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The relationship between science coordinator professional development and teacher change

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Abstract

This study examined how science coordinators who attended PD may have impacted teachers in their districts. We sought to understand if there was a relationship between science coordinator and teacher understanding of inquiry, nature of science, and problem-based learning, and how these understandings impacted instruction. Three cohorts of science coordinators (n=21) participated in PD designed to support and encourage their understanding of inquiry, nature of science, and problem-based learning. Four cohorts of teachers were identified as either treatment (n=103) because they had a coordinator who attend the PD or as control (n=71) because they did not have a coordinator that attended the PD. Data sources included a teacher perceptions survey and observations of teachers in the classroom. This study employed a mixed-methods approach. The study's qualitative components employed systematic data analysis (Miles & Huberman, 1984). The quantitative component used ANOVA to analyze the data. Analysis is ongoing, but preliminary results indicate there is no relationship between a science coordinator and teacher understandings and/or practices.

Introduction

Professional development (PD) has become the key method for improving science teachers' current beliefs and practices in order to meet the needs of new reform efforts (Hewson, 2007). Most frequently, school districts are the primary provider of PD, spending billions of dollars on PD for their teachers each year (e.g., Pianta, 2011). As the primary provider of teacher PD, the literature clearly indicates that school districts play a key role in improving teaching and learning (Corcoran, Fuhrman & Belcher, 2001). However, a district's effectiveness is largely dependent on the decisions of district administrators including science coordinators, math coordinators, testing coordinators, etc. (Firestone, Mangin, Martinez & Plovsky, 2005). In most districts, the science coordinator is responsible for overseeing the science curriculum and PD for science teachers. Researchers call for research exploring the role of educational leadership in science (Luft & Hewson, 2014; PCAST, 2010), yet little of the current science education literature addresses the role of the science coordinator in supporting and facilitating science teacher PD and change. This investigation attempts to add to this area of research.

Ongoing Leadership for Teacher Change

Teachers come to PD opportunities with different backgrounds, confidence, and motivation. The schools and districts they work within have different policies, approaches, and visions. The size, resources, working conditions, and leadership styles of administrators are also unique. District leadership encompasses the roles of staff developers, subject-area supervisors, district coordinators, mentor teachers, school-board members, directors, and community members (Murphy & Hallinger, 1988; Petersen, 1999; Waters & Marzano, 2007). The focus of the present study is on district coordinators whose role is to support teachers in science instruction.

School leadership is a vital part of improving science teachers' instruction through PD and other administrative practices (Banilower et al., 2007; Corcoran et al., 2001) and has a significant impact on student achievement (Marzano, Waters, & McNulty, 2005). Schools lacking effective leadership or with a high principal turnover rate can result in a negative effect on teacher programs (Bollough, Kauchak, Crow, Hobbs, & Stoke, 1997). Characteristics of effective leadership that directly correlated with student achievement, included: monitoring and evaluating school curriculum, instruction, and assessment practices; creating a collaborative culture; working from a well-defined set of ideals and beliefs; maintaining knowledge of and involvement with the curriculum, instruction, and assessment; and forming concrete goals (Marzano et al., 2005). With the influence of district leadership on teachers and student learning, it is imperative to support district leadership in creating PD opportunities for teachers.

In most districts, the science coordinator, usually a district administrator with science classroom experience and an advanced degree in education, is responsible for overseeing PD for science teachers and the development of the science curriculum (Edmondson, Sterling, & Reid, 2012). The literature on science coordinators is meager; and only two investigations specifically address the role of the science coordinator (Madrazo & Hounshell, 1987; Perrine, 1984). Both studies found that different individuals perceived science coordinator's role differently and recommend how science coordinators can be effective in supporting teachers. Perrine (1984) suggested providing teachers with content and pedagogical supports and effective communication with teachers as critical to coordinator effectiveness.

Madrazo and Hounshell (1987) recommended the role of the science coordinator be continuously evaluated in order to understand changing attitudes toward and different perceptions of this role. Taken together, the results of these previous investigations reveal district science coordinators play a role in supporting teacher instruction. They also suggest the science coordinator role needs to be more clearly defined for district stakeholders (e.g. principals, teachers, district administrators), and science coordinators need PD to help them in supporting their teachers. Finally, these studies indicate that there is still much we need to understand about district science coordinators, how they can support teachers and student learning, and how that support impacts what teachers do in their classrooms.

