Abstract Title Page

Title: The Effect of an Analysis-of-Practice, Videocase-Based, Teacher Professional Development Program on Teacher and Student Outcomes

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Abstract Body

Background / Context:

Over a decade ago, Borko (2004) raised the awareness of the education research community to the critical need for studies of teacher professional development (PD) programs. She states on page 13:
"My challenge to the educational research community is this: We have much work to do and many questions to answer in order to provide high-quality professional development to all teachers. It will take many different types of inquiries and a vast array of research tools to generate the rich source of knowledge needed to achieve this goal."

Studies of PD programs clearly ensued from this charge, but there is evidence that few studies tested causal relationships between teacher PD programs and both teacher and student outcomes (Author, 2011; Yoon, et al., 2007) and even fewer used rigorous research designs.

The line of research around the [program name] professional development (PD) program was intended to help address this problem, particularly in science education. [Program name] is a year-long analysis of practice, videocase-based PD program for elementary teachers that uses lesson video analysis as a context for supporting teachers' learning about science content and effective science teaching. The PD is intended to increase students' science achievement by increasing teachers' ability to attend to student thinking and to the content storyline of science instruction.

Traditional PD efforts seldom provide teachers with the necessary science content and pedagogical skills to help them teach in ways that support the kinds of student science learning called for in national reform efforts. These problems are especially prevalent for elementary teachers who have little training in science-specific pedagogy or in the science disciplines they are expected to teach (Fulp, 2002). There is a growing consensus that professional development should:

- engage teachers actively in collaborative analyses of their practice;
- treat content as central and intertwined with pedagogical issues;
- enable teachers to see these issues as embedded in real classroom contexts;
- focus on the content and curriculum teachers are teaching; and
- be guided by an articulated model of teacher learning that specifies what knowledge and skills teachers will gain, what activities will lead to this learning, and how this new knowledge and skills will appear in their teaching practices.

These features of effective PD are drawn from studies and conceptual pieces that have not rigorously tested impact on student learning. Most studies of PD focus instead on teacher level outcomes – teacher knowledge, teacher beliefs, and teaching practice. While this body of research shows that PD can impact teacher knowledge and beliefs, it highlights the difficulties of impacting teaching practice (Desimone, 2009) and leaves unanswered questions about the impact of PD on teacher and student learning.

Purpose / Objective / Research Question / Focus of Study:

This research sought to address the question: *what is the effect of [program name] on teacher and elementary school student outcomes compared to that of a PD program of equal duration that focuses only on content deepening*? The student outcome of interest was science achievement and the teacher outcomes were content knowledge and pedagogical content knowledge.

Setting:
The study took place along the Colorado Front Range (I-25 corridor).

Population / Participants / Subjects:
The study included 77 schools, 142 teachers, and 2830 4th and 5th grade students.

Intervention / Program / Practice:

The [program name] program is guided by a conceptual framework (Figure 1) that serves as a focus for the entire [program name] program. This conceptual framework guides both teachers' analysis-of-practice in the PD program, and their classroom science teaching practice. The framework challenges teachers to think about teaching and learning through two lenses: the Student Thinking Lens and the Science Content Storyline Lens. These are lenses that teachers do not typically use to guide their planning and teaching so they challenge teachers to question and change their practice. For each lens, teachers study and practice using a limited set of teaching strategies that are drawn from the literature on effective science teaching (seven Student Thinking Lens strategies and nine Science Content Storyline strategies).

The theory of change for the [program name] PD is shown below in Figure 2. Simply put, through the activities described above the program is designed to increase elementary teachers' science content knowledge, and their pedagogical content knowledge. These knowledge bases are then transferred into improved classroom practice, in which the key elements of the [program name] framework are present. This improved classroom teaching ultimately leads to increases in student achievement.

