities need to go one level deeper than subject specificity. Providing teachers with concrete, topic-specific learning opportunities appears to help them change mathematics teaching practices, which impacts student learning.

Conclusions

The 1994 survey of California elementary school teachers indicated to the researchers that professional development that was not grounded in academic content was less likely to have constructive effects. Professional development that was fragmented, that was not focused on curriculum for students, that did not afford teachers additional learning opportunities, and that did not involve collaborative activities had less of an impact on teachers.

Literature Checklist

Author(s): Young, D. B., Dougherty, B., Lai, M. K., & Matsumoto, A.

Title:

Source: *Journal of Women and Minorities in Science and Engineering*

Publication Date: 1998 **Volume:** 4 **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a post-test only with nonequivalent group)

Data Collected: Data were collected from GOALS: A Performance-Based Measure of Achievement and classroom observations.

Population: The tests were administered in fall 1995 and spring 1996 to students at three sites. Two sites were in Mississippi and one was in Hawaii. The sites represented a wide diversity of socio-economic and achievement levels.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

In 1995-1996, an evaluation using a pre-test, post-test, norm-referenced design was conducted of the Hawaii Algebra Learning Project. GOALS: A Performance-Based Measure of Achievement was used because the items cover topics beyond first-year algebra, including geometry, probability, and statistics. The test's open-ended format matched the format of the project's classroom instruction. GOALS emphasizes justification and explanation of answers, so students can demonstrate their thinking and reasoning. Although not a true control group, the national norming group provided an acceptable comparison group for statistical analysis.

The tests were administered in fall 1995 and spring 1996 to students at three sites. Two sites were in Mississippi and one was in Hawaii. To compare the scores, the mean of the raw scores were converted to their corresponding scaled scores. These scaled scores each corresponded to a percentile whose value depended on whether the test was administered in the fall or spring. Students who participated in the project performed significantly better than the comparison group.

At all sites, large gains beyond expectations were found. All pre-post-percentile scores were statistically significant at the $p<0.001$ level. Even though there were large differences in pre-test means at the three sites, the gains shown at each site were very similar in magnitude, indicating a significant value-added component. Percentile gains ranged from 15 to 21 points.

All teachers involved were either directly observed or videotaped during the year to assure that the quality of instruction was aligned with the goals of the program, that teachers covered the expected amount of course material and concepts, and that they used a variety of instructional strategies consistent with the program and designed to meet student learning needs.

Conclusions

The Hawaii Algebra Learning Project is a combined curriculum and staff development effort. The use of teacher resources, student texts, and assessments, coupled with a professional development program, led to significant improvements in student achievement in mathematics with students of diverse backgrounds.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

Literature Checklist

Author(s): Dass, P., & Yager, R.

Title: *Iowa Chautauqua Program final performance report*

Source: University of Iowa

Publication Date: 1997 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a non-equivalent control group design)

Data Collected: Data were collected from project-specific multiple-choice tests and National Assessment of Educational Progress attitude survey.

Population: The project has been implemented in five of Iowa's 15 Area Education Agencies and in 10 other states. Students in grades 4-9 were included in the assessment

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

Multiple measures of student performance and changes in teacher practice indicate that the Iowa Chautauqua Program has produced positive results for students. For example, researchers have used project-specific, multiple-choice tests to measure the concept, process, application, and creativity domains. The attitude domain was assessed using a Likert-type five-point scale with items from the National Assessment of Educational Progress, Third Assessment of Science. Pre- and post-tests were administered to all students of 15 lead teachers in 1989-1990. In total, 723 students were assessed. The 15 lead teachers were selected from a pool of 50 lead teachers for the formal assessment.

Lead teachers taught two or more sections, one serving as a control group with conventional instructional procedures and one serving as the experimental group with Science-Technology-Society approaches to instruction. Data were also collected from at least one section of the 250 new teachers in the program. No contrasting data were available for those classrooms. Researchers state that the sample of teachers and students were representative of the larger population of teachers and students.

