Urban School Leadership for Elementary Science Instruction: Identifying and Activating Resources in an Undervalued School Subject

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Abstract: This article explores school leadership for elementary school science teaching in an urban setting. We examine how school leaders bring resources together to enhance science instruction when there appear to be relatively few resources available for it. From our study of 13 Chicago elementary (K–8) schools' efforts to lead instructional change in mathematics, language arts, and science education, we show how resources for leading instruction are unequally distributed across subject areas. We also explore how over time leaders in one school successfully *identified* and *activated* resources for leading change in science education. The result has been a steady, although not always certain, development of science as an instructional area in the school. We argue that leading change in science education involves the identification and activation of material resources, the development of teachers' and school leaders' human capital, and the development and use of social capital. © 2001 John Wiley & Sons, Inc. J Res Sci Teach 38: 918–940, 2001

The past decade has witnessed considerable efforts to improve the quality of science instruction in America's schools, with school reformers arguing that *all* students should do more intellectually rigorous science work. Raised expectations for students' academic work have increased the expectations for teachers' instructional practice, expectations that imply substantial changes for existing classroom pedagogy. National and state standards along with new assessment systems press teachers to revise their teaching. Because of the nature and magnitude of the reforms, most teachers struggle to understand their substance and their implications for practice (Cohen, 1988; EEPA, 1990; Schifter & Fosnot, 1993; Spillane, 1999). Transforming reformers' proposals for instruction into sustained daily practice is difficult and depends largely on local circumstances, especially school conditions that support teacher learning (Newmann & Wehlage, 1995). The challenge of going to scale and to substance with recent science reforms also depends in important measure on the local school, especially the school's resources for leading reform of science education. Absent the mobilization of these resources in the cause of science education, recent reforms are likely to have only marginal effects on instructional practice.

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Yet it is part of the folklore in education circles that science education falls through the cracks in most elementary schools, failing to make it onto schools' innovation agendas, let alone into most classrooms. In elementary schools science is largely a fringe subject, taken up when time allows, but mostly forgotten or treated intermittently and unsystematically (McCutcheon, 1980; Smith & Neale, 1991; Stake & Easley, 1978). Our research on urban school leadership for mathematics, science, and literacy supports these impressions—science tends to get short shrift. We suspect that science is devalued in urban elementary schools for two reasons. First, teachers often believe that children from low-income families, concentrated in urban school districts, are incapable of handling instruction beyond basic skills (Anyon, 1981). Teachers commonly assume that these students need to master the basics—particularly mathematics and language-arts skills—before engaging in more intellectually challenging materials (Spillane, 2001). This view was pervasive among the teachers in the schools we studied. Their perspective was that a large percentage of their low-income, African American, and Latino and Latina students needed to hone their basic literacy and mathematics skills before engaging in more challenging work. Hence, mathematics and language arts occupy the bulk of the urban elementary school day. Second, recent policy initiatives that hold schools accountable for student performance in language arts and mathematics, especially common in large urban school districts, have accentuated the inattention to science instruction. Accountability measures create considerable instructional pressure for teachers in urban schools where the gap is great between performance goals and students' actual performance. Bridging this gap in language arts and mathematics can exhaust schools' resources, and subjects not targeted by accountability mechanisms, such as science, fall through the cracks.

As one might expect, urban schools in our study worried less or not at all about those subjects for which no tangible rewards or sanctions existed under accountability regimes. As a result, elementary-school science teaching was left largely to teacher discretion and to resources outside the school that individual teachers might tap. Our goal in this article, however, is not to dwell on the unequal distribution of resources for leading reform across school subjects. Our central aim is to analyze the resources for leading innovation in urban elementary schools in order to understand how resources are *identified* and *activated* in the cause of science education. More specifically, we examine how school leaders bring resources together to enhance science instruction when other subjects, by virtue of tradition and formal policy, command the bulk of the resources. We begin by outlining the theoretical frame for our research and describe our study of leadership for instruction in 13 Chicago elementary (K–8) schools. We then consider how the subject matters when it comes to resources for leading instruction in urban elementary schools by comparing resources for leadership in mathematics, science, and literacy in these schools. After describing the between-school variation in the resources for leading science education, we analyze a case of one urban elementary school that successfully identified and activated resources for leading change in science education.

Theoretical Underpinnings

We frame the research reported here using a distributed perspective on school leadership. We also draw on theoretical work about the nature of resources for human action and the activation of these resources in particular contexts.

By leadership we mean the guiding and directing of instructional innovation in schools. We define school leadership as the identification, acquisition, allocation, coordination, and use of the human, social, and material resources necessary to establish the conditions for the possibility of instructional innovation. "Innovation is the generation, acceptance, and implementation of new ideas, processes, products, or services. . . .[I]t can involve creative use as well as original invention'' (Kanter, 1983; p. 20). Leadership involves mobilizing school personnel and clients to notice, face, and take on the task of changing instruction as well as identifying and activating the resources needed to support this process.

Our study is premised on a distributed notion of leadership (Spillane, Halverson, & Diamond, 1999, 2001). Consistent with previous work that critiques the focus on positional leaders (Barnard, 1968; Heenan & Bennis, 1999; Heller & Firestone, 1995; Katz & Kahn, 1966; Lipmam-Blumen, 1996; Ogawa & Bossert, 1995), we see school leadership as distributed among formal and informal leaders. Leadership is an organizational quality (Ogawa & Bossert, 1995; Pitner, 1986; Pounder, Ogawa, & Adams, 1995) that reaches beyond the work of individual positional leaders. Hence, any investigation of the resources for leading innovation in science education has to consider more than positional leaders. Our distributed perspective, however, goes beyond considering a division of labor for leadership functions to argue that the thinking and practice of leadership is stretched over school leaders and the material and symbolic artifacts in the environment. Appropriating several concepts from work in distributed cognition and activity theory (Cole & Engestrom, 1989; Hutchins, 1995b; Lave & Wenger, 1991; Leont'ev, 1981; Pea, 1993; Resnick, 1991), we argue that the social, material, and symbolic situation is an integral and constituting component of leadership practice. Leadership practice emerges in and through the interaction of leaders, followers, and situation in the execution of leadership tasks.

If a distributed perspective on leadership is assumed, then what constitutes the resources necessary for school leadership is a central issue. Much of the literature on relations between school resources and student outcomes focuses on conventional resources that are easily measured—expenditures, teachers' educational levels, physical materials, and the like (Cohen, Raudenbush, & Ball, 1999). We use three categories of resources for leadership, which correspond to the economic concepts of physical capital (i.e., financial resources as deployed in time, etc.) and human capital and to the sociological concept of social capital.

Physical resources include money and other material assets. The time and staffing that school leaders have available to spend on reforming instruction do not constitute a form of capital because according to Webster's Third New International Dictionary, capital is the ''accumulated assets, resources, sources of strength, or advantages utilized to aid in accomplishing an end or furthering a pursuit.'' However, time and staffing do represent an allocation of the financial resources, a method of using or expending continuing revenue rather of accumuling capital. Therefore, we view them as material or financial resources (Spillane & Thompson, 1998).

