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District Leadership for Science Education: Using K-12 Departments to Support Elementary Science Education under NCLB

Abstract

By contrasting two case studies of school districts, this paper illustrates the effectiveness of K-12 science departments in supporting elementary science education, especially in response to NCLB's push towards the articulation of curriculum across all grades and as a response to the erosion of instructional time on science in elementary schools under NCLB.

Introduction

Scholars and practitioners have long been concerned about the quantity and quality of elementary science teaching and have sought ways to support elementary science education. In part, this longstanding concern stems from the failure of elementary science education to have secured a prominent or permanent place throughout elementary schools across the United States, having "not yet made the shift from passing trend to accepted regular practice" (Century, Rudnick, & Freeman, 2008, p. 31). More recently, there has been increased pressure for the support of elementary science education in response to the No Child Left Behind Act (NCLB). In part, the increased pressure to support elementary science education is due to the erosion of instructional time spent on science that results as elementary schools concentrate on NCLB's math and reading accountability measures (Center for Education Policy, 2006, 2008; Griffith & Scharmann, 2008; Hamilton & Berends, 2006). Given that NCLB has "placed science on the backburner in the face of other curricular demands" (Levy, Pasquale, & Marco, 2008, p. 3), there is a compelling need for science supports that serve as a bulwark to such erosion of instructional time. Conversely, an increased need for strong elementary science supports stems from NCLB's 2007 requirement for standardized science tests with publicized results. Some advocates hope that this feature of NCLB will refocus attention on science education (Marx & Harris, 2006). Moreover, NCLB encourages the alignment of elementary curriculum and instruction with state science standards and the use of standardized test data to inform instructional improvements at every grade level, which creates a need for a district-wide approach to science curriculum management.

Keywords: science education, elementary education, departments, NCLB, policy, administration

We have come to understand, particularly within the last decade, that the local school district is an important context for supporting policy implementation and instructional reform (Marsh, 2002; Marsh, et al., 2005). Although research has revealed ways that districts support science in general (Gamoran, et al., 2003; Spillane, 2004; Spillane, et al., 2002), very few studies have shed light on the ways that districts support science programs specific to elementary schools. This is particularly concerning given research that suggests that "to be fully effective, reform efforts must begin in elementary school" (Levy, et. al., 2008, p. 3). The dearth of research on ways that districts can support elementary science education exists despite a multitude of models to be found throughout the thousands of school districts that teach elementary school science.

Districts play a key role in supporting elementary science education by bringing in additional expertise or by strengthening existing expertise. This is an especially critical strategy, because most elementary school teachers are generalists who teach all subjects, have little or no training in science, and who frequently have a "tendency...to prefer non-science subjects" (Levy, et al., 2008 p. 3).

One way that school districts deliver science teaching expertise to elementary schools is by employing science specialists. These specialists often operate out of their own classroom/labs. This model of support for science education has perhaps received the most attention by scholars, and it has prompted repeated calls for further investigation (Century, Rudnick, & Freeman, 2008; Gess-Newsome, 1999; Levy, et al., 2008; Schwartz & Gess-Newsome, 2008). However, most elementary schools do not employ science specialists, chiefly due to financial considerations (Schwartz & Gess-Newsome, 2008). Due to increasing budget constraints and competition for resources from math and reading created by NCLB, financial implications are necessarily a crucial factor in any policy decision. Employing a science specialist "may not be an economically feasible option for many schools, especially those in rural and small districts; and an alternative is needed" (Rhoton, Field, & Prather, 1992, p. 14). Moreover, Schwartz and Gess-Newsome (2008) report that scant empirical data exist on the impact of science specialists.

An alternative to science specialists, proposed by Rhoton and his colleagues (1992), involves developing the science expertise of a cadre of elementary teachers who would then become science instructional leaders at their schools while simultaneously providing professional development to school principals that emphasizes content-focused leadership skills. This alternate approach to the elementary science specialist clearly has the potential to serve as a district support mechanism for elementary science education. However, these documented approaches represent only some of the possible methods of improving elementary science education, and many questions remain. Specifically, what other relatively inexpensive and easily implemented innovations can districts draw upon to support elementary science education? Furthermore, what can smaller districts that have limited science education expertise in their central offices do to deliver science expertise to their elementary schools?