Results indicate that students in the control and experimental groups had similar conceptual knowledge about science on the post-test (effect size –0.03). Students participating in the Iowa Chautauqua Program had significantly higher gains in the process (effect size 2.20), application (effect size 3.21), creativity (effect size 2.12), and attitude (effect size 1.62) domains.

Conclusions

The Iowa Chautauqua Program increases teacher confidence in teaching science and increases teacher understanding and use of basic features of science. Lead teachers involved in the program had students who mastered more scientific concepts, better understood the basic processes of science, applying concepts and processes to new situations, developed more creativity skills, and had more positive attitudes about science, their science teachers, the usefulness of science, and science careers when compared to students in other classrooms.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

Literature Checklist

Author(s): Planning and Evaluation Service

Title: *Does professional development change teaching practice? Results from a three-year study*

Source: U.S. Department of Education, Office of the Under Secretary

Publication Date: 2000 **Volume:** **Issue #:**

Peer Reviewed? No

Type of Study: Quasi-experimental (a time series design)

Data Collected: Data from the National Profile, the Case Studies, and the Longitudinal Study of Teacher Change were examined in this study.

Population: Using a purposefully selected sample of teachers in 30 schools, in 10 districts, in 5 states, the researchers examined the quality of teachers' professional development in Eisenhower and other professional development activities and its effects on changing teaching practice in mathematics and science from 1996-1999.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	*
Occurs with Colleagues	*
Provides Technical Assistance & Support to Teachers	*
Incorporates Evaluation	

Findings

Data from this study suggest that discussing professional development experiences with colleagues and participating in follow-up activities made the experience more meaningful for participating teachers. Results from the study provide evidence of the link between focusing on specific teaching strategies in professional development and having teachers

use those specific strategies in the classroom. Specifically, professional development focused on specific, higher order teaching strategies increases teachers' use of those strategies in the classroom. Professional development is also much more effective in changing teachers' classroom practice when it has specific features of high quality, such as the collective participation of teachers from the same school or grade. Results suggest there is great variation in the quality of teachers' professional development experiences. Findings also indicate that the average teacher's professional development experiences do not add up to a long-term, coherent, high-quality program. High-quality professional development that focuses on specific teaching strategies does affect teacher practice. In sum, the findings show that the most effective professional development is focused on specific, higher order teaching strategies and has features of high quality such as addressing student-learning needs, applying to specific curricula, occuring over time, and occuring with colleagues.

Conclusions

The researchers concluded that six key features of professional development are effective in improving teaching practice: three structural features (characteristics of the structure of the activity)—reform type, duration, and collective participation—and three core features (characteristics of the substance of the activity)—active learning, coherence, and content focus.

Literature Checklist

Author(s): Swafford, J., & Thornton, C.

Title: *The PUMP algebra project*

Source: Retrieved from http://www.nsdc.org/library/authors/NSDCPlan.cfm

Publication Date: 1998 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (pre-post test with no control group)

Data Collected: Data were collected from the Illinois Goal Assessment Program (state mathematics test), Mathematics Learning and Teaching Survey, algebra enrollment at middle and high school, and minority student enrollment in algebra.

Population: Peoria Public Schools serves approximately 17,000 students and all middle school mathematics teachers participated in project.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

Peoria Urban Mathematics Plan for Algebra has impacted student achievement, teachers' beliefs, and instructional practices. Pre-project scores and annual scores of student achievement on the Illinois Goal Assessment Program (IGAP) were collected in March of each year. The sixth-grade scores, while demonstrating an overall increase in the district of 10 points, increased in 7 of the 14 schools, decreased in 6, and remained the same in 1 after only two years of implementation. Differences in scores were statistically

significant. At the eighth grade, scores increased in 13 of the 14 middle schools. The mean increase of 13.2 points across all schools was significant ($p<.05$).

While the results at the sixth grade are not significant, possibly due to the brief implementation time and the low number of sixth-grade teachers in the project, the increase at half of the schools showed promise for continued improvement. The strong results at the eighth grade demonstrated the program has the potential to dramatically improve student achievement.