Human resources include individual knowledge, skills and expertise that might become a part of the stock of resources available in an organization. ''Just as physical capital is created by changes in materials to form tools that facilitate production, human capital is created by changes in persons that bring about skills and capabilities that make them able to act in new ways'' (Coleman, 1988, p. S101). For example, the knowledge and skills of school leaders represent a form of human capital that may be productive in transforming science education.

Social capital concerns the relations among individuals in a group or organization and results from the prevalence among individuals of such norms as trust and collaboration as well as a sense of obligation. ''Social capital . . . comes about through changes in the relations among persons that facilitate action. . . .'' (Coleman, 1988, p. 98). Social capital facilitates productive activity just as physical capital and human capital do. It ''inheres in the structure of relations between actors and among actors'' (Coleman, 1988, p. 98). For example, ''a group within which there is extensive trustworthiness and extensive trust is able to accomplish much more than a comparable group without that trustworthiness and trust'' (Coleman, 1988, pp. S101–S102).

Moreover, social capital can facilitate the transfer of information among people, thus increasing the individual and collective knowledge of organizational members. Social capital can also refer to information and resources that are inherent in social relationships that extend beyond the particular organization. For example, the social networks of school leaders might provide them with access to useful information or resources with which to enhance a school's instructional program, resources that would not have been accessible to the school absent these relationships.

Our distributed leadership perspective presses us to understand the role of situation in leadership practice, especially the differential configuration of resources by subject matter, as delineated in this article. To better understand situation, we borrow from the work of Bourdieu, who argued that human action occurs within fields of interaction (Bourdieu, 1977, 1990, 1991; Bourdieu & Wacquant, 1992; Lareau & Horvat, 1999; Thompson, 1990). Fields of interaction are characterized by rules, conventions, and schemata that, although often implicit, shape the interaction within them (Lamont & Lareau, 1988; Lareau & Horvat, 1999; Thompson, 1990). Research using the fields of interaction concept often focuses on specific rules or expectations that structure interaction in specific contexts. For example, a defining characteristic of the educational field is that teachers demand that parents approach schools with support rather than criticism (Lareau & Horvat, 1999).

We view the relative valuation of different subject-matter areas as a defining characteristic of elementary education. Science instruction typically receives less attention in elementary schools than mathematics and literacy instruction (McCutcheon, 1980; Stake & Easley, 1978; Smith & Neale, 1991). Thus, within this field of interaction, the "rules of the game" favor reading and mathematics instruction over science instruction. Likewise, in the context of Chicago and other urban districts, teachers' and administrators' beliefs about the importance of basic skills for poor children, as well as recent accountability policies emphasizing mathematics and reading, further undermine the importance of science instruction. Hence, in urban elementary schools science tends to be devalued as a subject area and to receive limited resources. It is addressed only intermittently in a school's reform agenda.

To understand how people identify and activate the resources necessary to lead change in science instruction in urban schools, we appropriate the work of Swidler (1986), who argued that social actors draw on "tool kits" or resources through which they deploy "strategies of action" to address issues they face. These tool kits do not determine action but instead provide resources for action from which actors pick and choose to create desired strategies.[1] We argue that although resources for instruction are limited in urban schools, certain schools are able to identify and activate them in the service of instructional change in science. Their strategies of action involve the creative configuration and activation of these resources, underscoring that the possession of resources does not automatically translate into their use in meaningful instructional innovation absent this activation.[2] Our discussion will explain this process.

Methodology

This article is based on data from the pilot phase and Phase 1 (or Year 01) of the Distributed Leadership Project, a 4-year longitudinal study of elementary school leadership funded by the National Science Foundation and the Spencer Foundation. The 6-month pilot phase was conducted during the winter and spring of 1999 and involved seven Chicago elementary schools, four interview-only sites, and three schools where we conducted interviews and extensive fieldwork. The first full year of data collection (Phase 1) got underway in September 1999 and involved eight Chicago elementary schools, two of which were also part of the study's pilot phase. The collection of data, completed in June 2000, involved 50–70 days of fieldwork at each of the eight sites.

Site Selection

We used a theoretical sampling strategy (Glaser, 1978; Glaser & Strauss, 1967) to select schools based on four dimensions. The first dimension was that all schools in our study be high-poverty institutions, with a minimum of 60% of students receiving free or reduced lunch (Table 1). Second was the requirement that selected schools be varied in student demographics—in our study seven schools were predominantly African American, three were predominantly Hispanic, and three were mixed (Table 1). The third dimension was some schools show no changes in instruction, though we were chiefly interested in schools that had shown signs of improving mathematics, science, or literacy instruction (gauged by either process or outcome measures). The fourth dimension was that the duration of change efforts varied amongst the schools. We used the Longitudinal database of Consortium on Chicago School Research to identify elementary schools that had shown indications of improvement on such measures as ''academic press,'' ''professional community,'' and ''instructional leadership''[3], which are all process measures, and ''academic productivity.''[4] Based on these indicators of change, we were able to divide our 13 schools into three broad categories—change efforts in the past 1 or 2 years, tangible indicators of change over the past 3–5 years, and tangible indicators of change over the past 5–10 years.

Data Collection

Research methodologies used included observations, structured and semistructured interviews, and videotaping leadership practice. The methodologies varied across schools. In

Table 1
*School demographics**

School	Student Enrollment	Low Income	Black	White	Hispanic	Asian	Native American	Limited English
School A	861	93%	100%	0	0	0	0	0
School B	1,048	96%	7%	47%	22%	24%	1	38%
School C	1,498	73%	8%	40%	19%	34%	0	48%
School D	287	90%	100%	0	0	0	0	0
School E	928	97%	3%	0	97	0	0	46%
School F	363	97%	100%	0	0	0	0	0
School G	1,054	97%	100%	0	0	0	0	0
School H	1,331	96%	4%	3	88	5	0	29%
School I	748	61%	100%	0	0	0	0	0
School J	662	88%	100%	0	0	0	0	0
School K	1,363	84%	3%	23%	23%	52%	0	23%
School L	503	64%	3%	53%	43%	1%	1%	25%
School M	889	96%	24%	1%	75%	0	0	36%

*Schools G–M formed part of the pilot study, with Schools G and H continuing as case-study sites for the research project. In the pilot study Schools A, C, D, and E were interview only sites, with no classroom observations done. The research currently involves eight schools—A–H.

4 of the 13 schools (all part of the study's pilot phase), we relied entirely on structured and semistructured interviews with teachers and school leaders. In the remaining 9 schools we observed school leadership events, meetings, and classroom instruction in Grades 2 and 5 in addition to conducting interviews with teachers and school leaders. During Phase 1 of the study researchers spent the equivalent of 3–4 days per week at each school over a 10-week period in the fall of 1999 and a 12-week period in the spring of 2000. Leadership events observed in these schools include grade-level meetings, faculty meetings, school improvement planning meetings, professional development workshops, and supervisions of teaching practice. In addition, we observed a number of other events at which subject matter was discussed, including homeroom conversations among teachers, lunchroom conversations, grade-level meetings, and subject-specific workshops and meetings.