Central to the form of the program is teachers' interactions with each other and with videocases as they analyze science content, science teaching, and science learning in small (5–10 teachers), grade-level study groups, each led by a PD leader. These interactions begin during a two-week summer institute and continue in monthly 3.5-hour meetings across the school year. There are three basic phases of the PD work:

Phase 1: Two-week summer institute. During the summer institute, teachers are introduced to the [program name] lenses and strategies, the science content for two content areas, the lessons they will be teaching in the fall, and the lesson analysis process. To deepen their understandings, they analyze video clips of experienced teachers and practice identifying the [program name] strategies in use in these classrooms.

Phase 2: Fall teaching and video analysis, Content area 1. During the fall, teachers teach lesson plans provided by the program. These lessons support teachers in their first attempts to use the Student Thinking Lens and Science Content Storyline Lens teaching strategies. In monthly, 3.5-hour study group meetings, led by a [program name] PD leader, they learn from analysis of videos from each other's classrooms and from analysis of their students' work.

Phase 3 Winter/Spring lesson planning, Content area 2. The third phase of the [program name] program begins in January when each study group switches to a second content topic area. In addition to switching content areas, the focus of the study group work shifts from implementing provided lesson plans to developing lesson plans, using the [program name] lenses and strategies as guides. Thus, teachers are not provided with [program name] lesson plans in this second content area. Instead, they work collaboratively to develop lesson plans, using their learning about the science content and about the [program name] lenses and strategies.

Research Design:

To empirically test the assertions of the growing consensus about effective PD, this study compares two PD programs for 4th and 5th science teachers in terms of their impact on student science learning. The [program name] program is designed to include the features of analysis-of-practice PD described in the consensus model of PD. It seeks to promote changes in science teaching and learning through an analysis-of-practice approach where teachers' science content learning and their learning about science pedagogy emerge from collaborative, videocase-based inquiries of practice. Alternatively, the Content Deepening comparison condition engages elementary teachers in science content-based learning experiences designed to increase teacher content knowledge and confidence in teaching science effectively. This comparison condition was selected for three reasons. First, prior to the development and initial study of the [program name] innovation, this content-focused PD approach was being used by the [state name]-supported science PD network [name of the state network program] where the original study of the [program name] program was conducted. Secondly, teacher content knowledge has been shown to be a strong predictor of student learning. In fact, it was the strongest predictor of student learning in the previous, quasi-experimental study (authors, 2011). Finally, this approach was in high demand by area teachers in both [state where original study was conducted] and [state where current study was conducted]. The study of the [program name] program we present here includes:

- a cluster randomized trial with assignment at the school level,
- a sampling frame that included diversity in demographics,
- a specified comparison condition that matched the treatment condition in duration, intensity, and contact hours, and;
- a treatment that was delivered entirely by PD providers who did not participate in the development of [program name].

Data Collection and Analysis:

The instruments used to collect outcome data for the study were developed by the researchers. For the teacher and student content knowledge tests, instrument development activities included a) identifying extant items from current assessments, such as American Association for the Advancement of Science Project 2061, the Horizon *ATLAST* project, the Harvard *MOSART* project, as well as NAEP and TIMSS assessments, b) writing new items where items aligned with learning goals did not exist, c) piloting items with students during the second year of the project, d) analyzing pilot data and examining item difficulty, discrimination, selection of distractors, and reliability. Teacher PCK was measured using a video analysis task, which required teachers to watch a series of short classroom videos and write about what they saw. A rubric scored their attention to student thinking and the teacher's pedagogical moves.

We quantified the treatment effect by comparing post-treatment outcomes across treatment groups, adjusting for baseline measures of those outcomes. The baseline (pretest) adjustment is to account for any pre-treatment achievement differences across treatment groups that might have been introduced through the random assignment process. To account for the nested nature of the data (i.e., students within schools), we used a multi-level modeling approach, and within this framework, we were able to estimate pretest adjusted mean differences in outcomes (Raudenbush & Bryk, 2002).