Overall algebra enrollments at the middle school increased slightly, primarily as a function of increased minority population participation. At the high school level, the proportion of minority students in enrolled in algebra increased from 42.5% to 54.3%.

Survey results indicate that teachers reflect more on their teaching and are more likely to incorporate new instructional strategies into their practice. Statistically significant differences were found in instructional beliefs and practices in five of the eight clusters of the Mathematics Learning and Teaching Survey.

Conclusions

Peoria Urban Mathematics Plan for Algebra is a professional development program focused on improving teacher performance: teachers' content knowledge, teachers' pedagogical and professional knowledge and support for the implementation of new knowledge into practice. This professional development program increased student achievement in algebra at the 8th grade, improved teacher practices, and increased minority-student participation and representation in high school algebra.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

Literature Checklist

Author(s): Acquarelli, K., & Mumme, J. A.

Title: *Renaissance in mathematics education reform*

Source: Phi Delta Kappan

Publication Date: 1996 **Volume:** 77 **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a post-test only with nonequivalent group)

Data Collected: Data were collected from the1994 New Standards Reference Exam and case studies.

Population: During its five years as a component of California's State Systemic Initiative, more than 500 schools, including 2,500 math teachers, participated. This represents nearly 50% of the state's middle schools. Thirty-eight percent of schools in the project were involved for three or more years. Statewide, 74% of the project districts had 100% of their middle schools participating.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	*
Incorporates Evaluation	*

Findings

Mathematics Renaissance student performance was assessed in a subset of classrooms across the state of California. The 1994 New Standards Reference Exam was administered in the spring of 1995. Students in the Renaissance sample participated in two days of testing on a range of performance tasks of 5, 15, and 45 minutes in duration.

The exam was scored by Renaissance staff and teachers using New Standards scoring rubrics during a summer professional development session.

Analyses of the scores were performed by New Standards staff. In the analyses, Mathematics Renaissance students consistently scored significantly higher than the multi-state comparison group. Overall findings indicated a strong, statistically significant evidence that students in the Renaissance sample performed at higher levels on all aspects of the New Standards exam, including skills, concepts, and problem-solving.

The professional development resulted in significant changes in classroom practice, documented by case studies, school profiling, and survey data.

Conclusions

Teachers in this project collaborated with one another and received in-class support. Mathematics Renaissance has positively impacted student achievement in mathematics and teacher instructional behaviors, and influenced district policy regarding curriculum and instructional materials.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

Literature Checklist

Author(s): Student Watershed Research Project

Title: *Fifth annual student watershed summit: Summary evaluation comments*

Source:

Publication Date: 1997 **Volume:** **Issue #:**

Peer Reviewed? Yes

Type of Study: Quasi-experimental (a post-test only with nonequivalent group)

Data Collected: Data were collected from student data samples, professional and peer review of student analysis reports, and student presentations and displays.

Population: This project originally trained 91 teachers who directly impacted more 6,000 students in grades 8-12 from 18 public and private school districts in the Portland/Vancouver metropolitan areas.

Professional Development Component(s):

Component	Addressed
Addresses Student-Learning Needs	*
Incorporates Hands-on Technology Use	*
Is Job-Embedded	*
Has Application to Specific Curricula	*
Addresses Knowledge, Skills, and Beliefs	*
Occurs Over Time	
Occurs with Colleagues	
Provides Technical Assistance & Support to Teachers	
Incorporates Evaluation	*

Findings

The evidence of student success for the Student Watershed Research Project (SWRP) is atypical. Rather than demonstrating increased performance on a standardized assessment of science knowledge, students demonstrated knowledge of data collection and analysis by having their test results compared to duplicate samples analyzed by professional laboratories. SWRP staff combined professional laboratory results with the students'

data, provided feedback on the data for both the student and teachers, and audited student data. SWRP standards for reliability of student-collected data were very high. SWRP staff coordinated and supervised a rigorous quality assurance/quality control program.

