The need for K8 science supervision:
Instructional leadership in the era of reform

Rebecca Lowenhaupt
(Corresponding Author)
Boston College
140 Commonwealth Avenue
Chestnut Hill, MA 02467
rebecca.lowenhaupt@bc.edu
(617)552-0216

Katherine L. McNeill
Boston College

Kyle Fagan
Boston College

Rebecca Katsh-Singer
Boston College

DRAFT: PLEASE DO NOT CITE WITHOUT AUTHOR PERMISSION

Abstract

Purpose. In US public schools, principals are implementing a range of recent policies, including instructional reforms and teacher evaluation systems that elevate their roles as instructional leaders across subject areas. Little is known, however, about subject-specific supervision in instructional improvement. *Methods.* Through interviews with 26 K-8 principals, we examine instructional leadership for science, a subject currently undergoing significant reforms. Transcripts were analyzed using Nvivo qualitative coding software. *Findings.* Our findings showed that science supervision was not a priority; when observed and evaluated, principals reported a 'content-neutral' approach that did not emphasize science-specific aspects of instruction, but rather focused on classroom management, general pedagogy, and student engagement. Principals explained this lack of science supervision in terms of accountability pressures, which emphasized literacy and mathematics, as well as their own lack of science experience and knowledge. *Implications for Research and Practice.* We conclude with implications for future research and practice. (250 words)

Keywords: Instructional leadership; Science Supervision; Standards-based reform; Principal practice; Science teaching

Article type: Empirical, qualitative

Introduction

Given the current policy context, the role of the school principal has shifted considerably, with principals responsible for implementing sweeping instructional reforms in many school contexts (Spillane et al., 2007; Horng et al., 2010). The press toward accountability, proliferation of high-stakes testing, and adoption of curriculum standards have led to substantial change in principal practice, as principals are expected to implement new teacher evaluation systems and lead curriculum reform across subject areas (Camburn et al., 2003; Donaldson, 2009; Hallinger, 2005). Instructional leadership and teacher supervision have become central to the work of the school principal (Camburn et al., 2003; Spillane et al., 2011).

Importantly, the school subject matters for these emerging responsibilities and practices. Instructional policy reform in the US differs by school subject, with emphasis on literacy and mathematics (Burch & Spillane, 2003). Although research has documented substantial subject-matter differences in terms of teacher practice and improvement efforts (Spillane & Hopkins, 2013; Stodolsky & Grossman, 1995), principals are generally responsible for supervising across content areas, regardless of the principal's expertise (Nelson & Sassi, 2000; Sergiovanni et al., 2013). This is particularly challenging in elementary and middle schools, where principals often serve as the primary instructional leader without support from subject specialists beyond minimal support from the district. Despite recognition of distinctions in instruction depending on the school subject (Spillane, 2000), there is a need for further attention to those differences in terms of instructional supervision (Nelson & Sassi, 2005).

In this paper, we consider instructional leadership of K-8 science, a subject which is currently undergoing substantial reform with the recent release of the *Next Generation Science Standards (NGSS)* (NGSS Lead States, 2013).

Unlike most current state standards, these new science standards seek to influence science instruction beyond the content, toward engaging students in the practices of science (Bybee, 2014). These practices have been defined as the social interactions, tools and language that scientists use as they construct, evaluate and communicate scientific knowledge (Duschl, Schweingruber & Shouse, 2007). Currently, k-12 science instruction fails to engage students in such practices in part because of a focus on discrete science facts and a lack of opportunities for students to experience science (NRC, 2012).

As part of a larger study to develop subject-specific supervision materials and training related to these scientific practices, this paper presents findings from a qualitative analysis of 26 semi-structured interviews with K-8 principals. Specifically, we answer the following research questions: How do K-8 principals supervise science instruction? What influences their practice of science supervision? We first situate our work in the current policy context of reform, before describing our approach to the present study. We then present findings from our research, before concluding with a discussion of the implications of our findings for policy and practice.

Framing the Work

We frame our work in relation to the broader context of instructional policymaking that characterizes the last several decades of the educational reform movement. In particular, we anchor our work in the extant literature about the influence of accountability policies and standards-based reforms on classroom practice, with an emphasis on recent science reform efforts. Additionally, we build on prior research about evolving supervision and evaluation policies and practices as they relate to the subject of science. Finally, we briefly discuss sensemaking theory, as it applies to the study of science supervision.

The Era of Accountability & Science Reform

Over the last several decades, education policies in the U.S. have changed considerably with growing emphasis on standards-based curricula and test-based accountability (Booher-Jennings, 2006; Olsen & Sexton, 2009; Mehta, 2013). Often traced to No Child Left Behind (2001), the accountability movement actually pre-dates this particular federal policy, with roots dating several years earlier (Au, 2011; Mehta, 2013). The influence of these policies on classroom practice has been well-documented, with increased time spent on testing (Valenzuela, 2005), narrowing of the curriculum to tested topics (Au, 2007), and reliance on test-scores to drive decisions about teaching and learning (Booher-Jennings, 2006).

Recent education reforms have expanded accountability policies to an unprecedented degree. For example, the implementation of a national set of standards and assessments associated with the “Common Core” (Porter et al., 2011), as well as “Race to the Top”, which tie high-stakes decisions regarding school turnaround and teacher evaluation to standardized test-scores (Mehta, 2013; Pullin, 2013). Although the most current iteration of national education policy, ESSA, has tempered the federal role in these initiatives somewhat, practices at the school level have been fundamentally influenced by this era of accountability and standards-based reforms (Klein, 2015).

Importantly, these accountability reforms have not been content-neutral; indeed, they have elevated some school subjects over others, with an emphasis on literacy and mathematics as core content areas within the accountability system (Au, 2007; Spillane, 2005). However, recent efforts have sought to address other content areas. In particular, various STEM and STEAM initiatives have brought science and engineering into the fore (Bybee, 2014). In response to this renewed emphasis, the NGSS have emerged as a key set of standards promoted by professional organizations and aligned with the Common Core State Standards (NGSS Lead States, 2013).

This new set of science standards focuses on engaging students in the practices of science both to learn important content and develop more accurate understandings about how scientific knowledge develops (Bybee, 2014). As such, it represents a transformation in the goals of science education in the United States. The NGSS aim to shift science teaching and learning away from teacher-dominated discourses and instruction, and toward students constructing and critiquing knowledge in ways similar to scientists (Krajcik et al., 2014).