One possible answer is the adoption of K-12 department structures that link the high school science department to elementary and middle schools, thereby tapping into the science expertise of the high school teachers. As described in this paper, the K-12 department is a logical response to NCLB's press for K-12 curriculum articulation for small to medium-sized districts. Smaller districts face numerous issues of capacity in responding to NCLB and in supporting instruction in general, yet they are largely overlooked in policy implementation research. "Small and medium-sized districts... are often ignored" (Tyack, 2002, p. 21), even though more than 90% of school districts in the United States have enrollments of less than 10,000 students each and almost half of public school students attend districts of this size (National Center for Education Statistics, 2004). These districts often lack science education expertise at either the elementary or central office level, but all districts are required to have content-specialized high school science teachers that could potentially serve as a valuable resource for science expertise.

This paper reports on two case studies that were taken from a broader study that examined eight small to medium-sized school districts in order to investigate the ways in which these districts supported science education. One district, here referred to by the pseudonym Millikan, employed a district-wide K-12 department structure that supported elementary science education by insuring a place for science teaching in every grade and school and by helping this district respond to NCLB's press for the alignment of curriculum and instruction to K-12 science standards. The district indicated that its K-12 department system was largely responsible for the high science test scores seen at all levels. Both of Millikan's elementary schools had some of the highest scores of any of the eight districts, which showed that there was consistency in science education between these schools. District leaders also pointed to the K-12 department as a foundational building block of the district's professional learning community. A case study of a second district, referred to by the pseudonym Banneker, is offered as a contrasting model, in that this district employed a site-based management of curriculum rather than a K-12 department structure. Although Banneker scored equally as impressively as Millikan at the high school level, Banneker's state science scores at the elementary level were lower than any of the other seven districts, and the results varied widely between the elementary schools. The achievement scores ranged by nearly thirty percentage points in the year of the study, and this was taken by administrators as evidence that some schools were not dedicating enough instructional time to science content.

Methods

In accordance with a positioned-subjects approach (Conrad, Haworth, & Millar, 1993), the case studies began with semi-structured interviews (Bogdan & Biklen, 1998) with the central office administrator designated to receive the state science test data and the chair of the science department in each district. The recommendations of these four individuals determined further interviews and observations in accordance with snow-ball methods developed by Miles and Huberman (1994). These techniques resulted in two uniquely designed case studies that matched the very different organizational structures employed by each district.

For the district designated as Millikan, in addition to the two initial interviews of roughly an hour each, a three hour interview was conducted with the assistant curriculum director, a second interview of roughly 30 minutes in length was conducted with the K-12 science department chair, and an interview of over an hour was conducted with the science department's administrative liaison. In addition to these interviews, a K-12 science department meeting was observed and relevant documents from district, state, and public records were reviewed.

For the district designated as Banneker, in addition to the initial interviews of roughly an hour each, a yearlong observation was completed to understand and document organizational changes discussed in the findings. Semi-structured interviews of one to two hours in length were conducted with one principal at each level—elementary, middle, and high school. In addition, three formal interviews, each lasting over one hour, were conducted with the curriculum director, and a number of informal interviews, of roughly 15 minutes in length, were conducted before and after each of four district-wide curriculum committee meetings that were also observed. Documents and emails concerning the committee's work were also collected and analyzed, in addition to other district, state, and public records.

Each interview was audiotaped and transcribed. Email correspondence was used to pose clarifying questions. Fieldnotes were taken during all observations. In addition, reflective and analytic memos were written immediately after formal and informal interviews and meetings in order to identify and organize the emerging themes (Bogdan & Biklen, 1998; Miles & Huberman, 1994). Data analysis began with the first interviews and informed the developing research process in an inductive manner (Boyatzis, 1998).