The reliability of SWRP data enabled local agencies to use the data to make policy decisions. The SWRP model has been recognized locally and nationally for the quality of the data produced, which reflects the quality of student and teacher performance. Data produced by students were used in a publication by Oregon's Department of Environmental Quality in establishing surface water quality standards for dissolved oxygen.

In addition, students wrote their group findings and then presented them to a panel of their classroom peers. Students became specialists in the particular parameters they measured, and each group presented both background and findings for their testing during the presentations. Annual summits allowed students to display their data on posterboard and give oral presentations, where the quality and content of presentations were judged by various watershed health professionals. Students also had opportunities to provide information to regulatory agencies regarding the watershed they monitored.

Conclusions

The Student Watershed Research Project developed teachers' understandings of watershed research and provided an excellent model of authentic performance assessment for students. SWRP contributed to students' understanding, appreciation, and practice of science as a result of their teachers' participation in professional development models hands-on, practical learning experiences.

Related Resource

Killion, J. (1999). *What works in the middle school: Results-based staff development.* Oxford, OH: National Staff Development Council. Retrieved March 22, 2003 from http://www.nsdc.org/midbook/index.cfm

APPENDIX B

Description of Texas Instruments' Educational and Productivity Solutions Division Approach to Professional Development

Prepared For

Texas Instruments Educational and Productivity Solutions Division

by

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Description of Texas Instruments' Education and Policy Services Division Approach to Professional Development

Introduction

The Professional Development Services group of Texas Instruments' (TI's) Education and Policy Services (E&PS) Division offers a variety of professional development services, including face-to-face institutes as well as on-line courses. All instructors for professional development offered by E&PS are current or former classroom teachers, who have successfully used TI products (e.g. TI-73, TI-83+, Navigator, Voyager 200, TI-89) with students in classrooms. These instructors understand the needs of the teachers in their classes. They work with the organizer and sponsor prior to the training in order to adapt specific content to the needs of teachers at the local site.

The purpose of this document is to provide a cohesive and comprehensive description of E&PS's professional development services to guide a review of the scientific research literature relative to E&PS's approach to professional development. As defined by the Educational Resources Information Center (ERIC) thesaurus, *professional development* refers to "activities to enhance professional career growth." In this paper, we take a broader look at professional development, which has been summarized in a quote found on the Web site of North Central Regional Educational Laboratory (www.ncrel.org, n.d.)—appropriate for TI's focus on professional development related to technology in education:

> Professional development…goes beyond the term "training" with its implications of learning skills, and encompasses a definition that includes formal and informal means of helping teachers not only learn new skills but also develop new insights into pedagogy and their own practice, and explore new or advanced understandings of content and resources. [This] definition of professional development includes support for teachers as they encounter the challenges that come with putting into practice their evolving understandings about the use of technology to support inquiry-based learning…. Current technologies offer resources to meet these challenges and provide teachers with a cluster of supports that help them continue to grow in their professional skills, understandings, and interests.

In this document, we present information about the professional development offered by TI's E&PS Division. The description is organized so that it relates to nine critical components of effective professional development, which were synthesized from the following three main sources:

1. *Providing Professional Development for Effective Technology Use*, a critical issue Web site produced by the North Central Regional Educational Laboratory (http://www.ncrel.org/sdrs/areas/issues/methods/technlgy/te1000.htm). On this site, the North Central Regional Educational Laboratory (NCREL) identifies 14 essential components of effective professional development.

2. Eight principles of effective professional development—identified from research as well as literature and best practice—on the Knowledge Loom Web site (http://www.knowledgeloom.org/pd/).

3. The National Staff Development Council's (NSDC) 12 standards for staff development, revised in 2001. (http://www.nsdc.org/standards/index.cfm)

Each of the nine components is described, with references to the source of the component. These descriptions are followed by further description of TI's professional development services as they relate to each component.