Within this policy context, the role of the school principal has shifted considerably (Lowenhaupt, 2014; Mintrop & Sunderman, 2009; Valli & Buese, 2007). Recent work has found that many administrators transform the formal school structure by designing new organizational routines that embody accountability and facilitate coupling between instruction, administration, and policy (Spillane et al., 2011). In particular, principals have been responsible for implementing new systems of teacher supervision, which bring greater accountability to teacher observations, feedback, and evaluation (Camburn et al., 2003; Donaldson, 2009; Hallinger, 2005). Below, we examine instructional supervision, before turning to a discussion of the present study.

Instructional Supervision

School principals wear many hats within schools, but their role as 'instructional leaders' has recently received significant attention from policymakers and practitioners alike (Ylimaki, 2013). At the same time, there remains much to learn about the knowledge principals draw on to successfully navigate their roles across subject areas (Stein & Nelson, 2003). Recent scholarship has sought to develop a construct of "Leadership Content Knowledge" (LCK) to determine the cognitive underpinnings of instructional leadership and define the knowledge principals draw on to improve instruction, including subject-specific knowledge as well as knowledge about how to support teacher learning (Overholt & Szabocsik, 2013; Stein & Nelson, 2003). Although a few have focused on LCK in the context of mathematics (Nelson & Sassi, 2005; Stein & Nelson, 2003) and literacy (Overholt & Szabocsik, 2013), there have been no such investigations of leadership for the subject of science (Halverson et al., 2011).

This is increasingly important in the current context of education reform, which requires principals to lead ambitious school improvement efforts (Darling-Hammond et al., 2008; Horng et al., 2010; Goldring et al., 2008; Lortie, 2009; Lowenhaupt, 2014). An emerging body of research has established a positive relationship between principal practice and measures of student achievement, particularly in relation to the principal's 'instructional leadership' (Leithwood & Mascall, 2008; Leithwood et al., 2009; Spillane & Hunt, 2010). Although instructional leadership has long been considered part of the principalship (Hallinger & Heck, 1996; Hallinger, 2005; Ylimaki, 2013), recent education reforms have moved instruction to the center of principal practice (Leithwood et al, 2009). As education policies associated with accountability and standards-based reform have required US public schools to engage in large-scale instructional improvement efforts (Mehta, 2013; Spillane et al., 2011), the role of the school principal has shifted away from pure administrative tasks (Firestone, 1985) and towards the core technology of schooling, instruction (Spillane and Hunt, 2010).

Taken together, these reforms focus principals on instructional leadership in the form of teacher supervision, generally considered to include formative teaching observations and feedback, teacher evaluation, and support for professional learning (Camburn et al., 2003; Glickman, 2002; Sergiovanni et al., 2013). These supervision responsibilities have been a longstanding aspect of instructional leadership (Hallinger, 2005; Marks & Printy, 2003), all the more critical in the policy context of mandated curriculum standards, accountability, and teacher evaluation (Donaldson, 2009; Sergiovanni et al., 2013). Traditionally, principal supervision has been critiqued as superficial and compliance-oriented, characterized by infrequent observations, meaningless checklists, and watered-down evaluations supporting a "culture of nice" (Marshall, 2009; Sergiovanni et al., 2013). However, new systems of teacher evaluation promote a more rigorous supervision system of formative and summative observations to provide ongoing feedback to teachers linked to curriculum planning and instructional improvement (Bambrick-Santoyo, 2012; Marshall, 2009). Principals are now asked to conduct frequent formal and informal classroom visits to view typical teaching in action and gather evidence to provide ongoing feedback for teachers to improve their instruction (Marshall, 2009).

This shift in supervision practices has been accompanied by a proliferation of practice-based resources designed to support ongoing observation and feedback. For example, some have developed rubrics for observation to clearly identify areas of improvement (Glickman, 2002); the most commonly used is known as, "the Danielson framework" (Danielson, 2002). Additionally, resources related to providing feedback scaffold principal conversations with teachers about teaching and learning (e.g. Bambrick-Santoyo, 2012) as well as a wide-range of checklists, tables, and technology-based applications to help principals manage these new duties of instructional supervision (Marshall, 2009; Ribas, 2005). While these materials offer valuable resources for principals, a critical analysis reveals two important features relevant to the present study. First and most striking, these tools are designed to offer generalized support for instruction, broadly defined; none of the leadership frameworks or tools consider subject-specific features of supervision. Although researchers have long acknowledged distinctions in teaching and learning depending on the school subject (Shulman, 1986; Spillane, 2000), this has received little to no focus in the design of these new supervision practices. Arguably, the nature of principals' understanding of the subject is important for the ways in which they exercise instructional leadership and supervision (Nelson & Sassi, 2005; Spillane, 2005). Second, these new systems of supervision focus on what principals ought to *do* without first considering what it is principals need to *know* (Nelson & Sassi, 2005). In the context of instructional reform, teachers' existing and emergent knowledge has been established as crucial to adopting new practices (Cohen, 1990; Shulman, 1986). However, little is known about how principals construct knowledge about instructional reforms. This is all the more important for principals responsible for supporting teachers' development of new instructional knowledge and skills.

In terms of the subject of science, the NGSS represents a tremendous instructional shift for science teachers, especially related to the practices of science (Bybee, 2014). Principals' supervision of teachers will impact the learning opportunities of teachers (Horng et al., 2010; Nelson & Sassi, 2005) and influence whether the goals of the NGSS can be met. However, research and theory about the role of principals and leadership in the context of science education is limited, although some studies indicate that they have limited knowledge about how best to support teachers' learning about science (Halverson et al., 2011). Elementary school leaders have been found to be more involved in discussions related to English language arts than mathematics or other school subjects (Spillane, 2005). However, the demands of science reform require substantial instructional leadership in support of a shifting vision of science teaching and learning at the K-8 level.

Sensemaking Theory

Our methodological approach is anchored in prior research on curriculum reform and instructional supervision, as we seek to understand the subject-specific supervision practices related to K-8 science. We draw on sensemaking theory to interpret the ways in which educators adapt to policy reform (e.g. Spillane, 2004). In this context, a sensemaking approach studies how policy implementation is influenced by the cognitive process of interpreting and making meaning in relation to existing knowledge and/or practices. As Spillane (2004) explained, “the new is always noticed, framed, and understood in light of what is already known” (p. 76). In the midst of instructional reform, teachers’ existing and emergent knowledge has been established as crucial to adopting new practices (Cohen, 1990; Shulman, 1986). Previous waves of instructional policy reform have shown that implementing such reforms relies on deep teacher learning and a shift in teachers’ knowledge and beliefs about the reform (Cohen, 1990; Spillane, 2004). Support for reform comes from embedded, ongoing professional teacher learning supported by strong instructional leadership, generally overseen by the school principal (Bredeson, 2003; Hallinger, 2005; Lowenhaupt et al., 2014). Yet principals often lack the necessary knowledge, resources, and skills to make sense of such reforms, particularly in science (Halverson et al., 2011; Spillane, 2005). As we enter an era of science reform, motivated by the implementation of the NGSS and the Common Core State Standards, we explore principals’ current practices and understandings of their roles in the supervision of science, before considering their implications for principal sensemaking about these reforms. First, we describe the empirical methods used for this study.

