



Professional Development Connected to Student Achievement in STEM Education

Date	February 14, 2012
Number	00117
Request	A state department of education (SDE) served by the Southeast Comprehensive Center (SECC) at SEDL requested information regarding professional development (PD) for teachers that may be connected to student achievement in science, technology, engineering, and mathematics (STEM) education.

OVERVIEW

Improving the effectiveness of teachers and leaders in low-achieving schools and ultimately advancing learning and achievement for students in these schools continues to be a key focus of education reform. The overall objective is to provide a well-rounded education for all U.S. students that will prepare them to compete and succeed on a global scale (U.S. Department of Education [ED], 2010). President Barack Obama underscores the commitment to this objective as he states, “We will support states, districts, school leaders, and teachers in implementing a more complete education through improved professional development and evidence-based instructional models and supports” (ED, 2010, p. 4).

As a result of state and federal requirements, an increased focus in this area, and other factors, many states are seeking information on the connection between professional development and student achievement. This report looks at the evidence on how professional development for teachers may affect student achievement in the STEM content areas.

The procedure by which resources for this report were selected is discussed below as well as limitations of this report and the results of the resource review.

PROCEDURE

In response to this request, SECC staff conducted web-based and hand searches of resources for literature on the topic. They conducted searches of EBSCO’s Academic Search Elite database, the Education Resources Information Center (ERIC), and online search engines (i.e., Bing, Google, Google Scholar, and Yahoo). They used a combination of the following search terms K-12 education + professional development (learning) strategies (plans) + student outcomes + professional development (learning) strategies (plans) + student achievement + professional development (learning) strategies (plans) + student engagement + professional development (learning) strategies (plans) + student interest. In addition, they used all the above terms + STEM + science + technology + engineering + math.

Literature selected by SECC staff for inclusion in this report includes a variety of peer-reviewed journal articles, case studies, and reports that have been published within the past 10 years. Publication sources include the Council of Chief State School Officers, *Exceptionality*, *Journal of Education for Students Placed at Risk*, *Learning Disabilities: A Multidisciplinary Journal*, Regional Educational Laboratory Southwest, and the Institute of Education Sciences’ What Works Clearinghouse, among others.

LIMITATIONS

SECC staff focused their efforts on reviewing resources that provided specific information on PD that may be connected to student achievement in the STEM content areas, with an emphasis on initiatives and practices that have been implemented and evaluated. As such, the summaries featured in this report are not inclusive of all available information on the topic.

SECC does not recommend or endorse any initiatives or practices discussed in this report.

SUMMARIES OF RESOURCES

SECC staff compiled and reviewed information for over 30 resources based on the procedure detailed above; however, only six resources from federally-funded projects or among those reported in recent, peer-reviewed publications included an examination of the link between PD and student achievement. Summaries are provided of the key findings and highlights of these resources, which are listed in alphabetical order by title. Additional information on these resources appears in the References section of this report.

Effects of Teacher Professional Development on Gains in Student Achievement: How Meta Analysis Provides Scientific Evidence Useful to Education Leaders

(Blank & de las Alas, 2009)

Under a grant provided from the National Science Foundation, the Council of Chief State School Officers (CCSSO) conducted a meta-analysis on the effect of professional development on improving student learning. The focus of the study was on K-12 mathematics and science teachers. There was significant evidence that PD for mathematics teachers does have a positive effect on student achievement. Twelve of the 16 studies in the meta-analysis were concentrated on teachers of mathematics. The four studies that focused on science also showed significant effects on student achievement.

In looking more closely at the 16 mathematics studies, the authors found commonalities between these programs. PD programs were focused on specific subject content as well as “how to teach the content to students.” The programs also included multiple activities, implementation assistance, and support systems in schools such as mentors and coaches. The duration of these programs was generally for 6 months or more, and the mean contact time with teachers was 91 hours. Most of the programs studied were focused on PD at the K–8 level. Analysis also showed a greater effect on elementary teachers than their middle and high school peers.

Results were higher when measured against criteria that were specifically chosen to align with program content; however, several of the studies showed significant effects when measured with large-scale statewide assessment programs. The study also confirmed a positive relationship to student outcomes of specific components of design of PD programs, including learning specific subject content and strategies for how to teach that content. Continuation of professional learning following the initial training and teacher internships was positively related to increases in student achievement, while design components such as mentoring and collaborative networking among teachers had little to no effect on student outcomes.

Implementing and Sustaining Strategies Instruction: Authentic and Effective Professional Development or “Business as Usual”?

(Boudah, Blair, & Mitchell, 2003)

This study on the authentic professional development (APD) model examined the impact of the use of the model on teacher instructional practice, teacher performance and satisfaction, and student academic outcomes. The study was conducted in a school district in the South-Southwest that serves more than 28,000 students with 2,000 professional staff members. The authors indicated that there was a diverse student population residing in rural areas and planned communities but did not provide specific information about the population. The district placed increased emphasis on

including students with disabilities in general education classes. The study included both quantitative (experimental) and qualitative (evaluation) aspects. The experimental group involved 57 teachers from four schools.

