EVALUATING THE IMPACT OF A FACILITATED LEARNING COMMUNITY APPROACH TO PROFESSIONAL DEVELOPMENT ON STUDENT ACHIEVEMENT

The focus of this research was an evaluation of the impact of teacher professional development (PD) on student achievement. We created an environment for teachers to engage in active learning and collaborate with their colleagues while implementing a reform science curriculum for eighth grade electronics. We considered the PD to be an essential element through which teachers would align their practices with the intents of the reform curriculum, and consequently impact student achievement. The PD consisted of five four-hour workshop sessions distributed over the time teachers were implementing the reform curriculum in their classrooms. The research was conducted in a mid-size, urban school district over the span of two years. Three groups of teachers were contrasted: teachers who continued to use the established curriculum (N=5), teachers who implemented the reform curriculum without participating in the PD sessions (N=5), and teachers who implemented the reform curriculum while participating in the PD sessions (N=13). Teachers who participated in the PD had approximately a one standard deviation advantage in their students' achievement over those who did not. We collected evidence of particular features of the PD that explained the differences in student achievement. The features included: distributing the workshops throughout the implementation; engaging teachers in an active learning process situated in the curriculum; and facilitating a collaborative community of teacher professionals. This study led us to believe that not only are the individual features of the PD important, but the combination of all three together is particularly powerful.

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Background and Objectives

Science education reform promises to significantly improve student achievement by transforming the way science has been traditionally taught and focusing on scientific literacy (National Research Council, 1996). The success of this reform movement is dependent upon teachers, who often have learned themselves in traditional settings, sometimes with very little education in science. It is therefore essential to provide science teachers with opportunities to participate in high quality teacher professional development (PD) that is consistent with reform ideas. On the other hand, what constitutes "high quality" PD has not been well defined, and many of the PD opportunities currently available are not sufficient (Borko, 2004).

Much of the research concerned with PD has taken place in contexts other than science. In a mathematics reform initiative, Cohen & Hill (2000) found that most PD available for teachers had very little or no impact on teacher practice or student achievement. Only PD that closely aligned policy, assessment, and curriculum was likely to have an impact. In a review of the research that connected PD with student achievement in math and science, Kennedy (1999) found that the content of PD was of primary importance by comparing effects on student achievement. PD focused on general instructional strategies had very little impact on student achievement, with effect sizes less than 0.20. Content-focused PD that emphasized how students learn particular subjects had a larger impact, with effect sizes of 0.40 and higher (Kennedy, 1999). The available PD opportunities are not equal and the impact that they have on student achievement can vary considerably, depending on the features that are emphasized.

Research surveying national samples of teachers has articulated the features that have the largest impact on changing teacher practice (Guskey, 2000). Among those features include: engaging teachers in an active learning process; focusing on content knowledge situated in a particular curriculum; and having collective participation among groups of teachers with similar goals, such as those that all teach the same unit (Porter et. al., 2003). Taking this research into account, we can begin to understand the impact of PD in the context of reform. We can then begin to measure the importance of particular approaches to PD in terms of student achievement.

The objective of this research is to provide evidence for the necessity of PD when implementing reform science curricula by relating teacher participation directly to student achievement. We will analyze one reform curriculum and its associated PD. Student achievement will be measured by a multiple-choice assessment of conceptual knowledge. We will supplement these quantitative analyses of student achievement with qualitative evidence of prominent features of the PD that led to teachers' enhanced ability to implement the reform curriculum.

Context and Setting

This research was conducted in a mid-size, urban public school district. District leaders identified a need to reform the second half of the existing eighth grade science curriculum focused on electronics. The established curriculum emphasized scripted inquiry and had been in place for five years. In collaboration with district leaders and teachers, university researchers developed the *Electrical Alarm System* module in the winter of 2003–2004 (Doppelt, Mehalik & Schunn, 2005). The reform curriculum was designed to supplement and partially replace the first four to six weeks of instruction in the established curriculum with an open-ended design project (Schunn et. al., 2004; Roth, 2001), because design-based learning has been found to be effective for teaching science (Mehalik, Doppelt & Schunn, 2005; Fortus et. al., 2004; Puntambekar & Kolodner, 2005). In 2004–2005, the district officially adopted the reform curriculum and encouraged all teachers to implement it in their classrooms.

A series of PD workshops accompanied the reform curriculum, distributed throughout the implementation of the unit. Teachers participated in five four-hour workshop sessions.

Two workshop sessions occurred before teachers implemented the module. Two workshop sessions were distributed while the teachers were implementing the curriculum. Finally, a workshop occurred at the end of the implementation as a final reflection on the unit. Distributing the workshops allowed teachers to receive continued, targeted support for their concerns. Having teachers participate as learners emphasized active learning. After teachers engaged in the same process their students would do, they reflected on that experience from an instructional perspective. The workshops also served as a risk-free, collaborative setting for teachers to share ideas with colleagues, including district resource teachers and the university researchers that developed the reform curriculum. Distributing the workshops throughout the implementation, engaging teachers in an active learning process situated in the curriculum, and facilitating a community of teacher professionals were features we viewed as essential for the quality of the PD effort. These workshop features are assessed from video taken at all of the workshops.