Methods

Study Context

This study used a purposive sampling method of public school principals in elementary, K-8, and middle schools in Massachusetts. At the time of the present study, the Massachusetts Department of Elementary and Secondary Education was in the process of adapting the NGSS to create a similar set of standards and initiate statewide science reforms. At the district and school levels, administrators were aware these changes were underway, but had yet to receive specific information or mandates related to standards implementation.

Additionally, and relevant to instructional supervision, another major policy reform had just been implemented, leading to the design and roll-out of new evaluation systems as part of the Massachusetts Model System for Educator Evaluation (DESE, 2014). The new evaluation system substantially increased the frequency of classroom observations, with additional requirements related to the documentation of classroom practices, as well as incorporating test scores to evaluation processes. The system promotes a cycle of continuous improvement with five stages: (1) self-assessment, (2) goal setting and plan development, (3) plan implementation, (4) formative assessment and evaluation, and (5) summative evaluation. Central to these stages is the placement of student learning at the center, using multiple measures of student learning and growth, and shortening the timelines for improvement. At the time of the study, principals were in the midst of either their first or second year of using the new system and identified this as a crucial aspect of their supervision practice.

Sampling

Using state data, we identified a range of districts based on 5th grade science MCAS scores, the percent of students identified as low-income, and the percent of students identified as English language learners. We chose districts that represented different points along this continuum in an effort to capture various school contexts (See Table 1). The six districts in the study included both urban and suburban districts. They ranged in size from more than 120 schools to only 8 schools. In addition to relatively high-performing districts in terms of science achievement test scores, we also included some districts with low performance as well.

Within these districts, school principals were invited to participate in the study by email. Schools in which they worked were roughly representative of their districts and included elementary, middle, and K-8 schools. Table 2 outlines the demographic information of interview participants (N=26). Most of the principals (85%) in the sample were veteran principals, with more than 5 years of experience as administrators. However, four principals (15%) had fewer than 5 years of experience. Not surprisingly given national trends, the majority of principals in the study identified as white, with a minority of 7 principals (27%) who identified as African American or Latino/a. Similar to the demographics of elementary school principals, there were more women in the sample, though 10 men participated (38.5%). While 3 principals had a background in the sciences (11.5%), the vast majority had no formal training in science beyond what they received in their teacher training coursework.

This method of purposive sampling yielded a range of principal perspectives and experiences with science supervision. However, it is important to note that we did not seek or achieve a representative sample of Massachusetts's principals. For example, we did not interview any principals from the many small, rural districts in the state. As such, it is important to note that we cannot generalize to the population of principals supervising science at the elementary, middle, and K-8 schools, although we hypothesize that a representative sample would likely yield similar findings.

Data Collection and Analysis

To explore current principal practices related to science supervision, we conducted semi-structured interviews. These interviews allowed for probing and eliciting in-depth responses (Strauss & Corbin, 1998). Interview protocols were developed as a research team; we piloted questions with practicing administrators to ensure relevance and interpretability in the field. Each interview lasted approximately 40-60 minutes and included four different sections: general supervision practices, science supervision practices, the infrastructure for science, and responses to video clips of K-8 science instruction. All interviews were audio taped, transcribed, and coded using Nvivo, a qualitative coding software. A background survey that collected demographic information about the participants was administered prior to the interview.

Data analysis identified relevant themes and common practices associated with science supervision. An iterative, open-coding process was used to generate substantive categories and identify salient themes across interview transcripts (Strauss & Corbin, 1998). Once an initial set of codes was developed, independent raters coded a random subset of transcripts (approximately 20%) to calculate interrater reliability and resolve differences through arbitration. For the purposes of this paper, we focused primarily on the science supervision section of the interview. Findings were drawn from codes related to the focus of science supervision and prior principal experiences with science. Table 3 includes a list of codes, definitions, and interrater reliability, as measured through Nvivo's Coding Comparison Report of the Kappa Coefficient.

Findings

In what follows, we share results from our analysis. First, we discuss how participants described their supervision of science, consistently reporting the marginalization of science in relation to other subject areas. Second, we consider the influences on this lack of an emphasis on science, presenting factors relevant to this finding about supervision. We then turn to a discussion of the implications of these findings for science reform efforts.

Minimal Science Supervision

To answer our first research question, we explored the ways in which principals responded to the question of how they supervised science instruction. Not only did they describe very minimal attention to science, but they also described taking what we call a ‘content-neutral’ approach to the supervision of science. In terms of supervision practices such as classroom observation, providing feedback to teachers, and professional goal-setting, the subject of science was rarely emphasized. We discuss this finding in detail below.

“It’s not something we’ve really ever focused on”

First, we found that almost all of the participants referred in some way to the marginalization of science in the supervision process, which prioritized literacy and mathematics. Out of 26 participants, 16 (62%) explicitly referred to having either minimal or no emphasis on science supervision. As Principal 7 put it, “It’s not something we’ve really ever focused on.” Another participant, Principal 18, acknowledged, “I do believe, at this school, we value good science instruction, but I can’t say that I'm placing that value in my supervision.” Although participants recognized the importance of the subject, they pointed out time and again that they did not find themselves prioritizing science as a subject for supervision.

This lack of emphasis on science was identified across various supervision practices. In particular, principals noted that they rarely observed science classrooms, unless they were supervising science specialists. At the heart of teacher supervision is the process of observing instruction and providing teachers with feedback about that instruction. Although participants identified this as a crucial aspect of their supervision practice, the majority of them admitted that they rarely, if ever, observed science as part of this observation process, unless teachers were designated science specialists. For example, as Principal 3 noted, “You’re going to shudder. This is my fifth year. I typically let teachers pick what lesson they want me to come in and observe…I’ve never had a teacher say come in and watch me teach a science lesson.” As Principal 14 explained, “I visit science classes occasionally. I don’t think I’ve actually observed one for evaluation in probably the whole time I've been here." Despite spending some time in science classrooms, the formal observation of science was reported as extremely rare.