Effective Professional Development Addresses Student-Learning Needs

The first essential component of professional development that enables effective use of technology by teachers is that it be *connected to student learning* (NCREL). The NCREL authors elaborate by saying that professional development should enable teachers to implement teaching techniques that will help students (1) accomplish specific and required standards, (2) learn to think at higher levels, and (3) be engaged in the process of learning. Additionally, it is important that these technology-related teaching practices assist students who have different learning styles and preferences.

Closely related to NCREL's position that effective professional development must be connected to student learning are principles and standards from other sources. As described in the *Knowledge Loom* (http://www.knowledgeloom.org/pd/), professional development "should be based on analyses of the differences between (1) actual student performance and (2) goals and standards for student learning." One of the NSDC standards is even more specific, i.e., "Uses disaggregated student data to determine adult learning priorities, monitor progress, and help sustain continuous improvement." As seen in these standards, effective professional development helps teachers close the gap between actual performance and goals or standards for learning.

Texas Instruments' Professional Development

Clearly, the professional development offered by TI has as a focus helping teachers learn and implement new teaching strategies. As described to us, the math-related courses are designed for professional educators and assume a basic understanding, on the part of participants, of the mathematics to be taught to students. That is, for the most part, the math-related professional development is not about the content of mathematics, but is about effective pedagogical processes and strategies for teaching math using specific TI products. To say it another way, the focus of the professional development is on helping teachers learn what they can do in the classroom to further the mathematical competence of students. (Note: As more and more schools and districts find themselves with a shortage of qualified teachers of mathematics, TI is beginning to provide much more in the way of "math fundamentals" as part of its training).

Reportedly, all of TI's professional development services are designed to be aligned with national standards, where those are available, such as the standards promulgated by the National Council of Teachers of Mathematics (NCTM). TI does not claim that its professional development services are aligned with state standards in all 50 states; this is perceived to be an impossible challenge made even more difficult because of district-specific standards and local school-adopted standards. TI has made specific connections to standards in certain large states and they work with local sites to make those connections. As instructors prepare they routinely adapt the training to the needs of the teachers at a given site.

TI's professional development services could more closely meet the standard of connecting with student learning needs by working with the local site to determine specific student problems, for example, by looking at an item analysis on an end-of-course assessment to see where students had the lowest scores, and then tailoring the professional development to those specific areas. This would require pre-work by the instructors; sometimes it would be impossible to structure because these kinds of data are not always available to the sponsoring organization. Many states do not administer end-of-course exams; even when they do, individual item analyses may not be available or may be available only by school or district.

The training offered by TI—while it may not be tied to specific state, district, or local standards—is clearly related to helping students learn the content of specific courses. For example, the professional development for teachers in Algebra I (in both the face-to-face training and the on-line training) clearly links to the student learning requirements as outlined in the table of contents of most Algebra I texts. The on-line courses, which are asynchronous and self-paced by individual teachers, allow more total coverage of a given course content; the face-to-face training is limited by the time available (one to five days.)

As described by TI staff, the professional development helps teachers understand how to make better use of student time for learning by encouraging the use of the technology to do the routine and mundane tasks such as collecting data and loading it into a table. What the teacher can then concentrate on is helping the students manipulate the data, speculating on—and then seeing immediately—the results if different data are entered. Students are helped to "see" how the output would change as individual factors are changed. Through the graphical representation, students are able to visualize the changes.

When used properly, these teaching techniques would seem to encourage higher-order thinking by students—skills such as question-asking, hypothesis-generating, speculating, drawing conclusions. Given the real-world problems that are encouraged, these teaching strategies would seem more likely to engage more students. The visual representation in the graphs would likely help a more diverse group of learners be able to master the basics of abstract math courses such as Algebra and Calculus. A basic question that remains to be answered relates to the research base on the product itself: Do students learn math (or science or other courses) better when taught using a graphing calculator? That is, do students score higher on end-of-course tests after using a TI handheld graphing calculator? A definitive "yes" answer to this question would certainly tie the professional development more closely to student learning outcomes.