We completed interviews with teachers of the second and fifth grades and with school leaders (including lead teachers). Interview protocols focused on school leaders' agendas and goals, their responsibilities, and the key tasks they performed as part of promoting instructional change in mathematics, science, and literacy. Our interview questions were designed to get at five core issues about the practice of leadership:

1. Getting the leaders to identify the key goals or macro functions on which they were working (e.g., building a school vision, promoting teacher professional development, improving test scores).
2. Getting them to describe what day-to-day tasks they performed to attain these goals, such as micro tasks (e.g., observing classrooms, forming breakfast clubs, facilitating grade-level meetings).
3. Getting them to describe how they enacted the micro tasks, that is, their practice as leaders.
4. Determining whether and how macro goals/functions and micro tasks were coenacted, i.e., the extent to which their functions were executed with the help of others in the school.
5. Determining what tools and material resources (including designed artifacts, memos, protocols, and organizational structures) the interviewees identified as important in the execution of macro and micro tasks.

We also observed specific instances of the practices of school leaders and then conducted postobservation interviews with these leaders about the observed practice. Observation protocols focused on: (a) the nature and substance of the task—what the leader(s) did and the goals of the activities, including the subject-matter focus of the activity, if any; (b) how the task was enacted, including the artifacts and materials used and how they enabled practice; (c) the timing and location of the task—the physical setting and context of the enactment and the time of the year, week, or day on which the task was enacted; and (d) the patterns of involvement, including what the leaders or facilitators did during the enactment, whether leadership was shared, and the role of participants.

To explore relations between leadership practice and teachers' efforts to change their teaching, we used classroom observations and interviews in Grades 2 and 5 at each school. These observations and interviews focused on three subject areas—mathematics, science, and language arts. The unit of data here was the focused observation *and* the interview. Refining and developing observation protocols used in previous work (Spillane, 2000; Spillane & Zeuli, 1999), our observations focused on dimensions of practice, including materials, content of academic tasks, and task enactment. Postobservation interviews focused on: (a) gauging the representativeness of the instances of practice observed; (b) understanding the nature of changes in practice from the teacher's perspective and (c) understanding what has facilitated and supported these changes, especially the influence of particular leadership practices. Our aim was *not* to establish causation, as that would require an entirely different research design. These data were supplemented with survey data from the Consortium on Chicago School Research.

Using these protocols, researchers wrote detailed field notes following each observation. Thus far, a 181 sets of field notes have been compiled, detailing observations of everything from a 30-min meeting to 3-hr professional development workshop. All interviews were tape-recorded and transcribed.

Data Analysis

Data collection and data analysis, the latter of which is ongoing, were closely integrated, allowing researchers to check out patterns and working hypotheses as they emerged from data analysis and to refine data-collection strategies as the study progressed (Miles & Huberman, 1984). Coding categories were developed based on the distributed leadership theoretical framework and initial analyses of our observation and interview data. A commercial computer-based qualitative coding program, NUDIST, was used to code all project data. NUDIST allowed us to code the emerging ideas and concepts from the data into free nodes that could be compared and related to each other, forming larger ''parent'' nodes that were stored in an index system that united the different components of the project.

For this article we focused on two of the index trees of our interview coding system. The first of these identified who or what influenced classroom instruction. Twelve nodes were created to code these data, including principal, assistant principal, teacher leaders, other teachers, standards documents, testing, Local School Council,[5] parents, and textbooks. The second tree identified the dimension of instruction over which influence was exercised by subject matter. We used five coding categories for subject matter—mathematics, science, literacy, other (e.g., social studies), and generic, with the generic category used when a teacher spoke about instruction in general or when it was not clear that the teacher was speaking about a particular subject. Using this coding scheme, we were able to analyze influences on instruction by working from teachers' reports about their practice. Coders worked together to do the initial coding of the transcripts so as to develop a common understanding of the meaning of each code. Once coders had developed a shared understanding of the codes, they worked independently. We also used our field notes, which document the actual observed practice of leadership over the last 2 years (including data from the pilot phase), to construct our account of leading for science at Adams School, our case study for this article.

Subject Matter, Instruction, and Elementary School Leadership

As a field, elementary education is characterized by the differential valuation of mathematics, science, and literacy instruction. Although most elementary teachers do not have well-defined subject-matter specialization and do not work in situations in which organizational arrangements (e.g., departmental structures) directly support subject-matter identities, subject matter is an important context for the work of teachers. One study found that elementary school mathematics received a greater allocation of leadership attention, resources and instructional time than did ''less essential'' subjects such as social studies (Stodolsky, 1988). Further, subject matter is an important context in elementary school teachers' efforts to reconstruct their practice because elementary teachers' identities as teachers and learners may differ from one subject to the next, influencing their efforts to reconstruct their practice in these subjects (Drake, Spillane, & Hufferd, 2000; Spillane, 2000).

Our analyses suggest that the resources for leading instruction vary by the subject areas of mathematics, science, and language arts. Three indicators of this variation are the availability of formal and informal subject-matter leaders, the roles played by school administrators across subject areas, and the role of specialists in different subject-matter areas. To begin with, the availability of leadership for instruction in our sites varied by school subject. Although leadership for instruction was distributed across two or more leaders in all schools, there were fewer leaders for science instruction than for both language arts and mathematics instruction. Leadership for science was typically confined to two or more classroom teachers, few of whom had any official designations (e.g., science resource teacher or coordinator). In contrast, those involved with leading language-arts and mathematics instruction typically included the principal and/or the assistant principal, a language-arts coordinator or specialist, grade-level lead teachers, and the school's external consultants or partners. Hence, the human resource pool available for supporting science instruction and its improvement was much smaller relative to other subjects.

The involvement and prominence of those in formal leadership positions—the principal and assistant principal—reflected the general pattern of science being less valued as a subject area. School administrators in our study schools paid less attention to science compared with mathematics and language arts, reinforcing the belief that science was less important than language arts or mathematics. Principals and assistant principals in our study were not usually directly involved with leading science instruction. When they were involved with science instruction (in four of the schools), their work was typically confined to supporting the work of the external partners, recruiting specialist faculty for science, and allocating discretionary school resources to science. This contrasts sharply with our findings for language arts, where leadership for instruction in all the schools involved the principal and/or assistant principal in addition to other leaders. Teachers' reports corroborate these findings. Teachers were twice as likely to mention principals and/or assistant principals as being influences on language-arts instruction than on science instruction.