Findings / Results:

The treatment effects on student achievement ($g = 0.68$, $p < .001$) and on teacher content knowledge and teacher pedagogical content knowledge were all statistically significant. With regard to the teacher effects, the [Program name] PD program teachers significantly outperformed the teachers in the comparison Content Deepening Condition ($p < 0.001$). The effect sizes were 0.66 for teacher content knowledge, and 1.17 for teacher PCK, and these are shown in the path model below in Figure 3).

Next we examined mediation (pathways X and Y in Figure 3), that is, to what extent were these differences in teacher content knowledge and PCK, responsible for the differences in student achievement? However mediation analyses showed only small and non-significant effects of these teacher variables on student achievement. That is, a teacher's science content knowledge or PCK, explained little of the differences in student learning. Reflecting back on Figure 3, we therefore must presume that the effects of teacher content knowledge and PCK on student achievement are mediated by classroom practice. We have recently completed scoring of the classroom practice measure (many hundreds of hours of classroom video) and will have examined this portion of the pathway well before the SREE 2016 conference and will report those classroom practice effects should this paper be accepted.

Conclusions:

Hill et al., (2008) conducted a synthesis of effect sizes for randomized control trials and found that for elementary school studies the average effect size for student effects was 0.33. Further, they found that the average effect size varied by the breadth of focus for the outcome measure, reporting on page 176: "within studies of elementary schools, mean effect sizes are highest for specialized tests (0.44), next-highest for narrowly focused standardized tests (0.23), and lowest for broadly focused standardized tests (0.07)." The student effect size reported in this study (0.68) compares favorably to those of similar studies with specialized outcome tests. Similarly, the effects on teacher outcomes (0.66 and 1.17) are also presumed to be noteworthy although much less is known about typical effect sizes for intervention effects on teacher outcomes.

In response to the calls for researchers to conduct more comprehensive research on the effects of teacher PD on both teacher and student outcomes (e.g., Borko, 2004), this study yielded strong evidence that the [program name] program is efficacious for a diverse sample of students, even when non-developers deliver the intervention. The first part of this statement supports the claim that elementary science teachers' learning will likely impact student achievement more if it occurs in the context of analysis of practice, providing empirical support for the idea that engaging teachers in scientific inquiry activities to deepen their content knowledge is not enough. Further, the second part of this statement suggests that the [program name] program could be scalable under the appropriate conditions.