Effective Professional Development Incorporates Hands-On Technology Use

This NCREL-identified component of effective professional development is based on research that confirms good common sense: when teachers receive training in technology, they are more apt to feel comfortable integrating it into their lessons. Additionally, when teachers are confident in using technology, they are more likely to think about ways to use it with students. Closely related is one of the NSDC standards, "Uses learning strategies appropriate to the intended goal."

Texas Instruments' Professional Development

All of the professional development offered by TI is activity-based. Teachers actually use the hand-held instruments to solve real-life problems. As reported to us, all of these activities can be immediately used with students in the classroom. Motivation is high because the activities are perceived by teachers as relevant to their needs and those of their students.

Effective Professional Development Is Job-Embedded

The *Knowledge Loom* presents this component of effective professional development in the following words: "Professional Development should be primarily school-based and built into the day-to-day work of teaching." One of the NCREL components similarly explains the necessity of using a *variety of different learning experiences*, including workshops, classroom observations, mentoring, and hands-on practice in the classroom with feedback. Adults require relevant learning with appropriate support and follow-up.

Texas Instruments' Professional Development

Face-to-face training for one to three days, conducted by expert trainers from outside the school or district, does not easily allow for professional development to be long-term or job-embedded. When TI provides this type of professional development, it is responding to specific requests by schools, districts, or other organizations. These agencies may not be interested in job-embedded and long-term professional development.

The opportunity for job-embedded professional development is heightened when the sponsoring agency hires TI to conduct a training-for-trainers session. During this long-term process (five days of training with four days of follow-up) teachers are trained thoroughly and then expected to train members of their own staffs in the use of the hand-held devices. When training is done at the school level by local, school-based trainers, there is increased opportunity for long-term professional development, i.e., more than workshops—to include observations, problem solving, and feedback. To ensure that this happens, TI could develop agendas designed to encourage job-embedded training (in addition to workshops) and establish the expectation that teacher-trainers, upon return to their local site, would facilitate opportunities for mentoring,

observations, and group discussions—as well as the more traditional training experiences of workshops.

The on-line courses, which are self-paced, allow flexibility. One could imagine a group of teachers completing the on-line course as a "study group," for example, and meeting regularly to talk together about the successes and challenges of using the technology with students. Although this is not the design of the TI materials, they would be usable in this kind of setting. One wonders what the professional development services group might do to encourage this kind of job-embedded use of their training materials.

Effective Professional Development Has Application to Specific Curricula

It is probably the case that much professional development has been delivered about the use of technology in education—in general—without tying it to specific curricula that teachers teach. NCREL found evidence that the use of technology is related to improved student achievement only when teachers can see a direct link between the technology and the curriculum that they teach. Their recommendation is that professional development for technology provides specific examples and demonstrations of the use of technology in teachers' specific curriculum areas.

Texas Instruments' Professional Development

All of the training that is provided by TI appears to meet this competency. The TI institutes and on-line courses are each tied to a specific curriculum area, such as Algebra I, pre-Algebra, Calculus, etc. Teachers not only learn how to use the technology to teach specific course content, but they also learn how to link the learning to real-world problems. As described by TI staff, the learning activities that teachers participate in during the training can be immediately used in the classroom with students so there is immediate applicability of the learning. The on-line discussion groups, to which teachers can belong, also focus on specific curriculum areas.

Effective Professional Development Addresses Knowledge, Skills, and Beliefs

This NCREL standard asserts that effective professional development in the area of technology helps *teachers develop new roles* for teaching. That is, effective professional development is about more than providing basic skills in the use of technology, but also engages teachers in thinking about the role of "teacher" transforming to the role of coach or facilitator, while students work collaboratively on real-world problems that are meaningful to them.

A related principle, from the *Knowledge Loom*, states, "Professional Development should provide opportunities to gain an understanding of the theory underlying the knowledge and skills being learned." Two of the NSDC standards also seem to relate to the idea of going beyond basic skills and knowledge: (1) "Deepens educators' knowledge, provides them with research-

based instructional strategies to assist students in meeting rigorous academic standards, and prepares them to appropriately use various types of classroom assessments" and (2) "Prepares educators to apply research to decision-making."