Finally, leadership for science instruction resided chiefly with classroom teachers, very few of whom had official designations or time release for their leadership work. And much of the work these leaders reported centered on ordering textbooks, purchasing laboratory supplies, arranging for the school's annual science fair contest, and getting standards documents for teachers. There were some exceptions to this trend. For example, in one school a seventh-grade teacher had used her connections to a local university to negotiate for curriculum materials, computers, and regular classroom support for interested staff members on the Grade 7–8 team. That few science leaders had official designations or classroom release time for their work suggests fewer financial resources for science compared with mathematics and literacy. Official designations, common in language arts and mathematics, often included release time and fewer teaching responsibilities and often were tied to monetary resources accessed by school leaders. Hence, subject-matter leaders in literacy and mathematics were more likely to have time to focus on the overall instructional program and time to both increase their own knowledge and to interact with teachers and administrators about instructional issues. These patterns were reflected in teachers' reports about leadership for instruction in their schools. Teachers seeking guidance about their science instruction were three times as likely to turn to other teachers as they were to turn to school administrators or teacher leaders. In contrast, they were only twice as likely to do so in mathematics and language-arts instruction.

These findings are all the more striking when one takes into account that we oversampled urban schools in which teachers and administrators were engaged in school reform efforts and were attempting to improve student achievement. Of the schools in the sample, all but one had shown improvements for 1–8 years in student test scores in mathematics and literacy on the Iowa Test of Basic Skills. Thus, in those urban schools at which one is most likely to encounter serious efforts to reform instruction, the resources for leading science instruction appear to be relatively thin.

A defining characteristic of elementary education is that mathematics and reading traditionally get much more attention and resources compared with science. The ‘‘rules of the game’’ favor language arts and mathematics over science. In the urban elementary schools we studied, science appears to be further undervalued because of the concern with ensuring that poor urban students master the basics, which typically means language arts and mathematics rather than science. Teachers and administrators in these schools were highly cognizant of the challenges faced by low-income and minority students and sought to ensure that they received instruction in what were considered the core academic subjects—mathematics and language arts.

Recent policy developments that establish high-stakes accountability systems, especially prominent in urban school districts, accentuate this undervaluing of science education even more. Teachers and administrators in our study captured the situation:

> So I go to my grade chairperson, and she’ll give me a list of the 10 objectives in reading and math that I must teach. Science and social studies are more flexible because the students are not tested on the IOWA [Iowa Test of Basic Skills] in science and social studies so that’s more, you know, on the teacher’s personal decision.

> You know science isn’t one of your guides for whether a child is promoted or graduates. So reading and math are what are stressed because those are what everybody looks at. And to a certain degree that’s what the teachers look at too. You know I’ve got to get you on. I’ve got to get you out of this building. You’ve got to get this in math, you’ve got to get this . . . in reading. So those two always come first.

> We aren’t able to teach science as much as I would like to, mainly because on the third-grade level we aren’t tested on [science and social studies], we’re not tested on those subjects; we are tested on reading and math. . . . I just can’t fit it in. It’s so much math and so much reading that it’s hard to fit the science and social studies. So most of the time . . . I began teaching science and social studies after the test.

Although subject area shaped the patterning of resources across our schools, there were also differences among schools in those patterns with respect to science education. Resources for leading science education were particularly scant in two of the schools we studied. Leadership priorities in these schools excluded science almost completely in favor of language arts and mathematics. Leaders in three other schools had recently paid some attention to science. For example, a new principal at one of the schools had a vision that included hands-on science for the primary grades and managed to identify and procure the resources to build a science laboratory and to hire a specialist teacher for this role. The building of laboratories for Grades 1–2 and 3–4, together with the existing subject area departmentalization of Grades 5–8, contributed to getting science on the school leader’s agenda. Although these schools were able to identify important resources necessary to lead science education, they were not (as of yet at least) successful in activating these resources to press changes in their science program. Three other schools in the study identified and activated a web of resources including the recruitment of teachers with knowledge about science, who in turn led efforts to transform science instruction at their grade levels and/or school-wide. Leaders at these three schools freed up space and financial resources to create science rooms and/or laboratories and established important science-related connections to local universities and institutions. Relative to those at the other schools in the research sample, leaders at these three schools were paying considerable attention to leading change in science instruction.

Absent their activation, the possession of resources does not automatically translate into their use in efforts to lead change in instruction. Some schools were able to identify and activate critical resources and use them to initiate and support efforts to transform science education. While the resources for science in comparison to other subjects were consistently limited across the schools, schools in roughly the same circumstances identified and activated resources for leading change in science instruction in different ways. Some schools successfully identified resources to enable leadership for science education, while others did not. Some schools that identified resources managed to activate them for leading reform of science education, while others did not. It is the identification of resources and their activation to support leadership for science instruction that distinguished Schools in our study from one another. We will illustrate this next through the case of Adams School, which has managed to give significant attention to science instruction. This case underscores that it is not the presence or absence of resources alone that is important, but how these resources are activated by human agents in particular organizational contexts.

Mobilizing Resources for Science Education Leadership: The Case of Adams School

The accountability measures of the Chicago public school system contributed to Adams School placing great emphasis on language-arts and mathematics instruction, a pattern common in our sample. Other subject areas such as science were intermittently emphasized as part of general efforts to improve instruction across subjects, but language arts and mathematics remained priorities. Efforts to improve student achievement at Adams were successful, according to improvement in test scores, and the district recognized these gains with Adams becoming, in fall 2000, one of a select number of Math and Science Community Academies in the city. In a district in which the priorities and incentives emphasize improving mathematics and language-arts instruction, how did science education find its way onto the agenda of Adams school leaders? Moreover, in a school where more than 90% of the students receive free or reduced-priced lunch and where there was a strong conviction among staff that these students needed to master the basics in mathematics and language arts, how did science get on the school's reform agenda? Framing our discussion around the various kinds of resources—human capital, social capital, and financial resources—for leadership, we explore efforts to lead science instruction at Adams. Our presentation highlights the strategic, interactive use of multiple resources in the development of leadership for science instruction.

By most teachers' accounts the transformation of instruction at Adams has taken place over a 12-year period with the tenure of the school's principal, Dr. Williams.[6] During this time Adams' coinciding leaders, with Williams at the helm, developed and sustained the school's capacity for instructional leadership by identifying and weaving together an array of resources and activating them in support of instructional improvement. Williams used her instructional knowledge to focus teachers' attention on curriculum and instruction and created opportunities for teachers to interact with each other. She supported ongoing instructional initiatives and identified and encouraged willing teachers, including two teachers with an interest in science, to take instructional leadership roles. These science leaders, in turn, drew on existing science initiatives in the school, notably the science fair and Adams middle school initiative, to create time and space for science and to identify and activate the resources for science leadership.

Most of the initial instructional resources for leading change in science teaching were connected to the school's instructional agendas for mathematics and language arts, resulting in leadership for science instruction occurring informally without any official sanction. Through connections with local universities, colleges, and science institutions, school leaders were able to access and mobilize resources for improving science instruction. The recent advent of a state accountability system for science instruction, coupled with Adams's designation by the school district as a mathematics and science academy, contributed to the establishment of a formal science coordinator position, designed to provide systematic support for science education.