Conceptual Framework

Desimone (2009) proposed a model for studying the effects of PD on teachers and students. This model suggests that PD characterized by content focus, active learning, coherence, duration, and collective participation would lead to increased teacher learning and a change in teacher attitudes and beliefs (Desimone, 2009). Desimone (2009) suggests that the increased teacher learning and changes in teacher attitudes and beliefs will then lead to changes in teacher practice and increased student achievement. There are many studies and reviews of the research supporting this model (e.g. Borko, 2004; Hattie, 2008; Luft & Hewson, 2014; Stronge, 2010; Wallace, 2009; Yoon et al., 2007). However, there is little research connecting the role of leaders and administrators who plan and implement PD to teacher change and student achievement (e.g. Borko, 2004; Little & Wong, 2007; Luft & Hewson, 2014; Whitworth & Chiu, 2015).

In Desimone's (2009) model leaders and administrators are identified as contextual factors influencing the effectiveness of PD. Whitworth and Chiu (2015) suggest a modification of Desimone's (2009) model by proposing that the role of school and district leadership in supporting and providing PD is more integral to the effectiveness of PD and improved student achievement. In this model, the ways in which school and district leadership provide support, both planning and designing effective PD and supporting teachers with resources, feedback, and opportunities for growth are what leads to increased teacher learning and changes in teacher attitudes and beliefs (Whitworth & Chiu, 2015). This study begins to evaluate the validity of this model by investigating if providing science coordinators with PD has an impact on teacher understandings and practices.

Purpose

This study examined how science coordinators who attended a PD specifically designed for them (the SCA) may have impacted the understandings and practices of teachers in their districts.

1. How, if at all, do teachers' understandings of inquiry, NOS, and PBL differ based on science coordinator participation in the SCA PD?
2. How, if at all, do teachers' science instruction differ based on science coordinator participation in the SCA PD?

Methods

This study employs a mixed-methods approach. The study's qualitative components employed systematic data analysis (Miles & Huberman, 1994) and used ANOVA and correlational analysis to identify differences and relationships in the data. Analysis is ongoing.

Context

A mid-Atlantic state-wide PD program for science coordinators served as the context for the present investigation. This PD comprised four components including an elementary PD for in-service teachers (ESI)[1], a secondary PD program for uncertified, provisionally licensed, and licensed first- and second-year secondary (grades 6-12) science teachers (STP), a Science Coordinator Academy (SCA), and PD for science educators (SEFA). The present study draws on participants from the SCA and the elementary PD program. Each of these PD programs were designed to support teachers' high-quality, reforms-based science practices. Another primary goal of the PD was to build infrastructure to support sustained, intensive science teacher PD to increase student performance.

The SCA provided PD for beginning science coordinators (i.e. those in their first five years in the position) across a 5-day institute. The primary purpose of the PD was to help science coordinators learn to support classroom teachers' instruction and, in conjunction with the other components of the broader PD program, foster the development of a statewide infrastructure for science education. The stated objectives of the SCA were:

1. Learn to make improvements in leadership, teacher learning, quality teaching, and student learning.
2. Develop a common understanding of inquiry, nature of science (NOS), and problem-based learning (PBL).
3. Identify aspects of effective science teaching and learning.
4. Compare district models of creating standards-based science curricula.
5. Investigate data sources available to use to provide a focus to improve district science programs.
6. Develop a science program strategic plan.

Over the five days of the Academy, participants engaged in presentations, activities, and discussions that addressed each of these objectives. Each day began with an overview of the topics and concluded with a participant-written reflection designed to help the participant identify what they learned, how they could apply it in their own setting, and to provide the implementation team with feedback. Integrated throughout each day were opportunities for collaboration and discussion. A more thorough description of the SCA and the state-wide PD program's definitions of inquiry, NOS, and PBL are provided in Whitworth (2014).

[1] The study was a randomized control design that included both treatment and control teachers.