Findings

The two case studies discussed in this paper were of neighboring school districts with similar student demographics. Both communities had once been principally farmland but had become increasingly suburban due to their close proximity to a small city. They had small, but increasing, minority populations and were both making AYP (Adequate Yearly Progress). The smaller district, Millikan, served approximately 3,000 students in grades K-12, while Banneker served just over 5,000 students in grades K-12. Yet, despite their similarities these two districts had developed very different approaches to the management of curriculum, which was revealed by tracing the flow of state science test data through the districts. In the Millikan district, science achievement scores were highly uniform, and the flow and the use of the data revealed that all of the elementary and middle schools were supported in science education through a district-wide K-12 department structure. Conversely, in Banneker, a site-based management of curriculum had resulted in a patchwork of state science test data flow that reflected an inconsistent focus on elementary science education.

The Millikan school district.

The Millikan School District employed a highly centralized curriculum management system that closely linked its five schools and the central office. For the science department this meant, as the science chair explained, that the K-12 department had "a coordinator at each building" and "representation in the science department from each grade level. ...We'll have a kindergarten teacher from both elementary schools on our department. We'll have a first-grade teacher from both elementary schools." These were classroom teachers that had an emphasis on science in their classrooms and were designated as teacher leaders in science for their grade and building. As described by the science department chair, they were, "at their grade level, the person to go to for science questions." Information about science issues was disseminated through these building coordinators by the department chair in meetings and by memos. The assistant curriculum director reported that building coordinators took "the lead in working at the building level, if there's a critical issue in science. And it also gets down to things like ordering new textbooks and labs kits." He also noted that the coordinators and chair received extra compensation for their duties.

As a result of this structure, every grade, in every school, was represented by at least one teacher, some of whom also served as building coordinators and one of whom served as the chair of the K-12 department. The assistant curriculum director explained the way it worked: "At the middle and secondary levels...if you're a science teacher... you're de facto a member of the [K-12] science department....For our elementary buildings...and our intermediate school...at each grade level, the teachers are assigned to departments." For the sciences, the chair of the high school also served as the K-12 chair, but this was a decision made by the department and not a matter of protocol, as demonstrated in other disciplines that selected department chairs that were not from the high school, such as a central office administrator. Monthly meetings lead by a central office administrator were attended by department chairs from all disciplines. This K-12 department structure resulted in a network of teacher leaders throughout the district that ensured that science had an advocate in every grade and linked every grade with the expertise of the high school science teachers.

Also a member of the K-12 department was an administrative liaison that linked the department to the central office. In the case of the science department, this person was a building administrator with a science/technology teaching background. The liaison described the position "as a conduit of information—whether it is taking questions or comments or concerns from the K-12 departments to the rest of the central office or administration, or vice versa." In addition, a central office administrator coordinated the department chairs and coordinators. Thus the K-12 department structure served to distribute leadership for science education throughout the district by designating clearly assigned science leadership duties to administrators and teachers and creating functioning channels of communication between the central office and the schools.

The K-12 department structure was nested within other district-wide structures similarly engaged in curriculum, such as a district-wide assessment committee and yearly data retreats. These structures were incentivized by a "nimble" professional development system, a description of which is beyond the scope of this paper, which facilitated rapid responses to new issues and was directed by a central office concerned with a coherent strategy of curriculum management. One result of this approach was a larger than usual number of central office administrators dedicated to curriculum, instruction, assessment, and technology – more than was found in any of the other seven districts from the larger study. The Millikan administrators were aware that they had a richer personnel structure involved in curriculum than similar districts in their state, and, furthermore, they indicated that several of the administrative positions uniquely combined technology and assessment with curriculum and instruction responsibilities. Directly under the superintendent were two administrators involved in these areas, a curriculum director, which was commonly found in districts of this size, and a director of assessment, which was more unusual for a district of this size. Another unique position was that of assistant curriculum director, which combined technology responsibilities along with curriculum and instruction.