Investing in Human and Social Capital for Instructional Leadership

Dr. Williams came to Adams as principal in 1988 and managed to shake things up, breaking down some of the walls between teachers and creating opportunities for them to meet and discuss their work. From the beginning she resolved to bring about change. An assistant principal explained, "I saw the transition. . . . I could remember the very first day that she [Williams] came in, and we had a meeting . . . that set forth her goal . . . to make sure that academically we were growing." Williams came with a strategy to achieve the goal of academic improvement. She explained that "the key is if you have a group of committed people [and to] try to work with them and arm them with the knowledge that they need to become professionals."

Developing her staff's human capital was at the core of Williams's reform strategy. According to the staff, Williams held them accountable for their actions and she set new expectations for them. For example, early in her tenure she removed from the school a particularly ineffective computer teacher who did not work with the other teachers: "I brought the data to a meeting that really documented the progress of the kids who have been in this program over time, and it was in black and white. . . . The children had not performed any better as a result of their participation. I moved her out of the lab and out of the building." Williams believed that actions like this helped to establish that she was serious about making changes in the school. As she stated:

> I think that with doing those kinds of things, people thought I was really serious, that I was not afraid, because [that teacher] was always able to do this power thing, and I guess you can say I was too stupid to know that.

Therefore, Williams not only provided opportunities for staff to develop their human capital, she also created very tangible incentives for teachers to do so.

Williams also shifted responsibility for the day-to-day managerial concerns, such as student discipline, to trusted, qualified administrative team members. This allowed her to concentrate on leading change in instruction, which she valued above her other roles.

> Before I became a principal, I [had] started a doctoral program in administration, and my goal then was to move into administration. . . . I dropped out of school [for a while, and then] I had the opportunity to go back . . . in curriculum and instruction. My philosophy had changed. . . . I feel that a principal now has to be an instructional leader first.

In the role of instructional leader, Williams emphasized the articulation, development, and implementation of curricula and became a catalyst for the staff to develop curricula that supported the school's goals and philosophy.

Williams's effort to build a focus on curriculum and instruction also included efforts to build relationships and get teachers to work together to develop the school's social capital. As one teacher explained, "Years ago, before Williams came, this school was a mess. No one worked together." Williams explained that when she first arrived in the school there was little communication.

> It was very strange. . . . There may be four classes at a grade level, and they did not even talk. They did not have a clue about what was going on in each other's classrooms. . . . It was a leadership issue for me because I could not see how kids could move from one grade level to the other and not have a common core of knowledge.

Efforts to build relationships and collaboration among the staff included the establishment of monthly grade-level meetings and school-wide mathematics and science committees. Teachers reported that these meetings enhanced communication and collaboration. A seventh-grade teacher commented that the grade-level meetings were important because:

> "It used to be in the school each teacher was like an island. It's the grade-level coordination that changes that the most. . . . It's the communication within grade level that makes the difference."

A second-grade teacher explained the importance of the collaboration and of experience sharing that occurs in these meetings:

> Our grade-level meetings are teacher-run. What happens is, you share what's going on in your classroom. Those meetings spark other things, too, other programs and ideas. I think it's very important because how would I even know what other classrooms are doing?

These sentiments were echoed by one of the school's assistant principals when she discussed the school's subject-matter committees: ". . . with the committees, the science, social studies, academic recognition, what have you, we have a chance to network more closely together. . . ." Getting staff to interact and talk with one another about work was a key ingredient in William's strategy for building the resources for instructional leadership at Adams.

Another important context for building relationships among the staff was the Teacher Talk sessions. In these meetings teachers met to discuss new research literature in education and curriculum and its relevance to their work. Although it took some time for these meetings to evolve, they came to be viewed as opportunities for substantive engagement with educational issues. After observing a Teacher Talk session, one researcher wrote the following field notes:

> I am really impressed by the fact that some teachers actually seemed to have read the article. They were actually engaging in a three-way (at least) discussion about the issues that were brought up by the piece. [Of] all of the schools that I've been in to date, this Teacher Talk has been unique.

These efforts highlight the importance of social capital development in Williams' efforts to lead instructional change. Adams' social capital depended in part on relations among staff, especially the prevalence of norms of trust, collaboration, and mutual obligation among teachers, teacher leaders, and administrators. Williams and others established organizational structures, including grade-level teams, subject-matter committees, and the Teacher Talk sessions, that involved the entire staff in order to support the development of the school's social capital. These efforts helped the school move from being a place where communication was rare to one where one teacher stated:

> We're family here.... We may not always agree. We have our share of problems like any other school. But you know, even brothers and sisters disagree.

The efforts of Williams and her colleagues got teachers interacting with one another and helped generate among the staff norms of trust and collaboration in which it was acceptable to disagree.

Williams adopted an instructional orientation to her role as principal and a set of skills that in the school context brought to bear her knowledge of instruction. She possessed significant knowledge of curriculum and instruction and was especially active in transforming language-arts teaching. However, she did not have a rich knowledge base in science teaching. For several years science was a back-burner subject for Adams' leaders, receiving little attention and few instructional resources. Williams and her leadership team built the human and social capital they believed essential for improving instruction and student achievement in language arts and mathematics. Science-related programs at Adams included the science fair and a middle school program, but neither were high priorities for Williams and her leadership team.

Getting Started: Leading Reform in Science Education

Two years after Williams' arrival, Jennie Clayton, who had recently earned a master's degree in math and science teaching, joined the staff as a fourth-grade teacher. Several years later she began teaching math and science to the school's sixth-grade students. With the advent of increased accountability measures in the school reform legislation of 1995, Williams decided to appoint subject-matter leaders to coordinate instructional leadership in mathematics and language arts. She made Clayton the school's mathematics and science coordinator. This reduced Clayton's classroom teaching responsibilities and allowed her to devote more time to developing curricula, increasing her knowledge, and developing resources for mathematics and science instruction. This appointment came in the midst of an initiative, sparked by a Carnegie report on adolescent learning, to develop a middle school program at Adams that would be attuned to the physical, emotional, and social needs of adolescents. Teachers in the middle school took courses together in adolescent psychology and learning, and they embarked on a collaborative redesign of the sixth-, seventh- and eighth-grade curriculum. In cooperation with Williams and Clayton, these teachers decided to make mathematics and science the instructional focus for the upper grades. This focus was slowly translated into practice, first in math and later in science.

The district accountability standards ensured that Clayton gave most of her attention to improving mathematics instruction at Adams. After all, without gains in math scores there would be no mathematics and science coordinator position. Clayton's work in math was extensive, particularly in providing staff development for new teaching approaches. Her attention paid immediate benefits, as the school tests scores over a 3-year period (1995–1998) revealed a nearly 15% school-wide increase in the number of students testing at or above national norms in mathematics.