Forty-four teachers participated in the experimental group while 13 teachers participated in the comparison or control group.

The APD model is based on four staff development activities (a) identification of instructional problems, strategy solutions, and training logistics; (b) teacher instruction and classroom modeling; (c) teacher practice with observation and feedback; and (d) teacher follow-up and instructional enhancement. The 44-member experimental group collaboratively defined and identified one instructional strategy (unit organizer routine) on which to focus its work. Members participated in 1.5 to 2 hours of on-site training, observed demonstration lessons by the trainer in various content areas, and met as individuals and groups in after-school meetings in which the trainer provided feedback on strategy implementation. The experimental group also met to share successes, problems, and to create needed instructional modifications.

The control group participated in a traditional format, single-day activity away from the campus. The training consisted of a description of the instructional strategy and how it can be used. However, their training did not include in-class modeling, teacher practice with observation, feedback, or follow-up. Teachers in the control group were trained in two groups on the same unit organizer routine.

Based on results from an Implementation and Student Performance Questionnaire, 95% (n=42) of teachers in the APD model training reported that they had implemented the unit organizer routine, while only 38% (n=5) of the control group reported that they had implemented the routine. Most of the APD group noted improved engagement rates and improved performance on classroom assignments. These findings should be tempered, however, by several key limitations of the study including a data set that relies primarily on self-report data; a relatively unequal, small sample size; and the absence of reliability and validity evidence for the questionnaires.

Middle School Mathematics Professional Development Impact Study: Findings After the First Year of Implementation (NCEE 2010–4009)

(Garet et al., 2010)

This study looked at 4,500 students—34% Caucasian, 36% African American, 25% Hispanic, 3% Asian, and 2% other, with 67% of the total student population qualifying for free/reduced lunch—and 200 teachers from roughly 80 schools in 12 districts during the 2007–2008 school year to see whether 7th-grade students' knowledge of rational numbers improved when the students' math teachers received related professional development. Half the schools in each district were randomly selected to offer 7th-grade math teachers PD on the teaching of rational numbers. Teachers in all schools in each district continued to participate in existing PD programs. This study has a high standard of evidence as a well-designed randomized trial.

Either America's Choice or Pearson Achievement Solutions provided the PD on the teaching of rational numbers, which included eight, 6-hour periods on pedagogy and content knowledge with resources provided. Following the PD, a coach to assist the teacher with the new strategies learned during the professional development provided a total of 20 hours of coaching in the classroom.

Northwest Evaluation Association developed the computer-adaptive rational number test used to measure student-level math achievement. The study's author created a test used to measure teacher-level content knowledge of rational numbers, and the teacher's instructional practices were measured during classroom observations. The effects of PD were measured by comparing outcomes at the end of the school year in the schools that received the rational number PD with outcomes in the schools that did not.

The study found that during the 2007–2008 school year, students performed no better on an assessment measuring their achievement in rational numbers in the schools in which teachers received the extensive professional development than students in the comparison schools. Additionally, the study showed that the PD had no impact on teacher knowledge of rational numbers and on how to teach them; however, the study did show a significant positive impact on one of the three measures of instructional practices examined. When compared with teachers who did not receive the extensive PD,

teachers who received the extensive PD engaged in 1.03 more strategies per hour that prompted student thinking (e.g., asking other students whether or not they agree with a classmate's responses, asking students for additional strategies or justifications for a problem).

Professional Learning Communities as a Leadership Strategy To Drive Math Success in an Urban High School Serving Diverse, Low-Income Students: a Case Study

(Huggins, Scheurich, & Morgan, 2011)

This case study focused on a mid-sized, urban high school in the Southwest and its use of a professional learning community (PLC) in its reform efforts to increase student achievement in mathematics and science. Enrollment at the school was approximately 700 students. Of those, about one half was Latino, a third African American, and a little over a seventh was Caucasian. Eighty-two percent of the entire population was listed as "economically disadvantaged." Mathematics PLC participants during the yearlong implementation consisted of academic leaders (n=3) and teachers (n=6). Through consistent and in-depth observations (2 days every other week over 6 months), the authors analyzed the implementation of the PLC from meetings to the classroom. The reader should note that as a case study, the findings below may be applicable to other similar settings but are not necessarily generalizable to the population. Additionally, the study should be replicated using a more rigorous technique such as a quasi-experimental approach to confirm the findings.

The analysis gleaned five distinct themes: implementation context, leadership style, PLCs as a reform strategy, the principal's PLC process, and improved teaching and learning.

The context of this case was a school that was described, as "in crisis" by its principal. Due to this status, the principal opted to focus the first reform efforts in the areas of mathematics and science. The principal also took a hands-on approach in attending 85%–90% of the PLC meetings. The focus of these meetings began with first increasing student achievement in math and science and then increasing the instructional skills of the teachers.