Participants

Because we were trying to ascertain the influence of the science coordinator on their elementary teachers' understandings and practices, selection of science coordinators for this investigation was contingent on elementary science teachers from their district in the control condition of the ESI following the science coordinator's participation in the SCA. Across five cohorts of science coordinators, 21 were identified as having elementary teachers from the control condition of the ESI and were included in the present investigation. These 21 science coordinators had 103 teachers (hereafter referred to as "treatment" teachers) in the ESI component of the study. Another 71 elementary science teachers in the control condition of the ESI were included who did not have a science coordinator who attended the SCA (hereafter referred to as "control" teachers).

Data Collection and Analysis

Data for all treatment and control teachers consisted of Perceptions surveys administered at the beginning and end of the school year, videotaped classroom observations, and observation forms.

Understandings. Perceptions surveys were designed to elicit teachers' understanding of key constructs (PBL, inquiry, and NOS instruction) at the beginning and end of the academic year. Face and content validity for the survey was supported by review by a panel of experts with backgrounds in science education and research evaluation. These surveys contained open-ended items that asked participants to define and describe PBL, inquiry, and NOS instruction which were used to identify their understandings of these constructs. Teachers' understandings of inquiry, PBL, and NOS were coded by two researchers based upon a previously validated rubric for not aligned (0), partially aligned (1), and fully aligned (2) for both time points. Reliability was approximately 90% for coding teachers' understandings of all three constructs. Teachers' inquiry, PBL, and NOS codes from the beginning of the school year were tested to ensure differences observed between treatment and control groups were nonsignificant using a t-test so any change could be attributed to science coordinator participation in the SCA. To answer research question one, an ANOVA was used to identify any significant differences in teachers' understandings of inquiry, PBL, and NOS.

Observations. Classroom observations were conducted for teachers four times at regular intervals throughout the academic year, within the same three-week interval for all teachers. Observers visited each teacher's classroom once during each observation period to videotape their science instruction. Videotaped observations of teachers' practice were assessed for the implementation (1) or non-implementation (0) of inquiry, PBL, and NOS for each observation. Observation forms were also completed by each teacher and included self-reported implementation of inquiry, PBL, and NOS three days prior to and following the observed lesson. Teachers also explained why they thought the lesson incorporated inquiry, PBL, and NOS to ensure teachers were actually implementing these constructs in practice. Based on teachers' description of their lessons, the observation forms were coded for presence (1) or absence (0) of inquiry, PBL, and NOS instruction for the context of the observed lesson. Teachers also received a 'teacher thinks' (2) if the explanation of the implementation did not align with the definitions of PBL and NOS described above. Each teacher received a score for each observation window for implementation (1) or non-implementation (0) if either the observation or observation form contained a 1. These scores were then averaged across all observation windows to provide a more comprehensive view of implementation for the academic year. For example, if a teacher was videotaped implementing inquiry in Observation 1 only, and self-reported implementing inquiry in observation 2, her average score would be .5 (2 implementations/4 total observations).

To answer research question two, these scores were used to identify differences between treatment and control teachers' practice using an ANOVA. Of those treatment teachers, correlation analysis was used to determine if teacher practice was related to the science coordinators' years of experience and the years since the science coordinator had participated in SCA.

Results

Analysis of science coordinator understandings are still ongoing; thus, these results represent preliminary findings based on teacher understandings and practices.

Teacher Understanding

There were no significant differences between treatment and control teachers' understanding of inquiry, PBL, and NOS instruction (Table 1). Even though we see no differences between the treatment and control teachers, the means are higher for inquiry than for the other constructs.

Table 1

Participants' Understandings of Inquiry, PBL, and NOS

	Inquiry (SD)	**PBL (SD)**	**NOS (SD)**
Control (n=71)	1.65 (.69)	1.04 (.21)	1.09 (.34)
Treatment (n=103)	1.51 (.60)	1.04 (.25)	1.16 (.39)

All ps>.05. 0=not aligned, 1=partially aligned, 2=fully aligned

Teacher Practice

Overall no significant differences between treatment and control teachers' frequency of implementing inquiry, PBL, and NOS instruction existed (Table 2). While no differences existed, the frequency of inquiry implementation is markedly higher for both treatment and control participants when compared to PBL and NOS instruction.