Still, in her position as mathematics and science coordinator, Clayton instituted several initiatives that helped keep science on the school's reform radar screen. First, Clayton undertook to strengthen the science fair program and integrate it more effectively into the instructional program at Adams. Although not an innovation, in some respects the science fair reflects reform ideas around hands-on science (Walker & Gomez, 1998), and it was well established at Adams. Teachers were accustomed to helping students prepare for the annual science fair, and Clayton built on this tradition to press for a more integrated approach to experimental science. Together with the science teachers across several grade levels, Clayton developed an exam on the scientific method. Next, she developed a procedure and rubrics by which students proposed and completed science fair projects for a class grade. These actions stressed the importance of reorienting instruction toward students doing hands-on projects that they themselves selected. At the same time her approach embraced a built-in performance assessment, the science project itself, whose visibility within the larger school community signaled to teachers and parents the value of science at Adams.

Recognizing that a single period was insufficient for project type work, Clayton and Williams instituted a weekly double-period program for science classes. This gave teachers more time to orchestrate the kinds of learning advocated by the reforms, that is, hands-on learning. Clayton also developed a science laboratory for the double-period. These changes signified the recognition that time and space needed to be reorganized for science instruction and that hands-on activities are necessary for learning in science.

Clayton played an important role in galvanizing the school's internal resources—time, space, human capital—for science instruction. She worked with Williams to procure financial resources and to identify and establish connections to external resources. In addition to finding money in the budget to create Clayton's position, Williams worked with Clayton to fund an assistant to help enact mathematics and science initiatives. Clayton described the relationship with her assistant, noting, "We have been a team since I got the job . . . I do not view her as an assistant. We have put together a program, and we were a two-woman team." At Adams, then, financial capital, including financial resources for time, staffing, and materials, was critical in efforts to lead change in science education. The allocation of time created opportunities for teachers and leaders to reflect on their practices and collaborate with each other. A key indication of school instructional priorities in the mid-'90s was the creation of both Clayton's position and the position of mathematics instructional assistant to support the teachers at Adams. Still, because science teaching was not among the instructional priorities pushed by district accountability measures or most school leaders, Clayton devoted most of her time to mathematics.

Social Capital and Leadership for Science Education

Williams and Clayton built relationships through connections with local universities, colleges, and science institutions, and the school district itself, which helped the school mobilize and leverage more resources for leading science. As one staff member noted:

> [Williams is] a person who was on top of all of the current issues statistic-wise, you know, according to research, and she stayed in contact . . . with university contacts or what have you. . . . Whatever information she found, she would pass it down to us. And we were able to look at it and see what we needed to do to apply it to our school.

Relationships were forged with several local universities, science consultants, and the district's Chicago Systemic Initiative (CSI), which focused on improving mathematics and science instruction in district schools. A specific example of these external networks involved collaborations with Ward, a science expert from a local college, who Clayton introduced to the school. Ward worked directly with the upper-grade teachers, focusing on their implementation of the hands-on science curriculum. One school leader explained: "We have Ward who worked with the middle school, eighth graders for several year. . . . He worked with the science department. And so they really got themselves organized." This external network established by Clayton—a form of social capital—was an important resource in the development of human capital among the upper-grade teachers.

Relationships with outside sources created opportunities for professional development among teachers, which were encouraged and supported by school leaders. Dr. Williams explained the importance of providing these professional development opportunities, noting, "I feel personally that that is important because if you look at the citywide structure, there are just not enough opportunities for teachers for professional growth and maturing within their profession." Williams worked to help faculty members increase their skills by identifying and allocating the resources necessary to support the science program. External associations provided opportunities for professional development critical for developing the school's human capital for leading reform of science education. Adams's participation in the district's CSI was one example. Moreover, the CSI provided opportunities for staff, first Clayton and later other teachers, to take on leadership roles in science instruction.

The relationships with external institutions and the school's ability to identify and activate them to develop the school's capacity for leadership, demonstrates the importance of a second form of social capital—a form derived through social networks. This type of social capital involves the ways in which faculty and staff are networked to external agents and agencies—parents, universities, consultants—and other resources that help school employees carry out their work. Although relationships with outside institutions created opportunities for science teaching at Adams, such relationships presented special challenges of direction and control. Williams paid careful attention but not because she wanted to stress her faculty with multiple instructional initiatives that might pull them in different directions. A blizzard of instructional initiatives in a school environment can easily lead to a fragmented instructional vision as teachers race to complete "new" curricula so they can acquire some particular resource. Williams filtered access to the resource by keeping track of individual faculty participation in professional development programs as well as overall school instructional priorities in an effort to both increase faculty competence in teaching science and identify emergent leadership in the subject area.

Intersection and Interaction of Capitals for Leadership

External networks were an especially important resource when it came to developing the human capital and material resources needed for leading instructional change at Adams. A critical component of social capital is its role in facilitating the development of other forms of capital. Coleman (1988) has argued that social capital, in the form of external relationships, is critical to the development of human capital. This was evident among Adams's teachers and school leaders. By forging and maintaining relationships with outside resources, the school was able to enhance its collective knowledge about science instruction. Associations with experts from local universities served as an important source of knowledge for school leaders when it came to instruction in general and science instruction in particular. These relationships also provided access to financial resources in the form of money and science materials that helped in the implementation of instruction and instructional change in science.

The role of social capital in the building of human capital and in the emergence of leadership is exemplified in the case of Steve Loomis, a teacher certified to teach both math and science. When Loomis first came to the school, he found that science instruction was not emphasized.

> The first couple of years I got into schools, science was not pushed as hard as it is now. They were saying, "Make sure these kids pass the IOWA test in reading and math." I integrated science and social studies into my language-arts teaching.

Loomis was unhappy in his position when Williams arrived, having worked under two interim principals in an environment in which the teachers kept to themselves: "I didn't know if I could deal with the situation." Williams, however, knew she wanted to keep Loomis in her school and communicated this to him. Loomis explained:

> As soon as she came in, we sat down and talked. She said, "I want to keep you. I just want you to know that there will be a lot of changes coming on as long as I'm here. . . . You are part of what I want to see for the future."

In 1994 Loomis moved to the sixth grade, where a strong mathematics teacher was already in place.

While Clayton defined her role as math and science coordinator, Williams encouraged Loomis to take on the responsibilities of designing engaging science instruction for the newly departmentalized sixth-grade class. His professional development depended heavily at first on participation with the Academy of Natural Sciences' Science on the Go series. This involvement gave him access to hands-on science units that made use of inexpensive and readily available supplies and provided him with support from Science on the Go staff members, who made regular visits to his classroom. Later Loomis participated in collaborative design projects involving the development and testing of project-based science curriculum units with outside agencies such as Northwestern University and Roosevelt University. Another university supported Loomis in sponsoring an after-school program to help students prepare science fair projects.

When Clayton took on the assistant principal position in 1997, Loomis acquired the added responsibilities of the science coordinator in addition to his full-time role as sixth-grade science teacher.[7] Loomis found that he did not have either the time or energy to play a strong role as science coordinator for the school. It would take an additional 2 years for Loomis to be released from his regular responsibilities as classroom teacher to assume the leadership role implied by the title of coordinator. Financial resources that accompanied the school's designation as a math and science academy eventually made possible the reassignment of Loomis from classroom teacher to coordinator. Until this occurred, Loomis continued to receive support from the principal for his professional development. The principal assigned Loomis and a language-arts teacher in the school to develop a curriculum with Northwestern University, paying them to work together after school hours to adapt the curriculum to the school. From Williams' perspective, the school thus gained both curriculum development knowledge and further developed collaborative relations among the teaching staff.