Design and Procedure

The study used a covariate design to evaluate the impact of PD on student achievement, comparing teachers from three groups: *Established*, *Reform-No-PD*, and *Reform-PD*. The *Established* group consisted of teachers who continued to use the established curriculum (N = 5 teachers, 405 students). The *Reform-No-PD* group consisted of teachers who implemented the reform curriculum without PD (N = 5 teachers, 274 students). The *Reform-PD* group consisted of teachers who implemented the reform curriculum and participated in PD (N = 13 teachers, 977 students). Although officially encouraged to adopt the reform curriculum and attend the PD, teachers self-selected as to whether they would adopt the curriculum and/or attend the PD, as is typical in many districts. Decisions for or against participating were a complex mixture of positive and negative factors: generally being open to trying new things; wanting to try something new because they were struggling with the old; being content with current student achievement and therefore not needing to try something new; having other existing PD commitments; not being permitted to try something new by the principal; etc. As a result, all groups had a fairly even cross-section of student make-up and teacher make-up. However, to address the potential influence of minor differences, we used an ANCOVA approach, including student ethnicity and free/reduced lunch status as covariates, which are the variables that have the strongest impact on student achievement. We also examined teacher variables (such as certification levels and years of teaching experience), but found no influence of these teacher variables on student achievement.

In order to measure student achievement, we created a six-question knowledge assessment that was designed around core concepts in electricity, such as resistance, current, voltage, and series versus parallel circuits. The assessment was purposely short in order to get as many teachers as possible to agree to implement that assessment.

Findings

What impact did participating in the PD have on student achievement?

We first used an analysis of covariance on student achievement data to calculate the corrected mean student score for each teacher taking into account race and percent of students qualifying for free or reduced lunch. With the corrected means, teachers in the *Reform-PD* group (M=0.49) outperformed teachers in the *Reform-No-PD* group (M=0.40). Teachers in the *Established* group had a mean student achievement of M=0.44, which was higher than the *Reform-No-PD* teachers, but less than the *Reform-PD* teachers. This was not surprising given that teachers from the *Established* group had been using the established curriculum for five years and were very familiar with it. On the other hand, the *Reform-PD* group achieved higher than both groups. Figure 1 presents the means and effect sizes. The effect size of participating in PD versus not participating is greater than one standard deviation, which is a substantial effect size (Kennedy, 1999). A t-test analysis shows there exists a significant difference between mean student scores from the *Reform-PD* group in comparison to mean student scores from the *Reform-No-PD* group ($t(16)=2.09$, $p<0.05$). These results suggest that PD is a large and necessary factor in having reform curriculum positively impact student achievement.

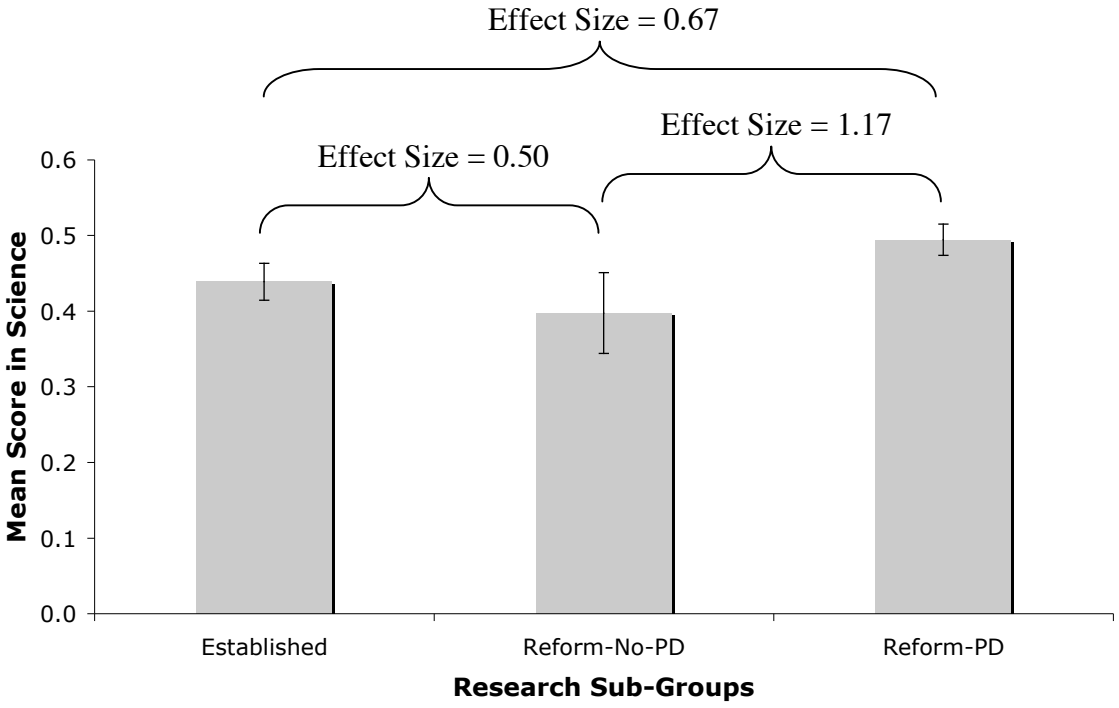

Figure 1: Student mean scores with standard error bars and effect sizes (Pooled SD=0.08).