Not only were teachers not electing to be observed for science as Principal 3 explained, but there was also evidence of principals prioritizing other subject areas to observe, primarily literacy and math, the two subjects which were the focus of district and state accountability systems at the time of the study. For example, Principal 1 pointed out, "I don't specifically go in for science. I tend to go in more for literacy and math just because the emphasis is there right now." This emphasis on literacy and math resulted in a lack of science supervision, not only strategically, but also incidentally as an artifact of the informal, unplanned observations, which principals were required to conduct as part of the new evaluation system. Principal 8 explained, "I'm much less likely to actually even see it happening, as I roam the building and randomly drop in on classrooms. Like I said, it's 90 blocks of 40 minutes in a given year, and it's the first thing to go, when there's this, that, or the other that needs to happen, or we forgot and need to catch up or whatever." Other principals noted similar trends, explaining that science was rarely observed, not only because it wasn't a priority for supervision, but also because it was a rare occurrence in the schedule, which privileged literacy and mathematics instruction.

In addition to reports of minimal observations of science, principals also described a similar lack of science in the goal-setting process with teachers. Another aspect of the new educator evaluation system requires that teachers set improvement goals. Principal 1 explained when asked about science in teachers' goals, "Not for their—not for the educator evaluation (goals). It's all either math or literacy. In fact, it's probably more literacy, actually now that I think about, this year, more literacy than math even." Given the interconnected system of educator evaluation, this lack of goal-setting about science impacted the observation practices.

For example, Principal 7 noted this in her emphasis on observing literacy, explaining that, "Because I have all their schedules. I know that their goals and most of their work is aligned to literacy so that's when I'm going in more." This principal emphasized alignment in her supervision process, and worked backwards from test scores to observation to goal setting, developing goals around test-based outcomes, which emphasized literacy.

Taken together, these results illustrate the multiple ways in which principals marginalized science in the supervision process. This minimized supervision stemmed from multiple facets of the evaluation system, including both teacher observation and goal-setting, as well as accountability systems and class schedules which privileged literacy and math over science. Overall, we found a general lack of priority placed on the supervision of science, as compared to other school subjects.

"Good instruction is good instruction"

Importantly, principals did not report a complete lack of science supervision. Although minimal, all principals noted that there had been times when they supervised science, albeit rare. When asked to reflect on those times in the interview, principals highlighted aspects of instruction that occurred across content areas, taking what we termed a 'content-neutral' approach. As such, the extent to which they supported science instruction focused on general aspects of teaching and learning, rather than content-specific support.

In terms of classroom observations, several principals remarked that they tended to notice features of instruction which were important for good teaching in general, rather than specific to science. As Principal 14 put it, "Good instruction is good instruction." This idea of recognizing good teaching when one sees it, regardless of the content, was echoed by 10 participants (38%). For example, Principal 1 explained, "When I do observations, it is—how do I say? I can't say that it differs drastically from what I tell anybody in terms of what good practice should look like." Similarly, Principal 7 explained, "If you can use good teaching strategies, and your focus point is clear, students are engaged, there's something that you know students are getting it, whatever it is, I don't really care what content area it is. I'm not thinking I need to know everything about that particular content because I can see good teaching." These principals identified their role as supervisors in a content-neutral way, defining their responsibility in terms of promoting a general vision of good instruction, regardless of the subject.

This is not to say that participants didn't identify particular features of 'good teaching' that anchored their supervision practice. In many cases, these features echoed those embedded within the supervision system and are generally recognized as crucial components of effective instruction. For example, Principal 9 explained, "I don't think it's really different because we're looking for clear objectives. We're looking for the students to be actually living the objectives, meeting the objectives, being engaged in the work, differentiated for kids who are having difficulty and kids who are able to do more. We're looking for positive interactions with the students. We're looking for a classroom that's got routines set up and is a safe learning environment. I mean, all of those things you're looking for no matter what the lesson is." Although not subject specific, Principal 9 identified certain aspects of instruction that she hoped to promote across content areas to support student learning. Several others identified similar components, including the importance of clear objectives, meaningful assessments, student engagement, and classroom environment as key elements of their supervision. Additionally, a few spoke about ensuring differentiation and support for particular student needs. As Principal 5 put it, "Rearranging supports if that's what's needed, troubleshooting around specific students we do a lot of." As such, this content-neutral approach emphasized particular pedagogical features and supporting individual students, but rarely engaged with subject-specific practices or content.

To a certain extent, this approach seemed aligned with and encouraged by the design of state and district supervision tools. For instance, the teacher evaluation rubric focuses on four standards: (I) Curriculum, Planning, and Assessment; (II) Teaching All Students; (III) Family and Community Engagement; and (IV) Professional Culture. This rubric has been adopted by local districts with slight adaptations and promotes a content-neutral approach to supervision. As six principals noted, the rubric was itself designed to be 'content-neutral', so as to align with the range of teachers who needed to be evaluated. For example, one principal explained, "I mean they're exactly the same. I don't—the rubric is not in any way catered to science. I think again it's good instruction. I think that they should—good instruction is good instruction" (Principal 22). As this quotation explained, the rubric used to evaluate teachers emphasized features of instruction that were generalizable across subject areas and promoted the assertion that 'good instruction is good instruction.' Another principal explained, "I think our rubric definitely fits any category of what you're teaching. It's not specific to any curriculum. The science, it would fit beautifully in there….It's just about planning, and assessment, and responding to students. It would fit. I don't need anything in addition to it. We just need the science to happen" (Principal 16). For these principals, the rubric was designed with an appropriate ambiguity that allowed versatility in use and anchored observations in particular features of effective instruction.

Within this rubric, disciplinary differences were not accounted for, unless those using it adapted it to the content. As Principal 11 explained, "For example, all the teachers have the same teacher rubric when it comes to the evaluation system. When I go into [Teacher]'s class, I just tailor it to science instruction. There's not a specific, "This is what you use for science teachers.

This is what you use." It's a specific rubric for all teachers, and then we kind of have to tailor it based on where we are." As such, the tool relied on the expertise of supervisors to adapt their interpretations of instruction based on their content-area expertise and without subject-specific scaffolding by the evaluation system.

It is worth noting that although the majority of principals acknowledged their use of content-neutral approaches, several problematized this practice, recognizing the limitations of not supporting teachers with content-specific feedback and supports. These principals explained that they were not opting for a content-neutral approach, but rather were falling back on it because they simply did not know how to provide content-specific feedback. For example, Principal 15 explained, "I feel pretty confident about going in and looking at solid instructional practices, in general, that are relevant and applicable to—across content areas. When it comes to content-specific kinds of things, I am not as confident about specific strategic moves that teachers can make to support specifically that content, nor am I adept at helping teachers zero in on what's most important here." Similarly, Principal 14 remarked that she did not know how to evaluate for subject-specific elements of science. She said, "I can look at instructional practices in science, but it's hard for me to evaluate was this a really good lesson? Is this what's important to be teaching kids? I can look at kind of the pedagogy; I can look at the components of a good lesson, but the background knowledge that is important to have, I don't have." These principals recognized their own limitations when it came to supervision; they relied on their general knowledge in instruction because they lacked content-specific expertise.