This cluster of competencies and standards support the idea that true learning must be deep and that because beliefs guide behavior, professional development must address teachers' beliefs and life experiences. Teachers need to understand *why* using a certain technology is important for learning; they need to understand it well enough to know *when* to use it and when it is not appropriate. With a solid understanding of the theory behind the knowledge and technology, teachers can make decisions and meaningfully adapt strategies to best serve their students' learning needs.

Texas Instruments' Professional Development

It appears that most of the TI training is specific to knowledge and skills, i.e., how to use the hand-held technology and how to incorporate it into the classroom. Much of the "deeper" learning and thinking about the use of the technology would require more time than the typical face-to-face institute provides. Teachers who take advantage of the "success stories" that are featured on the TI Website would begin to understand the power of the tool in transforming a classroom. But it appears that the focus of the training is on the knowledge and skills of using the technology. Lack of time is the major reason that more attention is not given to the theory and deeper understanding of what this technology can do to help learning.

According to TI staff, when teachers learn to use the equipment meaningfully in their classrooms, their roles do indeed change to facilitator/coach, rather than direct instructor. Using the technology allows teachers more time to "think" with their students, as opposed to doing more rote activities such as entering data into tables and calculating the results. In classrooms where the TI technology is effectively used, TI staff claim that students learn how to question data; their role as learner is to question and speculate. Students assume a more active role and have increased power in the learning process.

It would appear that *time* is required for this transformation to occur—time to become comfortable and more expert in the use of the technology. In most groups, a small number of teachers will "go with new ideas" and—through trial and error—learn how to use this technology and concurrently transform the culture of their classrooms. The question remains: How can you increase those numbers without also increasing the time required for training? Teachers who participate in on-line courses have more time; participants typically have four months to complete a course. Although they have the requisite time, they probably take the course in isolation; so they lack the valuable learning that comes from discussion with colleagues in face-to-face sessions. It would be interesting to see if the "level of use" of TI technology is different between the teachers who participate in face-to-face training versus those who participate in on-line courses.

Effective Professional Development Occurs Over Time

A series of principles and standards in the literature relate to the need for professional development to be more than a "one-shot" training experience. From the sources noted above, we find that effective professional development:

- should be continuous and on-going, involving follow-up and support for further learning, including support from sources external to the school that can provide necessary resources and new perspectives (*Knowledge Loom*)
- is an on-going process (NCREL)
- requires sufficient time and follow-up support (NCREL)

For teachers to master new content and strategies to the point where they can routinely integrate them into their classrooms requires time and follow-up support. Research confirms that meaningful change requires three to five years, with special attention given to the provision of support during the first two years of implementation.

Texas Instruments' Professional Development

The face-to-face institutes are traditional one- to three-day training experiences; however, TI encourages teachers to participate in its on-line courses as a follow-up to the training. The on-line courses extend over a four-month period of time and provide an opportunity for forum discussion groups on-line so that the learning can be extended beyond the initial training period. These courses are recommended as either (1) pre-workshop courses or (2) follow-up to a face-to-face training. In both cases, the professional development and support continues well beyond the training period.

Another opportunity for professional development to be extended over time is the utilization of the train-the-trainer program. A core group of teachers receives the initial five-day training and participates in up to four days of follow-up, with opportunities to share learning successes as well as problems with colleagues. This cadre of trainers, then, is expected to train other teachers in their building. With the trainer being on site, the professional development can easily extend over time.

Effective Professional Development Occurs With Colleagues

Two of the NSDC standards address the collegial aspect of professional development. The first stipulates that profession development "provides educators with the knowledge and skills to collaborate." The second suggests that effective professional development "organizes adults into learning communities whose goals are aligned with those of the district and school." The *Knowledge Loom* advocates that professional development "be organized around collaborative problem-solving."