What did teachers gain from participating in the PD?

The following two qualitative examples from the PD workshops illustrate the features of facilitating a collaborative learning community, engaging teachers as learners, and distributing the PD workshops during the implementation of the reform curriculum. They are representative of the types of interactions that teachers have with the reform curriculum, the electronics content, and the community of teachers. These types of interactions were commonly observed in our PD workshops.

Example 1: Learning to teach and teaching to learn a complex evaluation task. During one of the workshops, one teacher indicated she and her students were confused about a complex evaluation task that uses a decision matrix. This task requires students to rank three solutions in terms of how well that solution satisfies a set of student-generated requirements. It has proven challenging for teachers as well as students.

> Teacher 1: …going back to the matrix. …some of the students are still a little confused on it and after a while I started to get confused myself… How do you rank the solutions with each of the requirements? …I feel like I still need more clarification on that part.

In response, one of the workshop teacher leaders explained at length how she resolved the issue of the decision matrix in her class.

> Teacher 2: Remember the last [workshop] I said the same thing. I was having the same problem [in my class] and the only way we could decide was how we had decided the first [workshop] when you [referring to a district resource teacher who actively participated in all the workshops] were presenting... In our group [during the PD session], we talked about cost and size. And when we factored those things in, only then they [her students] could come up with a solution.

This prompted an extended discussion between several teachers and the workshop teacher leaders. When the discussion concluded, one of the researchers (Researcher 1) reflected on it by explaining that the purpose of the task is to elicit various modes of thinking (e.g., comparative and evaluative) from the students, a cognitive demand that is not often made of students. In this example, multiple players were actively involved in drawing on their experiences as learners while doing the task in the PD and as teachers implementing this task in their classrooms.

The teachers reported that due to this type of learning in a collaborative community of their peers around their specific needs, they could immediately put into practice what they had experienced in PD to assist the performance of their students. Teachers cited this as a primary reason they consistently attended PD sessions throughout the implementation of the reform curriculum.

Example 2: Adapting pedagogy to higher cognitive demand with electronics content. Several of the teachers report that they do not know a lot about electronics and that they attend the PD sessions to learn this content. As an added difficulty, the reform curriculum

has open-ended tasks that require a deep understanding of the content and a flexible use of alternative instructional strategies in order for teachers to scaffold the tasks effectively. In the following segment, a male teacher shared a student's complex circuit design and written description that was generated during his class' open exploration with the electronics components. Everyone in the PD session gathered around to view the circuit and help this teacher understand what his students had done.

> Teacher 3: This student here… I'm sort of not sure what he did... He did this yesterday… Well, for some reason, he hooked just this one battery… He said when he presses the left [switch], the light bulb comes on, and when he presses the right [switch], it doesn't. And together [both switches], it doesn't. So, I didn't have an answer for him. It was at the end of the period.
>
> Teacher 4: Thank goodness for the bell. [Everyone laughs]
>
> Teacher 3: My student tried to explain what was going on here but I don't really understand this. …I told my students, I'll take this to my workshop tomorrow.

Many teachers offered possible explanations. However, as a whole they were still uncertain about how the circuit functioned. Recognizing the confusion among the teachers, one of the researchers modeled an appropriate instructional intervention and suggested the following:

> Researcher 2: …so, if the student was here, I would ask him or her, to try to show the, ah, track of current, via, ah, the wires.

At that point, several teachers successfully tracked the current through the circuit and came to a consensus about how the student's circuit functioned.

> Teacher 3: So we're getting at it. I'm learning with them. This is my first time so I'm paying attention to this.

Having the workshop distributed during the implementation of the reform curriculum gave teachers the opportunity to bring challenging examples from their classrooms. Teachers received help with electronics content, alternative instructional strategies, and decisions about when and where each strategy is appropriate. In this community, the teachers felt safe to admit their limited content knowledge, open to learning pedagogical interventions, and enabled to address their students' questions with confidence. As a result of these experiences, the teachers changed their practice in ways that were more consistent with the reform curriculum.

Conclusion

Many districts do not require teachers to participate in PD when implementing a reform curriculum (Briars & Resnick, 2000), including the district in the current study. When comparing the *Reform-PD* group and the *Reform-No-PD* group, one can see that participating in PD has a large impact on student achievement. These findings lead us to suggest that districts should not implement a reform curriculum without strongly

advocating teacher participation in PD. In addition, the particular features of the PD matter. As mentioned earlier, it is not a given that PD has an impact on teacher practice or student achievement (Cohen & Hill, 2000). Particularly, distributing the workshops throughout the implementation; engaging teachers in an active learning process situated in the curriculum; and facilitating a collaborative community of teacher professionals are effective for successful science curriculum reform. This study further leads us to believe that not only are the individual features of the PD important, but the combination of all three together is powerful. Continued research linking features of PD with student achievement is necessary for achieving sustainable curriculum reforms.

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