The process implemented by the principal for the PLC was separated into six areas (a) focus, (b) structure/pressure, (c) support, (d) increased individual and public accountability, (e) increased group accountability, and (f) increased collaboration.

This school experienced increases in mathematics achievement for minority populations on state-mandated assessments. The authors attribute these increases to changes in teaching practice and most specifically to the leadership that was provided by the principal. This study suggests that strong leadership with a constant commitment to learning on the part of both the teachers and students can lead to increases in student achievement.

Reviewing the Evidence on How Teacher Professional Development Affects Student Achievement (Issues & Answers Report, REL 2007–No. 033)

(Yoon, Duncan, Lee, Scarloss, & Shapley, 2007)

Demonstrating how professional development for teachers affects student achievement is difficult. Over 1,300 studies have been conducted to address the effect of teacher PD on student achievement. Of these, nine meet What Works Clearinghouse's evidence standards. The studies show that teachers who receive an average of 49 hours of PD can raise their students' achievement by about 21 percentile points, indicating that providing PD to teachers had a moderate effect on student achievement.

The nine studies focused on elementary schools with about half concentrated on lower elementary and about half on upper elementary. Six studies were published in peer-reviewed journals. The other three were published doctoral dissertations. Five studies were randomized control trials, meeting WWC evidence standards without reservations. The remaining four studies meet evidence standards with reservations. Four of the studies measured student achievement in reading and English/language arts; two measured student achievement in mathematics, two measured student achievement in mathematics and reading and English/language arts, and one measured student achievement in science.

Studies in which the professional development provided to teachers was more than 14 hours showed a positive significant effect on student achievement. The three studies that involved less than 14 hours of professional development

provided to teachers showed no statistically significant effects on student achievement. All nine studies included workshops or summer institutes with follow-up sessions provided as a means of supporting the professional development experience. In all nine studies, the professional development was provided directly to teachers rather than through a “train-the-trainer” approach.

Science Achievement of Students in Co-Taught, Inquiry-Based Classrooms

(Brusca-Vega, Brown, & Yasutake, 2011)

This study focused on co-teaching as an instructional strategy for students with disabilities to determine its effect on student learning in a diverse or blended classroom in which an inquiry-based, hands-on science curriculum was in place. The study took place at a middle school in a multiracial, urban area in northwest Indiana. The 950 students in grades 6–8 were composed of 37% Caucasian, 32% Hispanic, 25% African American, and 6% other populations. On the English/ language arts and math sections on the Indiana Statewide Testing of Educational Progress, 52% of students met state standards. In science, 33% of 7th grade students met state standards, as compared to 55% of students statewide. There was no control group. The reader should be cautioned that results of this descriptive study would need to be replicated using more rigorous techniques to validate findings.

The curriculum used in the school was the Full Option Science System (FOSS) developed at the Lawrence Hall of Science, University of California at Berkley (2005). This inquiry-based curriculum is hands-on, utilizes active learning, multisensory methods, student-to-student interaction, and discourse and reflective thinking. Five 6th- and 7th-grade teachers participated in the study, and none had experience with co-teaching. Three were Caucasian, one was African American, and one was Hispanic. Two of the teachers were general education science teachers, and three were special education teachers who were not highly qualified in science content instruction. Each received an annual stipend for preparation, data collection, and meeting activities. The science teachers in the study piloted the FOSS program for 1 year prior to the study.

One science teacher co-taught two periods daily with different special education teachers, and the other science teacher co-taught only one period daily. The school year began with a total of 75 students across the three co-taught classes. Students with disabilities composed approximately 40% of the two larger classes and 20% of a third, smaller class. Disabilities represented included students with learning disabilities, mild intellectual impairments, mild autism, and other health impairments.

The Iowa Tests of Basic Skills (ITBS), Form A was used as a formal measure of factual and conceptual understanding of science. Selected subtests of the Woodcock-Johnson III Tests of Achievement were used at pretest to describe students’ reading and oral language abilities. Informal measures included observations using the Reformed Teaching Observation Protocol, and teachers completed a monthly report.

Observers reported that the one-teach, one-support method of instruction was most typically used in co-teaching. Some instructional adjustments were made available to the entire class. Science teachers reported that the need to adapt for students with disabilities was not as great as they had expected because of the interactive nature of the curriculum, including hands-on learning in cooperative groups, reduced reading requirements, and interaction between teachers and students. Students were more strategically combined to meet the needs of individual students, including those without disabilities, as science teachers became more familiar with the needs of students with disabilities and special education teachers became more comfortable with curriculum instruction. Students with learning and other disabilities were found to have made significant gains in science achievement, as did students without disabilities.

Co-teachers recognized increased value to students with disabilities who had greater access to the general science curriculum in an integrated setting, and they were impressed with the level of science learning and appropriate behavior by students with disabilities.

REFERENCES

Note. Open hyperlinks using Adobe Reader. If a hyperlink does not open after it is clicked, copy and paste the entire hyperlink into the Internet browser window to access the resource.

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