Collaboration appears to be necessary for any school-wide change to occur. Without it, isolated teachers may change their practice, but the numbers will be smaller than if there is a

school-wide effort. Examples of collaborative learning include study groups, action research, peer observations and problem-solving, shared lesson plans with systematic feedback. Learning a new teaching strategy is but the first step; using it, refining it, and making it work for individual teachers requires time, support, and feedback.

Texas Instruments' Professional Development

To achieve the collegiality aspect of effective professional development requires that a school or department transform its culture into one of collaboration for continuous improvement. This does not occur without strong leadership and an intentional effort to accomplish this change. TI, as an outside provider of training services, sees the creation of a school-wide learning community as outside of its purview. However, the possibility for the establishment of a collaborative learning culture exists through the train-the-trainers model. It is not clear to what extent the materials for the trainer encourage such collaboration.

Effective Professional Development Provides Technical Assistance and Support to Teachers

NCREL found that when teachers are trying to use technology as part of their teaching, when they have difficulties, they need immediate help—or "just in time" support. An on-site provider of technical assistance is ideal and most likely to be accessed without difficulty. The harder it is to reach the support, the less likely the teacher will persevere to find an answer to the problem and the more likely he or she will return to more traditional teaching methods.

Texas Instruments' Professional Development

Teachers who take the on-line courses can always post a problem and have an instructor respond quickly. TI provides free technical assistance through its 1-800-TI CARES phone number, where any teacher can call to receive help. Another service that TI provides involves a fee—on-line coaching provides access to a qualified instructor. On-line coaching was established to try to prevent the teachers' frustration of not being able to figure out a specific instructional problem immediately.

Effective Professional Development Incorporates Evaluation

All three of the major sources related to professional development address the importance of evaluation. The *Knowledge Loom* phrases it as follows: "Professional Development should incorporate evaluation of multiple sources of information on (1) outcomes for students and (2) the instruction and other processes that are involved in implementing the lessons learned." The NSDC standard is very similar, "uses multiple sources of information to guide the improvement and demonstrate its impact."

Evaluation provides information about how professional development can be improved and refined. Traditional "reaction" evaluation forms, gathered at the conclusion of a training or

an on-line course, yield important information; however, anecdotes gathered from teachers, teacher portfolios that demonstrate the use of the learned strategies, observations of teachers, peer evaluations, and ultimately, student performance all provide richer sources of data for assessing the value of specific professional development experiences. Knowing the extent to which professional development has contributed to improved student achievement gives confidence in the design of the training and can motivates teachers to use what they have learned.

Texas Instruments' Professional Development

TI conducts a simple evaluation at the conclusion of the face-to-face institutes and the on-line courses. An additional measure of potential usefulness of the training comes in a module during each on-line course, which requires that the persons taking the course inform TI how they intend to incorporate the technology into their classrooms. This reflective assignment encourages teachers to think about the application potential of their learning as they ask, "What have I learned here? How will I use this?"

TI has not gathered evaluation data to indicate (1) whether or not teachers are using the technology after the training—whether it is one-day training or five-day training; (2) for how long they use the technology after the initial attempts; (3) teachers' perceptions of improved student learning; and (4) actual student achievement gains, based on teacher-constructed assessments or state-wide tests. TI is beginning to work on a feedback process that would provide information about teacher use, but acknowledge that such data are difficult to gather.

Other Important Components of Professional Development

These final components seem less related to the professional development provided by an external source, such as TI, than they do to the internal supports at the home school or district that buys the training. To be effective, professional development must

- be adequately supported by school leaders
- have adequate access to resources and funding
- be connected to a comprehensive change process focused on improving student learning.

When teachers learn new skills, they need to have the support and opportunities to use these new strategies; they need the encouragement of administration to use them, including the expectation and accountability; and they need time to meet with colleagues. The school and district has control over establishing time to work collaboratively with other teachers, adequate funding, technical assistance, and access to the technology and support services to learn the use of the technology well. All of this is to say that the professional development needs to be part of a larger change process if it is to be effective.