The K-12 department met about four times a year on designated staff development days or on early release days. The science department meeting that was observed included 28 teachers, more than half of whom were from the elementary and middle school level. From this broad team, various subcommittees were formed and tasked with activities such as data analysis. These subcommittees generally met after school and were considered part of the duties of the coordinators and chairs, while other teachers were incentivized with pay to participate. The assistant curriculum director explained that if there was "something that needs work" time was created "for all of the teachers in the department to come together," due to the perception that "because the chairs and the coordinators get a little extra pay for extra duty, there is the expectation that if there is work to be done, discussion that needs to be had, that they will have additional meetings or discussions."

One clear example of how this K-12 department supported science teaching in the elementary schools came in the form of yearly refinement of the K-12 science curriculum's articulation to the state standards by using the state test data, particularly by using the state science test's item analysis, which allowed the department to determine areas of the standards that were not being adequately addressed. In the words of the assistant curriculum director:

> What [the K-12 department] enables us to do is to have, we

> hope, certainly better communication—but also better articulation in scope and sequence ...all the way from elementary through high school; so that, you know, when you have grade-level meetings—which occur pretty frequently in the lower grades—you've got somebody there... if there's an issue with science, you have somebody there that sits in on the meetings, K-12 in science—somebody who's on the departmental distribution list for science. And so...if, as a result of the item analysis, we say, 'Well, you know, there's something with our matter unit that's missing,' or, you know, 'Our coverage of volcanism is a little lacking,' well then you've got a person in each building at that grade level who can say, 'Well, this is something that showed up in our item analysis. We talked about this at the department level. Here are some ideas we have.'—and then it gets implemented in the classrooms.

The department chair provided the details that confirm this use of the K-12 department to analyze and act upon the state science test data:

> The elementary teachers looked at the fourth-grade [test data], and then I looked at the eighth and the high school. And so we went then and pulled out areas where we thought we may be lacking in the curriculum—which standards we may not be meeting....and actually wrote up a report for our first department meeting [where] we actually came down to a couple areas we felt that we were lacking in....We have, for the last three years, done an item analysis of the [test data]. This is the first year where we have actually set our building goals, in fall, from the [test data analysis].

In addition to refining curriculum alignment, the data analysis led to the adoption of specific science vocabulary found on the state test, and an increase in teaching about scientists throughout history, because questions about specific scientists had appeared on the state tests.

Aligning curricula to state academic standards is one of the principal goals of NCLB, which requires states to hone their state tests to a set of academic standards and then to provide districts with itemized test data to be used in identifying areas of the standards not being adequately addressed in the classroom. However, the capacity of districts to use the data in this manner varies greatly. In some of the other districts in the broader study, this state data was not used by elementary schools, and, in one small district with no central office personnel dedicated to curriculum matters, the data never left the central office filing cabinets. In Millikan, a clear channel between the central office and all schools in the district allowed the test data to reach the teachers and influence the curriculum. The district's organization was described by the assessment director as an attempt to "create a seamless process." The data's easy flow had illuminated that process. For the assistant curriculum director, this seamless process meant that "if you're a seventh-grade teacher, you know what the students are going to have coming out of sixth grade. And if you're a sixth-grade teacher, you know what the expectations are from the seventh-grade instructors." Furthermore, a K-12 department "means that if you've got some best practices, they more rapidly diffuse across the district." Lastly and most telling for districts responding to NCLB, the assistant director noted that "it also means that...you have a structure for...making change, when change has to be made."