This presented limitations in terms of advancing and evaluating content-area reforms. Principal 30 recognized the challenge of influencing reform without providing content-specific support. She explained that at her school, "you have a person with a good knowledge of students and an idea of what an effective classroom looks like, and very little science content expertise visiting a class. I think, therefore, there's probably pretty low pressure on the teacher to do better, because in general that supervisor knows way less about what's going on in there than the teacher does." While supervisors can provide some insight into improvement, without content expertise or focus, teachers have little incentive or support for substantial changes in practice.

With a few notable exceptions which we discuss later, principals did not focus on science-specific features while conducting observations and providing feedback to teachers. In other words, when they did on a rare occasion supervise science, they shied away from the science. As such, not only was there little emphasis placed on science supervision, but also principals generally did not provide subject-specific feedback to teachers, even when they did observe science. Next, we turn to our findings about why science-specific supervision was so limited among participants in the study.

Influences on K-8 Science Supervision

To answer our second research question, we examined factors influencing the lack of science supervision described above. We found that the emphasis on literacy and mathematics in the accountability system, as well as a lack of science experience and expertise among principals led to the marginalization of science supervision. We discuss each in detail below.

"It's all reading and math. Science, nobody even looks at…"

Overwhelmingly, principals identified aspects of the accountability system that marginalized the subject of science and led to minimal science supervision. In fact, all except one principal (96%) highlighted the role of accountability pressures, which led them to prioritize literacy and mathematics over science. In addition to state-level tests and evaluation policies, they also identified district-level priorities as influences, as well as limited time for the teaching of science in the early (and untested) grades.

The importance of statewide standardized tests was echoed across interviews. As one principal noted, the focus of school improvement efforts are “really based on what [the state test] is because that’s all we’ve really had to direct it per say, to backwards plan from that” (Principal 7). Another principal explained that, “If there’s no test, people don’t pay attention to it. As much as I hate [the state test]…I know. I’ve been around long enough. If they don’t test it, it gets neglected” (Principal 3). These principals, among others, explained that district priorities were set by the policy context, and more specifically, by the standardized assessments which determined their focus.

In terms of school subjects, this meant that science became slightly more important in fifth and eighth grade, when standardized science tests were administered by the state. Even so, as one principal explained, “Hypothetically, if we bomb science and do well in ELA and math, we are a high performing school. That is the reality of where we are in education” (Principal 10). Despite the state science tests, literacy and mathematics were clearly prioritized among school subjects, particularly in the elementary years. For example, Principal 22 explained, “You just don’t have the time. The accountability right now is on your reading and your math scores. Science, nobody even looks at…Here’s the new standards. Here’s the new test. We’ve got to pass it.” As Principal 24 put it, “I would say the science supervision in the elementary school is close to non-existent because again, living in such a test driven context at the moment…drives me and my fellow administrators to focus on the areas that are heavily assessed, which are math and ELA.” Although science was no longer untested as it was in the past, the accountability system continued to privilege literacy and mathematics. Across interviews, principals emphasized this, “hierarchy of content that exists” (Principal 15).

Though originating with state assessment policies, this focus led to district-level priorities to improve test scores in literacy and mathematics. As one principal explained, “The heavy emphasis, especially district-wide. There isn’t a lot around, in terms of like—so, at the district level, the district has specific focus lessons and common assessments that the expectation is every single teacher delivers the common assessment, and that occurs in ELA, in reading, writing and math. There’s nothing like that in science” (Principal 1). Another principal explained, “All of your accountability at this level is reading and writing and math...When the district, when the superintendent gives his [state test] presentation to the School Committee, it’s all about reading and writing. Science is just like *[whispering]* it doesn’t matter” (Principal 8). Several principals identified the role of the district in promoting the subjects of mathematics and literacy in terms of professional development resources, setting benchmarks, and directing time and expertise toward them.

As a result, science was not taught nearly as often as literacy and mathematics in most of the schools in the study. This also led to a lack of science supervision, as principals rarely found themselves in classrooms where science was being taught. For example, one principal explained, “It’s happened that I’ve been in the classroom where science is being taught, but if I’m not looking to see science, and I’m—it’s just going to be random. Chances are, just statistically, it’s going to be math or literacy in some way, and even if it is what they’re calling science, it’s going to be reading or writing about a science content” (Principal 16). This principal recognized that within this accountability context, science (and social studies) were viewed as subjects in the service of literacy and mathematics, which were elevated as clear priorities. With additional blocks for literacy and mathematics, several principals reported that science (and social studies) were taught only a few times a week and often for only half the year. As a result, science was neglected, not only in terms of classroom time, but also within the supervision process.

It is important to note that several principals recognized a shifting policy context which they thought might foster an increased emphasis on science. For instance, three principals remarked that implementing the Common Core had already led to an expanded emphasis on the content areas. As Principal 28 explained, a new set of science standards had the potential to push this shift even further in the direction of greater resources and support for science. He explained, “Then there’s the opportunity to pair other standards with that when it comes out, right. We’re looking at Common Core standards, plus we’re looking at the district effectiveness for teacher effectiveness rubric. You’re pairing those two things together. It’ll be nice when the science piece comes out to pair that together, as well” (Principal 28). These principals were hopeful that implementing the new standards, coupled with the push for subject-specific literacies in the Common Core, might support a renewed focus on the subject of science.

“I’m not a scientist”

In addition to an accountability context that privileged literacy and mathematics, principals acknowledged their lack of expertise in the subject of science. Although there were a few principals with a background in science, 17 participants (65%) cited their own shortcomings when it came to relevant experiences, knowledge, or capacity to supervise science. As Principal 11 put it, “I’m not a science person, so I’m not even close to an expert.” Another principal remarked that, “none of the administrators have science backgrounds, so right out of the gate, we're at a tough place because no one has the content knowledge” (Principal 13). Several principals noted their expertise in literacy or mathematics, but the lack of science expertise emerged as a clear theme among participants.