During this time Loomis also continued to ensure the science fair happened every year. This brought him together with the other science teachers, but leadership for science fair was typically administrative, involving forms, rules, and the basic question of the nature of science fair projects. Staff development in and discussions of science instruction related to science fair activities were impromptu and informal. Although to the larger school staff the science fair represented the school's science program,[8] from Loomis' perspective it was not sufficient to serve as a catalyst for leading change in science instruction: ‘‘[The science fair is] just not enough.’’ Loomis also took on what had been Clayton’s role in implementing the CSI program. In implementing this initiative, Loomis made use of the lab that Clayton had set up and the double-period scheduling for science.

It was his experience working with external organizations that led Loomis to push for a redefinition of his role as a science instructional leader in the school. His collaboration with Northwestern University’s Center for Learning Technologies for Urban Schools (LeTUS)[9], for example, allowed him to participate in a variety of curricular design workshops and gave him access to a wide variety of professional contacts and curricular resources to develop his teaching. In talking about a unit focused on the question of why it is necessary to wear a bicycle helmet, Loomis commented,

> They are trying to teach where moving mechanics is meaningful. I like that part about using an egg and how would you protect that egg and how your head is like, you brain is like an egg. You are going to show what happens to that egg. They have to picture their brain as being like that egg.

Working from an understanding of the bicycle helmet unit, a group of teachers, including Loomis, and Northwestern researchers, created another 8-week science unit. Loomis gained experience in working with sensors as part of these activities and decided to do a staff development session on sensors for the other science teachers and for the fourth- and fifth-grade teachers at Adams. ‘‘The sensors’’ he commented, ‘‘provide excellent tools for use in science fair projects.’’

Loomis had opportunities for influencing science instruction when he could find the time, but he personally did not receive much support or guidance within the school. He did not interact much with the science teachers at the seventh- and eight-grade levels of the middle school. When asked to whom he looked in the school for support in teaching science, he responded, ‘‘Just me.’’ Loomis’ isolation as science teacher stands in sharp contrast to the support he received for language-arts instruction. During weekly grade-level meetings he and his colleagues planned and coordinated their language-arts instruction. His prep periods were periodically spent creating integrated curricula around novels with other grade-levels teachers. Although he and his colleagues shared responsibility for language-arts instruction, Loomis had sole responsibility for science instruction. Loomis was not aware of what the other science teachers did instructionally in their classrooms.

Perhaps because of his accumulating professional development experiences with external organizations in science instruction, Loomis decided to press for a position as science coordinator for the 2000–2001 school year.

> My ideal position at Adams is as a science specialist. I could see myself overseeing the science program at the middle-school level, cleaning out the science lab on the second floor, and creating a new math-science teaching position at the school.

Shortly after this conversation, Adams was named as a Chicago public school community math and science academy, creating a funded position for a mathematics and science co-ordinator. Further, shifting school accountability measures recently began to include statewide measures that test students in science and social studies in addition to mathematics and language arts. Designation as a math and science academy enables Adams to access additional resources to support ongoing mathematics programs and initiate new science initiatives. The *academy* designation and the new accountability measures gave Williams the opportunity to appoint Loomis as science coordinator.

At Adams human and social capital for leading science education developed in tandem. The selection of Clayton as mathematics and science coordinator and her efforts to develop the school's human capital for leading science education also provided opportunities for social capital development by getting teachers to collaborate on science-related projects. Further, Clayton's and William's identification and activation of social capital in the form of external networks—a key source of professional development—were critical in building the human capital for science education leadership in the school. A similar situation emerged with respect to financial resources. Science teaching always presents special challenges in resource-starved urban schools in which the technological infrastructure to provide good science teaching, lab equipment, computer resources, and renewable materials is often in short supply. Although district initiatives have encouraged schools to use instructional resources to support mathematics and science instruction, science instruction often has depended on resource support from outside the school. The identification and activation of contacts with external agents and agencies has been critical in procuring some of the material and financial resources necessary for leading change in science education.

Although many of its recent professional development efforts in the school have been in language arts, Adams has developed a base of qualified professionals and a network of resources for science education. Its science-related resources network has its origins in Clayton's efforts and follows directly from the conditions of collaboration and professional judgment Williams has encouraged throughout the school. Yet it is the development of human capital in the school for science education, the professional development preparation of Steve Loomis in particular, that holds promise for bringing ideas of science education reform to the teachers and into the classrooms. Loomis has current knowledge of curriculum development and science education practices. He is also integrated into the staff of Adams and is supportive of its priorities, even if at times these overshadow science. Instructional change in science is part of the school's larger efforts to create learning environments that are engaging for students. Teachers such as Loomis are leading their colleagues away from reliance on textbooks and lectures and toward greater use of project methods in instruction. In science these methods come in traditional form—the science fair—and in innovative form: project-based science.

Leadership for science instruction at Adams School, a K–8 public school in Chicago, reflects the complexities of subject-matter leadership in urban elementary schools. This case of science instruction leadership shows how a shifting interplay of district and local accountability measures, external resources, traditional conceptions of science-teaching practice, and individual teacher initiatives has shaped the Adams science program. At this school the transmission model of instruction—that knowledge can be poured into students' heads—is being actively challenged through methods that emphasize the construction of knowledge. The question of teaching quality at Adams is an important issue that is beyond the scope of this article. Here we have focused on leadership for science instruction and how creative configuration and use of resources help to create the conditions that facilitate instructional change.

Discussion and Conclusion

We have argued that although science instruction is devalued in elementary education and resources for leading change in this instructional area are limited, some schools are able to successfully identify and activate resources to support leadership initiatives designed to transform science instruction. Those schools that do this have been able to do so through the skillful deployment of strategies of action (Swidler 1986) that draw on the available resources in the educational context. The identification and activation of material resources, the development of teachers' and school leaders' human capital, and the recognition and use of social capital both inside and outside the school must all be juggled simultaneously with an eye toward accountability measures and the desires of the school community. Our account has brought to the surface at least four issues related to the identification and activation of resources for leading instruction.

First, the resources necessary for leading change in instruction involve more than the knowledge and skill—the human capital—of school leaders. School leaders who have knowledge and expertise in science, teaching, learning, and leading change are undoubtedly important. However, human capital represents only one dimension of the resources needed to lead change in schools. The creation and allocation of social capital and financial resources are also important. Resources do not only come from knowledge possessed by individual organizational members. Social capital, both as trust and communication within the schools and as networking outside the school, facilitates the development of human capital and helps expand the resource base available to schools. In the case presented in this article, school leaders worked to build social capital at Adams by deliberately creating structures that supported communication and interaction among the staff. The example of the Teacher Talk meetings, during which teachers discussed their practice with each other and developed relations with colleagues, is a critical location for the development of social capital. In addition, the principal and other school leaders drew on external networks to bring in resources from local universities and education organizations in support of the school's instructional program. Links with these external agents and agencies helped generate material and fiscal resources as well as the human capital for leading instructional change in science. In a certain sense, this is an example of the conversion of social capital into human capital. Especially in resource-hungry and marginalized subject areas, such as urban elementary science education, networks of relations create the capacity for change and reflection. Taken together, the various species of capital complement and enhance each other, creating the conditions for the possibility of leadership for science instruction.