Appendix A. References

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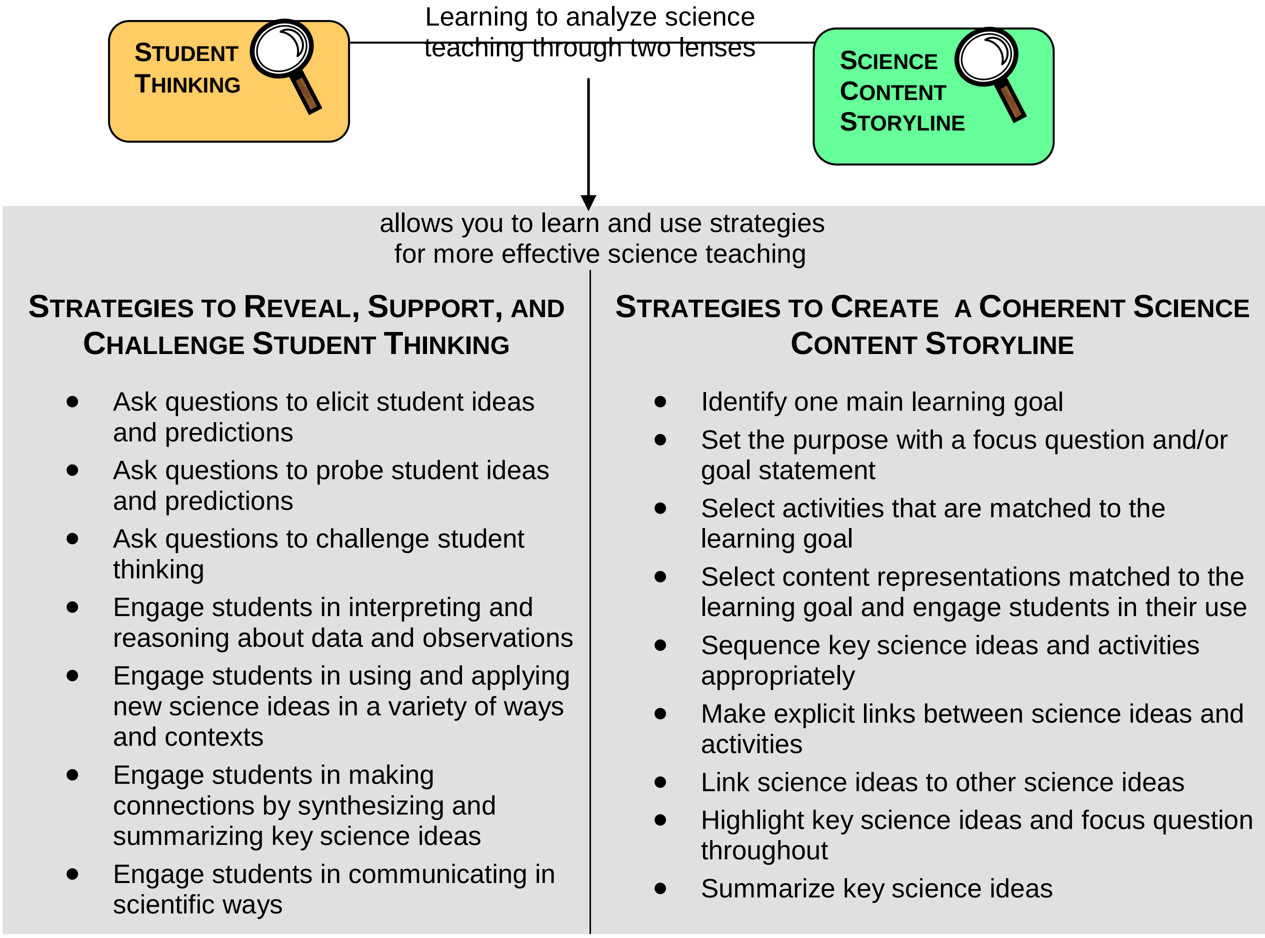
Appendix B. Tables and Figures

Figure 1. **The [Program Name] Conceptual Framework**



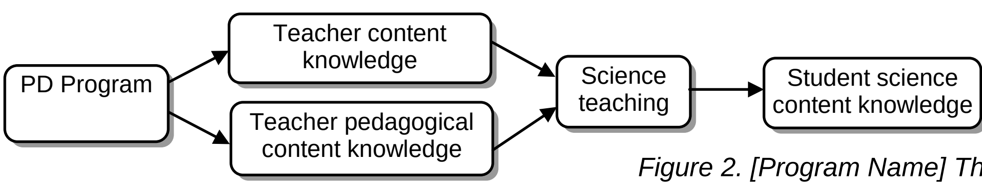


Figure 2. [Program Name] Theory of Change

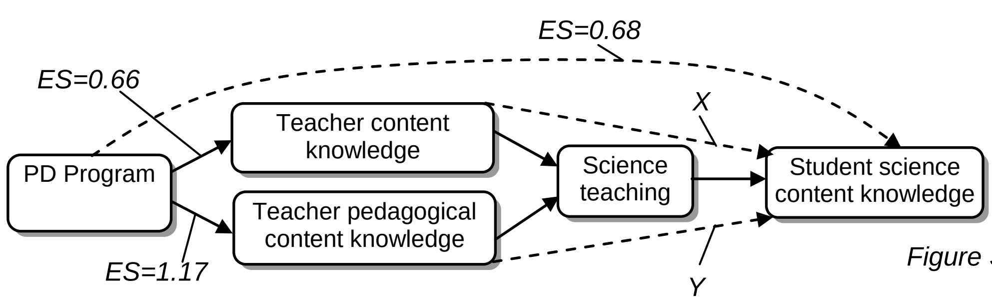


Figure 3. Results