In fact, a few principals shared that they actively disliked or were disinterested in science. They attributed this to their own negative experiences as science students. For example, Principal 8 explained,

> As a student, I sucked at science…I was awful because I couldn't remember everything. I couldn't remember, to save my life, the parts all the anatomy of the heart that I had to diagram, in seventh, grade for the test. That was science. I wasn't getting to cut apart a pig's heart and take it apart and look at it. I wasn't getting to do that, so my science life was very much grounded. The same with the high school, oh, my god, chemistry, biology, that kind of stuff. I passed, but, as a student, I was terrible. It was so bad, so I had no interest in pursuing any kind of career or further study in the sciences.

Prior negative experiences with science contributed to a lack of interest and expertise in the supervision of science.

Not only did principals describe a lack of interest in or experience with science in the past, but there also appeared to be a dearth of opportunities to learn about science through in-service professional development or training. Principals spoke about their districts' neglect of the subject of science in relation to developing capacity among supervisors and teachers. As one principal described, "I think over the last ten years, I've never gone to a [district training] where there was any professional development on science." (Principal 22). Another aspect of the privileging of literacy and mathematics was the need to expand opportunities to develop expertise in other subject areas.

Without background or learning opportunities about the subject of science, principals lacked confidence in their abilities to supervise science. As one principal put it, "I don't necessarily feel confident. Math, I can figure out the answer. I can do the math. We can debate the strategies or the way they explained it. The literacy stuff—I feel better equipped to say, "This is what I'm seeing from the kids," but the actual content in science makes that difference. I can see a lesson that looks terrific in a lot of ways; teacher making a lot of moves, kids picking up a lot of stuff that they want—and it could be the wrong…I have my own knowledge limitations" (Principal 15). This principal, among others, worried that their lack of expertise limited their ability to supervise teachers in the content area of science.

This lack of capacity in science supervision likely explains the content-neutral approach to supervision described above. Without experience or district support for science-specific instructional practices, they relied on theories of good teaching in general when required to supervise science. As Principal 30 remarked, "It's hard to be a great supervisor when you don't have that much content expertise. You have people end up talking much more about the student, and management, and stuff than about the science learning experience that's being created, just because they don't know as much about it. None of our administrators have been science teachers." An accountability context which deprioritized science, as well as a lack of capacity to supervise science, presented substantial barriers to the improvement of science instruction. Below, we discuss these findings in relation to current reform efforts and the role of supervision in implementing them.

Discussion and Conclusions

Prior work has shown the important role the principal plays in the implementation of curriculum reform (Spillane, 2004). Instructional leadership has been viewed as a key lever for such reforms, with increasing responsibility on the principal to support teacher learning and growth (Camburn et al., 2003). In the context of new evaluation policies, which require principals to engage even more in the supervision process via classroom observations, teacher feedback, and goal-setting, principals are central to instructional reform efforts in multiple subjects. However, as our study showed, principals are better equipped for this role in some subjects more than others, at least in K-8 schools. Here, we first discuss our findings in this regard, before concluding with implications for policy and practice.

Notably, we found that principals shied away from the supervision of science, not only due to an accountability context that prioritizes literacy and mathematics, but also because of a lack of subject-specific expertise. These factors, among others, contributed to the marginalization of science at the K-8 level and hindered the supervision of science. For the most part, principals in our study reported that they relied on their general knowledge of good instruction when supervising science. This yielded a ‘content-neutral’ approach to supervision that did not take into consideration the disciplinary-specific features of science instruction. Undoubtedly, they drew on considerable expertise about pedagogy and instructional design that supported teachers in many ways with their instruction. We do not disagree that these are important considerations when observing any classroom. However, although they attended to such crucial features of instruction as student engagement and differentiation, we would argue that to support the implementation of deep subject-specific reforms, this content-neutral approach is not sufficient.

In fact, this is problematic for several reasons. Good teaching in a literacy classroom does not look the same as good teaching in a mathematics or science classroom. Subject-specific differences inform pedagogies in the classroom and require distinct expertise for supervision (Stein & Nelson, 2003). We argue that supervisors need to understand the specific features of good ‘science’ teaching. Otherwise, they may not recognize good instruction when they see it, nor will they know how best to provide feedback and support to teachers so that they can improve their use of the science practices. Our work on implementing the science practices suggests that a science classroom might look like a very strong class, if one observes for pedagogy, or even for literacy, as several participants mentioned they did. However, with training and expertise in the science practices, principals might draw on this lens to foster and support their use in classrooms, supporting the transformation of science classrooms into more than just another opportunity to practice literacy skills.

Our findings showed that for the most part, these principals identified a lack of expertise in science that resulted in this content-neutral approach to supervision. In other words, if they knew more about science and the science practices, they would supervise for science. Several participants explicitly said as much, noting that in lieu of content expertise, they relied on their knowledge of general best practice, although they recognized this as a limitation.

We did not explicitly explore whether or not they face similar limitations in other subjects, but many of the principals in the study did identify literacy and literacy strategies as an area of expertise. While some literacy features of the Common Core, such as the interpretation of nonfiction texts, might be supported within science classrooms, this focus runs the risk of minimizing practices so central to the new science standards. Although there is clear alignment between these sets of standards, there are subject-specific features of each that must be addressed. As such, a content-neutral approach will not lead to the support necessary for teachers to establish subject-specific practices. Establishing effective science supervision will require explicit and purposeful reframing of supervision practices.

We identified several implications of this work. Although recent reforms promote instructional improvement in science, the dominance of literacy and mathematics has been well-documented in relation to accountability policies (Au, 2007). Some have emphasized that this necessitates principal ‘buffering’ to protect teachers from the onslaught of policy pressures (Wenner & Settlage, 2015). The extent to which principals have the capacity and motivation to respond to these shifting instructional policies is an empirical question worth further research. Although our study provides some evidence that they lack the capacity, but not the motivation, our sample was limited to a handful of school districts within a particular, fairly unique context of teacher evaluation, that incorporates observation, feedback and goal-setting processes. Future research might seek to explore the relative differences in states with teacher evaluation systems that rely more heavily on standardized test scores or more narrowly structured observations. Additionally, future research might examine the subject-specific knowledge principals need for science supervision, specifically related to the science practices, akin to previous work focused on this type of knowledge for mathematics (Nelson & Sassi, 2005).

We also consider implications for district-level practice and the development of principal supervision skills. With the introduction of the NGSS, districts will need tools and training for the supervision of science. We argue that learning to observe and promote the science practices is a crucial focus for this work (Duschl et al., 2007). Given that principals did feel prepared to supervise other subject areas, leveraging supervision expertise from these other subjects, for example highlighting the overlap (and differences) between the science practices and literacy strategies (Pearson et al., 2010), may help promote science supervision.