The articulation of curriculum is an example of one operational advantage of the K-12 department that is easily observed, but, beyond this obvious utility, another key benefit of a K-12 department that was emphasized by the chair and the assistant director was the formation of a content-based professional learning community. The chair described the experience of joining a K-12 department 15 years prior: "When I first started, it was overwhelming—as a brand new teacher...I can barely keep up with what's going on in ninth grade. Why do I care about kindergarten? ...But the longer I've been here, the more I appreciate that." The assistant curriculum director noted that the K-12 department structure was "very unique" and "certainly a strength of the district." The assistant director described the role of the K-12 department in developing "a more collegial atmosphere between administrators and instructional leaders in the form of department chairs and building coordinators....as opposed to a... hierarchical situation." While the assistant director acknowledged there were many intangible factors required to produce a culture of learning among teachers, they insisted that organizational structures were a great first step: "I think if you created K-12 departments, you might begin to move towards professional community....you might not have the culture in place; but I'd like to think, in a lot of districts, if you establish ...the structure—you could learn to have something of the culture." This culture had established science as a basic content area at every grade and school, not dependant on the proclivities of principals and teachers and, thus, offering a bulwark against NCLB's erosion of time dedicated to science. The Millikan assistant director emphasized that the K-12 department was a simple and straightforward organizational system with the words, "I don't really see any down side to the way our departmental system works."

The Banneker school district.

In contrast to Millikan, the Banneker School District, which was driven by a site-based approach to the management of curriculum, had less robust district supports for elementary science education and did not tap into the content expertise of the high school science department to support elementary science education. For most of the 1990s, the district's schools had increasingly made curriculum decisions independently, and no network of personnel concerned with curriculum existed between schools in the form of district-wide committees or a K-12 department structure as employed in Millikan. There was virtually no coupling between schools in terms of science education, and the high school science department was not involved directly with the two middle schools nor with any of the six elementary schools. Leadership for science education at the elementary level rested with the elementary principals and a lone central office curriculum director. This approach for supporting elementary science did not connect elementary teachers with content expertise and did not connect elementary teachers between schools.

Without the network for sharing expertise and information provided by the K-12 department in Millikan, elementary science education in Banneker relied on the leadership of the principals and the curriculum director. Neither Millikan nor Banneker had central office administrators dedicated solely to science education, as would be the case in large districts. However, as opposed to Millikan, Banneker had not mobilized their high school's expertise through a K-12 department and had not established teacher leadership for science education in the elementary schools. Without the network of a K-12 department structure fostering the growth of a content-based professional learning community throughout all grades, Banneker had not prioritized science education at the elementary level, and this resulted in widely varying amounts of science teaching among the elementary schools. Banneker administrators accepted the variation as a necessary consequence of what they saw as the benefits of site-based management; however, they were aware of challenges facing their system as a result of NCLB.

One particularly revealing decision made by administrators in Banneker was the reversal of the district's evolution towards site-based initiatives. While the press from NCLB to articulate curriculum across grades and schools was a logical fit with the K-12 system found in Millikan, in Banneker, the policy's approach led to the adoption of a more centralized approach to curriculum management. A district-wide curriculum committee was established in the fall of 2004, and, by spring 2005, it had implemented a district-wide electronic curriculum system that networked all teachers. The committee was led by the curriculum director, who spoke of the committee as a "dream come true." The director hoped the district could strike a balance between centralized curriculum management and site-based management. While far from the centralization of curriculum management seen in Millikan's K-12 department structure, Banneker's curriculum director characterized the establishment of the committee as representing a "paradigm shift" in the district. According to the curriculum director, the new committee was leading "to more K-12 discussion, more K-12 cohesion."

Another change was seen at the elementary school level and occurred because of NCLB's press for K-12 articulation and came about as a direct consequence of state science test data. As a result of the site-based management, Banneker's six elementary schools had increasingly individualized the foci of their curricula, and some schools emphasized science much more than others. This inconsistent approach to science teaching was indicated to administrators from various sources of evidence, but the most publicly available information was the elementary science scores which were, on average, lower than any of the other seven districts in the larger study and the results varied amongst the schools by nearly 30 percentage points in the measurement of students scoring proficient or advanced. At the same time, Banneker was the highest scoring district of the eight studied on the high school test. These low and inconsistent science tests scores across the elementary schools were below other benchmark school districts with which Banneker was normally compared, and this captured the attention of administrators. In response, the curriculum director reorganized a common curriculum in the elementary grades built around commercial science kits and provided more kits and associated professional development. The director used the state science test data to pinpoint weaknesses in the coverage of science standards to help align the curriculum with state standards, which was work that had been done by the K-12 department in Millikan. Banneker did respond to NCLB's press for K-12 articulation, but the district continued to lack the personnel rich network or content expertise of Millikan's K-12 department.