Table 2

Participants' Average Frequency of Inquiry, PBL, and NOS Use

	Inquiry (SD)	**PBL (SD)**	**NOS (SD)**
Control (n=71)	.38 (.29)	.03 (.10)	.04 (.10)
Treatment (n=103)	.40 (.30)	.04 (.12)	.03 (.10)

All ps>.05. 0=no implementation and 1=implementation

These data also illustrate that these teachers are very rarely, if at all, implementing PBL and NOS. When examining teachers explanations of self-reported implementation of PBL and NOS, around one-third of teachers incorrectly believe they are implementing PBL and NOS (Table 3). While no inferential statistics were performed, teachers whose science coordinator attended SCA appear to have fewer instances of inaccurate conceptions of implementing these constructs. This suggests that science coordinators may be positively impacting teachers' perceptions of their own practice.

Table 3

Percentage of Teachers Who Incorrectly Thought they Implemented PBL/NOS

	PBL (%)	**NOS (%)**
Control (n=71)	37.7	37.5
Treatment (n=103)	34.2	31.3

% Averaged from all four observation windows.

When examining the practices of treatment teachers only, there existed a significant, moderate positive correlation between science coordinators year in SCA and the frequency with which participants' were observed implementing NOS instruction ($r = .234$, $p = .017$). This suggests science coordinators who attended SCA in later years have teachers who more frequently implemented explicit NOS instruction in their classrooms. While not directly measured, this implies that science coordinator PD may have an impact on participants' nature of science instruction. No correlations existed between science coordinators years out from SCA and teachers' implementation of inquiry, PBL, and NOS.

Discussion

The following are possible discussion points based on our preliminary results and findings:

- While unexpected, some of these data indeed suggest science coordinators may impact teachers with whom they work. Science coordinators who attended the last SCA professional development had teachers who were more likely to implement NOS, and science coordinators who attended SCA may have had teachers who had less inaccurate conceptions of NOS and PBL implementation in their practice.
- However, there were no significant differences in teacher understandings or practice. One explanation for the lack of differences between science coordinators who attended SCA and those that did not may be how science coordinators interact with their teachers. We do not have any data to support that science coordinators had meaningful interactions with teachers about their understandings and practice.
- Previous research indicates coordinators may encounter barriers in impacting teacher change (Whitworth, 2014). These barriers include a lack of power to require teacher participation in PD, multiple district responsibilities beyond being a science coordinator, and a lack of focus on science at the elementary level within districts. These factors may be influencing the ability of science coordinators to impact teacher change in the current study as well. We suggest science educators advocate for policy changes to public school administrative structures to allow science coordinators more power in their ability to impact teacher practice
- While we provided PD for science coordinators in this study, the teachers impacted did not receive a targeted PD. It may be that in order to see change teachers must also receive PD. A science coordinator who has received PD may not be a sufficient intervention to impact teacher change.
- According to our data, inquiry understandings and practice were higher than that of PBL and NOS. There are many factors that may influence this finding; however, it is clear understandings of PBL and NOS were weak and rarely implemented in practice. PBL and NOS, if deemed valuable to science educators, may be an area of both science coordinator and teacher PD to focus on in the future.

- The SCA was a unique and novel PD program rarely provided to science coordinators. What is promising is that we did observe a relationship between the science coordinator cohort year and teacher implementation of NOS. This may suggest that as science coordinator PD becomes more well developed, we may see more and larger impacts on teacher practice.
- Future work should examine science coordinators understanding of constructs and how these correlate and relate to teachers' understanding and practice.
- Future work should also incorporate observations of teacher and science coordinator interactions to better understand what and how science coordinators can support teachers' instruction.

Conclusion

A better understanding of how district science coordinators' understanding influences teacher understanding and practices may help us understand how to better support teachers in changing their practice and have implications for the design of PD. It may also suggest the importance of working with science coordinators and incorporating these individuals in the design of PD in order to effect greater teacher change in practices and understandings. However, more research is needed to identify the influence and impact these administrators and leaders may have on teacher understandings and practices.

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