Given the substantial reforms necessary to implement the NGSS, it is essential for teachers to receive sufficient support to develop an understanding of science practices and appropriate instructional strategies to create supportive learning environments (NRC, 2012). As instructional supervisors for science, principals must prepare to provide this support. In this leadership role, they, too, must develop knowledge of the science practices and learn how to best support and improve their use in classrooms.

References

Au, W. (2007). High-stakes testing and curricular control: A qualitative metasynthesis. *Educational Researcher*, *36*(5), 258-267.

Au, W. (2011). Teaching under the new Taylorism: high-stakes testing and the standardization of the 21st century curriculum. *Journal of Curriculum Studies*, 43(1), 25-45.Bambrick

Santoyo, P. (2012). *Leverage Leadership: A Practical Guide to Building Exceptional Schools*. John Wiley & Sons.

Booher-Jennings, J. (2006). Rationing education in an era of accountability. *Phi Delta Kappan, 87*(10), 756-761.

Bredeson, P. V. (2003). *Designs for learning: A new architecture for professional development in schools.* Thousand Oaks, CA: Corwin Press, Inc.

Burch, P., & Spillane, J. P. (2003). Elementary school leadership strategies and subject matter: Reforming mathematics and literacy instruction. *The Elementary school journal*, 519-535.

Bybee, R. W. (2014). NGSS and the next generation of science teachers. *Journal of Science Teacher Education*, *25*(2), 211-221.

Camburn, E., Rowan, B., & Taylor, J. E. (2003). Distributed leadership in schools: The case of elementary schools adopting comprehensive school reform models. *Educational Evaluation and Policy Analysis*, *25*(4), 347-373.

Cohen, D. K. (1990). A revolution in one classroom: The case of Mrs. Oublier. *Educational evaluation and policy analysis*, *12*(3), 311-329.

Danielson, C. (2002). *Enhancing student achievement: A framework for school improvement*. Association for Supervision and Curriculum Development (ASCD). Virginia: Alexandria.

Darling-Hammond, L., LaPointe, M., Meyerson, D., & Orr, M. T. (2007). *Preparing School Leaders for a Changing World: Lessons from Exemplary Leadership Development Programs. School Leadership Study*. Executive Summary. Stanford Educational Leadership Institute.

Donaldson, M. L. (2009). So long, Lake Wobegon? Using teacher evaluation to raise teacher quality. *Center for American Progress*. Washington D.C.

Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (Eds.). (2007). *Taking science to school: Learning and teaching science in grades k-8.* Washington D.C.: National Academy Press.

Firestone, W. A. (1985). The study of loose coupling: Problems, progress, and prospects. In A. Kerckhoff (Ed.), *Research in sociology of education and socialization* (Vol. 5, pp. 3-30). Greenwich, CT: JAI Press.

Glickman, C. D. (2002). *Leadership for learning: How to help teachers succeed*. Association for Supervision and Curriculum Development (ASCD). Virginia: Alexandria.

Goldring, E., Huff, J., May, H., and Camburn, E. (2008), "School Context and Individual Characteristics: What Influences Principal Practice?" *Journal of Educational Administration*, *46*(3), 332-352.

Hallinger, P., & Heck, R. H. (1996), "Reassessing the Principal's Role in School Effectiveness: A Review of Empirical Research, 1980-1995", *Educational Administration Quarterly,* Vol. 32 No. 1, pp. 5-44.

Hallinger, P. (2005). Instructional Leadership and the School Principal: A Passing Fancy that Refuses to Fade Away. *Leadership and Policy in Schools,* 4(3), 221-239.

Halverson, R., Feinstein, N., & Meshoulam, D. (2011). School leadership for science education. *The role of public policy in K-12 science education*, 397-430.

Horng, E. L., Klasik, D., & Loeb, S. (2010). Principal's Time Use and School Effectiveness. *American Journal of Education*, 116 (4), 491-523.

Klein, A. (2015). "President Signs ESEA Rewrite, Giving States, Districts Bigger Say on Policy" Ed Week article. December 10, 2015.

Krajcik, J., Codere, S., Dahsah, C., Bayer, R., & Mun, K. (2014). Planning instruction to meet the intent of the Next Generation Science Standards. *Journal of Science Teacher Education, 25,* 157-175.

Leithwood, K., & Mascall, B. (2008). Collective leadership effects on student achievement. *Educational Administration Quarterly*, *44*(4), 529-561.

Leithwood, K., Louis, K. S., Wahlstrom, K., Anderson, S., Mascall, B., & Gordon, M. (2009). How successful leadership influences student learning: The second installment of a longer story. In *Second international handbook of educational change* (pp. 611-629). Springer Netherlands.

Lortie, D. C. (2009). School principal: Managing in public, University of Chicago Press, Chicago, IL.

Lowenhaupt, R., McKinney, S., & Reeves, T. (2014). Coaching in Context: The Role of Relationships in the Work of Three Literacy Coaches. *Professional Development in Education, 40(5), 740-757.*

Lowenhaupt, R. (2014). School Access and Participation Family Engagement Practices in the New Latino Diaspora. *Education and Urban Society*, *46*(5), 522-547.

Marks, H. M., & Printy, S. M. (2003). Principal leadership and school performance: An integration of transformational and instructional leadership. *Educational administration quarterly, 39*(3), 370-397.

Marshall, K. (2009). *Rethinking teacher supervision and evaluation*. San Francisco, CA: Jossey-Bass.

Mehta, J. (2013), How Paradigms Create Politics: The Transformation of American Educational Policy, 1980–2001. *American Educational Research Journal.*

Mintrop, H., & Sunderman, G. L. (2009). Predictable failure of federal sanctions-driven accountability from school improvement -- And why we may retain it anyway. *Educational Researcher, 38*(5), 353-364.

National Research Council (2012). *A framework for k-12 science education: Practices, crosscutting concepts and core ideas*. Washington, DC: The National Academies Press.-

Nelson, B. S., & Sassi, A. (2000). Shifting approaches to supervision: The case of mathematics supervision. *Educational Administration Quarterly, 36*(4), 553-584.

Nelson, B. S., & Sassi, A. (2005). *The effective principal: Instructional leadership for high-quality learning*. New York: Teachers College Press.

NGSS Lead States (2013). *Next generation science standards: For states, by states. Volume 2: Appendixes.* Washington, DC: The National Academies Press.

Olsen, B., & Sexton, D. (2009). Threat rigidity, school reform, and how teachers view their work inside current education policy contexts. *American Educational Research Journal,* 46(1), 9-44.

Overholt, R., & Szabocsik, S. (2013). Leadership Content Knowledge for Literacy: Connecting Literacy Teachers and Their Principals. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 86*(2), 53-58.

Pearson, P. D., Moje, E., & Greenleaf, C. (2010). Literacy and science: Each in the service of the other. *Science*, *328*(5977), 459-463.

Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Common core standards the new US intended curriculum. *Educational Researcher*, *40*(3), 103-116.

Pullin, D. (2013), “Legal Issues in the Use of Student Test Scores and Value-added Models (VAM) to Determine Educational Quality”, *Education Policy Analysis Archives*, Vol. 21.

Ribas, W. B. (2005). *Teacher Evaluation that Works!!: The Educational, Legal, Public Relations [political] & Social-emotional [ELPS] Standards & Processes of Effective Supervision & Evaluation*. R&L Education.

Sergiovanni, T. J., Starratt, R. J., & Cho, V. (2013). *Supervision: A redefinition*. New York: McGraw-Hill, Incorporated.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher*, *15*(2), 4-14.

Spillane, J. P., & Hopkins, M. (2013). Organizing for instruction in education systems and organizations: *How* the school subject matters. *Journal of Curriculum Studies,* DOI: 10.1080/00220272.2013.810783.

Spillane, J. P., & Hunt, B. R. (2010). Days of their lives: a mixed-methods, descriptive analysis of the men and women at work in the principal’s office. *Journal of curriculum studies*, *42*(3), 293-331.

Spillane, J. P., Camburn, E. M., & Pareja, A. S. (2007). Taking a Distributed Perspective to the School Principal's Workday. *Leadership and Policy in Schools, 6(1),*103-125.

Spillane, J. P., Parise, L. M., & Sherer, J. Z. (2011), “Organizational Routines as Coupling Mechanisms: Policy, School Administration, and the Technical Core”, *American Educational Research Journal,* Vol. 48 No. 3, pp. 586-620.

Spillane, J. P. (2000). A fifth-grade teacher's reconstruction of mathematics and literacy teaching: Exploring interactions among identity, learning, and subject matter. *The Elementary School Journal*, 307-330.

Spillane, J.P. (2004). *Standards deviation: How schools misunderstand education policy*. Harvard University Press.

Spillane, J. P. (2005). Primary school leadership practice: How the subject matters. *School Leadership and Management*, 25(4), 383-397.

Stein, M. K., & Nelson, B. S. (2003). Leadership content knowledge. *Educational evaluation and policy analysis*, *25*(4), 423-448.

Stodolsky, S. S., & Grossman, P. L. (1995). The impact of subject matter on curricular activity: An analysis of five academic subjects. *American Educational Research Journal*, *32, 2*(227--249).

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage.

Valenzuela, A. (Ed.). (2005). *Leaving children behind, How "Texas-style" accountability fails Latino youth*. Albany, NY: SUNY Press.

Valli, L., & Buese, D. (2007). The changing roles of teachers in an era of high-stakes accountability. *American Educational Research Journal*, *44*(3), 519-558.

Wenner, J. A., & Settlage, J. (2015). School leader enactments of the structure/agency dialectic via buffering. *Journal of Research in Science Teaching*, *52*(4), 503-515.

Ylimaki, R. & Jacobson, S. (2013). School leadership practice and preparation: Comparative perspectives on organizational learning (OL), instructional leadership (IL) and culturally responsive practices (CRP). *Journal of Educational Administration*, *51*(1), 6-23.

Tables

Table 1. District Demographics.

District	Number of Principals Interviewed (n = 26)	Enrollment	Number of Schools	Locale*	% Gr. 5 Students Scoring A or P** on 2014 Science State Test	% Students Identified as Low Income	% Students Identified as ELLs
Oak Park	2	5,368	8	Suburb: Large	89%	9.6%	1.0%
Ogden	7	12,674	22	City: Small	89%	11.4%	7.2%
Clinton	2	7,508	12	Suburb: Large	87%	11.4%	9.0%
Greenville	4	8,153	14	City: Small	85%	39.7%	13.4%
Troy	3	4,987	11	Suburb: Large	67%	66.9%	16.8%
Chester	8	54,312	120	City: Large	47%	77.7%	29.9%
State		---	---	---	71%	38.3%	7.9%

Note. *Locale determined from the National Center for Educational Statistics. ** A = Advanced and P = Proficient.

Table 2. Principal Information

ID	Grades	District	Years as Admin	License in Science	Race	Gender
08	Elementary	Oak Park	6-10	No	White	Male
10	Elementary	Oak Park	6-10	No	White	Male
12	Elementary	Ogden	6-10	No	White	Female
13	Middle	Ogden	6-10	No	White	Male
14	Elementary	Ogden	2-5	No	White	Female
15	Elementary	Ogden	6-10	No	White	Female
16	Elementary	Ogden	6-10	No	White	Female
18	Elementary	Ogden	More than 20	No	White	Male
19	Elementary	Ogden	6-10	Yes	White	Male
05	K-8	Clinton	2-5	No	White	Female
20	Elementary	Clinton	16-20	No	Black or African American	Female
03	Elementary	Greenville	11-15	No	White	Male
06	Elementary	Greenville	11-15	No	White	Female
07	Elementary	Greenville	11-15	No	Hispanic or Latino	Female
09	Elementary	Greenville	More than 20	No	White	Female
01	K-8	Troy	6-10	No	White	Female
02	K-8	Troy	16-20	No	Black or African American	Female
11	K-8	Troy	6-10	No	White	Male
22	K-8	Chester	11-15	No	White	Female
23	K-8	Chester	11-15	Yes	Hispanic or Latino	Female
24	K-8	Chester	2-5	No	Hispanic or Latino	Male
25	K-8	Chester	6-10	Yes	White	Female
27	Middle	Chester	2-5	No	White	Male
28	K-8	Chester	2-5	No	Black or African American	Female
30	Middle	Chester	11-15	No	White	Male
31	Elementary	Chester	6-10	No	Black or African American	Female

Notes.

Table 3. Key Codes and Interrater Reliability

Code	% of 26 Principals	Definition	Example Quotation	Kappa Coefficient
Lack of science supervision	62 % (16)	References related to not supervising science.	"I just don't see science that often"	0.57
Science supervision as same as other disciplines	96% (25)	References to how science supervision is similar to other content areas. Or talks about how their supervision for science is the same as their general supervision.	"I mean, it's pretty much the same as the other subjects. I'm looking for literacy strategies, are kids paying attention, you know."	0.57
Principals' lack of science experience or expertise	65% (17)	Quotations about their own lack of knowledge or experiences in science. This could also be in terms of their discomfort with science.	"I am not comfortable with science." "I'm not a science person."	0.98
Accountability	92% (24)	References to the focus of accountability systems or pressures caused by accountability.	"The accountability right now is on your reading and your math scores."	0.78