Conclusions

The history of elementary science education in the United States of America, if not the world (Fensham, 2008), is one of isolated pockets of success, at the state, district, school, or classroom level, but science teaching has never achieved a secure place in the curriculum. As Century et al. state, "elementary science education has enjoyed increased popularity in some settings during isolated pockets of time, but it has not yet made the shift from passing trend to accepted regular practice" (2008, p. 31). The competition for a place in the curriculum for science has become more difficult under NCLB's focus on math and reading, especially at the elementary level. In order to secure a place as a basic subject, science educators have realized the need to support the traditional elementary teacher, because elementary teachers often lack science expertise and, without structure, are easily able to express their preference for non-science subjects through manipulation of the flexible schedules found in elementary schools.

The K-12 department creates a district-wide network that is rich in personnel and able to respond to the need in science education for distributed leadership (Spillane, Diamond, Walker, Halverson, & Jita, 2001) and content-focused teacher leaders (Klentschy, 2008). In Millikan, the K-12 structure widely distributed leadership for science education to the high school science department chair, an administrative liaison, and a broad collection of elementary teachers serving in building- and grade-level science coordinator roles—roles that began cultivating science-focused teacher leadership.

The K-12 structure also was an important mechanism for connecting elementary teachers to a source of content expertise—high school teachers and the high school department chair. Drawing on this existing internal source of content expertise from the high school appears especially critical given that central offices in small and mid-sized districts may have limited content-focused expertise, and such expertise is generally missing in principals (Lanier, Gallard, & Southerland, 2009; Rhoton, Field, & Prather, 1992). In particular, Jorgenson, MacDougall, and Llewellyn (2003) note the lack of science expertise found in many leaders: "The instructional specialist function is laudable and yet complex, perhaps unrealistic, for some individuals in science leadership roles, such as principals in underserved schools who lack the subject expertise, site personnel, or district-based resource to offer such help" (p. 60).

Beyond these benefits, the K-12 structure also provided a network that supported the flow of science information to elementary science teachers. Moreover, the K-12 structure ensured that there was at least one teacher at each grade level in each elementary school advocating for science education and instruction, and this served to cultivate a content-focused professional learning community, which is a critical point of entry for site-based professional learning communities (McLaughlin & Talbert, 2006). Lastly, the K-12 structure provided a mechanism for responding to NCLB's press for the articulation of elementary curriculum to state standards and for the alignment of curriculum across grades.

Given the relative affordability of this system, the K-12 department structure also appears to provide another approach for supporting elementary science teaching in underserved schools, many of which are also failing to make AYP and, thus, are more likely to be shifting resources and instructional time from science to reading and math (The Center for Education Policy, 2008). Jorgenson and colleagues note that the challenges for science leaders "are complicated in the context of increased accountability, particularly in schools and districts where resources and support for science instruction are diminished by emphasis on 'The Three Rs'" (2003, p. 60). These often economically-disadvantaged districts require simple and inexpensive innovations that support science teaching while simultaneously responding to NCLB's press for articulation of the K-12 curriculum.

Quality elementary science teaching is rare because of the lack of content knowledge on the part of elementary teachers. Given the expense of science specialists and central office science administrators, especially at a time of shrinking budgets and NCLB's emphasis on reading and math, districts must find additional sources of content expertise to mobilize in the support of elementary science teaching. Such a source exists in each high school science department. The K-12 department structure is a simple method of bringing the content expertise of high schools into elementary classrooms and providing a foundation for the professional learning communities that are essential to sustained improvements in science education.

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