Second, based on our account we argue that in analyzing the types of capital necessary for leading instructional improvement, a distributed perspective is both necessary and productive. Consider human capital. Our account illuminates how different aspects of the knowledge and skill needed to lead change in science education were distributed across different formal and informal leaders at Adams. For example, the principal at Adams school had a great deal of knowledge about curriculum and instruction but relied on her science experts when it came to the subject matter and pedagogical knowledge of science needed to forge change in that subject. Different actors bring their different knowledge and skills (i.e., human capital), sometimes together, to the task of leading instructional change. This pooling of human capital enables a different form of leadership than that which an individual leader could have engaged in on his or her own (Spillane, Halverson, & Diamond, 2000). Hence, the group rather than the individual is the more appropriate unit when investigating the resources for leading instructional change.

The importance of focusing on the group rather than the individual in order to understand a school's human capital for leadership underscores the importance of other species of capital. Some measure of social capital is essential if school leaders are to pool their knowledge and skills and work together to lead instructional change. Social capital can be critical to the creation and the mobilization of human capital because individuals who trust one another are more likely and able to pool their knowledge and skills in order to lead instructional change. Further, social capital is important in the transfer and development of knowledge among organizational members. And, of course, social capital in the form of networks is essential if schools are to tap essential resources in their environment. Likewise, resources such as time and materials are important if school leaders are to have opportunities to develop their human capital and potentially to build stronger relationships with their colleagues. Hence, the resources for leading change in science education reside in the interaction of different species of capital rather than in any one species. Developing the resources for leading change in science instruction involves identifying and activating these different species of capital because it is their interaction, the interplay between them, that generates the capacity for leading instructional change.

Third, in investigating the identification and activation of resources for leading science instruction it is imperative to look beyond the particular school to the multiple contexts in which that school is nested. As the Adams case illuminates, an interagency perspective, as distinct from an exclusive focus on the individual school, is important. Specifically, to understand the resources for change at Adams, it was essential to look beyond the school to the various agencies with which Adams' staff networked in order to forge change in science education. Analyzing a school's resources for leadership requires careful attention to the ways in which school leaders engage agencies and agents in the school's environment in their efforts to lead instructional change. Further, shifts and changes at different levels of the school system have consequences for resource identification and activation at other levels. As the Adams case demonstrates, changes in the local government and state policy environments had important consequences for the activation of resources for science instruction at the school. District accountability policies that targeted literacy and mathematics contributed to science not making it on to the school leaders' reform agenda (at least initially). At the same time these initiatives did contribute to the activation of resources for leading mathematics instruction, resources that were later key in the development of resources for leading science education. Similarly, recent shifts in state policy coupled with the district designation of Adams as a mathematics and science academy influenced the identification and activation of resources for science leadership at Adams.

Finally, simply identifying and naming the resources necessary for leading change is insufficient. Understanding the activation process is essential. The strategies of action engaged in by social actors in school contexts is important. Although schools may be embedded in contexts with similar configurations of support, accountability mechanisms, and external resources for science instruction, some schools are still able to parlay these resources into substantive efforts to lead change in science instruction. We argue that the skill with which these resources are identified and configured by school leaders is important.

Notes

[1]Swidler's work is most concerned with understanding culture. She argues that culture provides social actors with tool kits that facilitate the development of strategies of action. Her primary concern is to move the sociological examination of culture away from values and toward a framework that emphasizes culture as a resource for action. We borrow from her work, particularly to explore how people configure resources for action and how these configurations may differ when objective resources are similar.

[2]Here we borrow from Lareau (1989) and Lareau and Horvat (1999), who examine the role of cultural capital in parents' educational participation. In studying the conversion of cultural resources into cultural capital, both studies emphasize that resources must be *activated* in order to become capital. The ideas of

Lareau and Lareau and Horvat help us highlight that resources for innovation in science instruction must be activated to be meaningful in instructional transformation.

[3]The instructional leadership measure assesses teachers' perceptions of principal and teacher leadership (e.g., questions about setting standards and communicating a clear school vision) and is based on interviews with school personnel and observers of the system. The *academic press* measure gauged the extent to which students felt their teachers pushed them to reach high levels of academic performance. For *professional community* we used measures of collegiality (the degree of a collective work ethic among the staff), teacher–teacher and teacher–principal trust, and shared norms among staff. Finally, for the *academic productivity* measure we used ITBS scores to determine the academic gain for students spending the entire year at individual schools. This measure was used to determine the productivity of schools over time.

[4]Although we use the consortium's data on ''academic productivity,'' a weakness with this measure is that the ITBS is inadequate to assess students' mastery of more challenging reading and mathematics content.

[5]Each Chicago school has a site-based management team called the Local School Council that includes parents, teachers, community members, and administrators.

[6]The school name and the names of all school personnel are pseudonyms.

[7]Two middle-school teachers split the role of math coordinator.

[8]School discussions about the science fair illustrate how it continues to act as a framing artifact for science instructional efforts in the primary grades. A first-grade teacher, Irene Lorenzo, is regarded by her colleagues as a science resource teacher. Together with her first-grade colleagues, she designed a science program that would help children build the skills necessary to compete in the required science fair project by the fourth grade. Lorenzo commented that the problem with having the primary school children do a science fair project is that there is little support or knowledge at home for such independent investigations. What the teachers needed to do was model for the children the inquiry skills they could then share with their parents:

> It may be that you will send it home, and it will come back totally done by the parent. They want their child to succeed, they figure that this might be too hard for the child, whatever the reason; then the child, once we've done it in the classroom, can say, ''No, we've done it this way, we did it this way at school,'' and [parents] can help as work as partners at home. So we figured that the more we could do together in the classroom, the more comfortable the child would be in working together with the parents at home or to get some help.

The first-grade teachers then decided on a series of experiments that would first introduce children to science as a methodological investigation of the world, then shift to the different domains in which science applies, so that when the students reached fourth grade, they would be familiar with the processes of scientific investigation.

> We at first decided to simplify it for parents. But then we decided, Wait a minute—what we need to do is model for the kids, model the experiments. We still don't have it right, but we need to model the scientific method and have the kids go home and try out the experiments.

Further, when students were recognized for science achievement at a recent end-of-the-year honors and awards assembly, students in Grades 4–8 were given certificates for first-, second-, and third-place finishes, by grade, in the city science fair.

[9]LeTUS is a National Science Foundation–funded project in which the Chicago and Detroit public schools, the University of Michigan, and Northwestern University collaborate to develop and implement teacher- and researcher-designed technologically rich project-based science curricula for urban schools.

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