Running Head: Leadership Supporting Teacher Learning

**Leadership Practices that Facilitate
Effective Teacher Learning Environments**

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Abstract:

Five case studies of team-based technology leadership in schools with laptop programs are analyzed for their teams' membership, focus, and practices, and the implications of these configurations for teachers' learning environments about technology-supported instruction. In these sites technology leadership is expressed through artifacts such as a technology vision, providing instructional support personnel, aligning the technology resources to the curriculum, and ensuring opportunities for teachers to learn and to provide their input. These leadership practices are related to how they make teachers' learning environments more community, learner, and knowledge-centered.

Leadership Practices that Facilitate Effective Teacher Learning Environments

An emphasis across the nation on raising student achievement and the complexity of this work has intensified the interest in studying school improvement, and effective classroom instruction. Studies have shown that leadership matters for school improvement; indeed its effects are considered increasingly important the more demanding the situation is (Leithwood, Louis, Anderson & Wahlstrom, 2004). The focus on instructional leadership and its complexities has contributed to increased interest in how positional leaders might work with instructional specialists and teacher leaders to improve teachers' instructional practices, including how to create effective learning environments for teachers' professional development.

Because of its potential to improve classroom instruction and student achievement U.S. schools invested heavily in educational technology; for example over $5.8B in 2003 alone (QED, 2004; Hoff, 2005). One of the most rapidly growing implementation models is one-to-one student to laptop configurations (Zucker, 2004). These one-to-one laptop implementations demand not only a huge monetary investment, but a huge leadership effort as well because rapid technical change and highly uneven distribution of expertise make technology leadership particularly challenging. There has been little research on technology leadership in general, and even less on how leaders design effective opportunities for teachers to learn about how technology can support instructional innovations and improvements. Schools with laptop programs can serve as optimal opportunities to learn about what leaders must to do in situations that demand strong team-based instructional leadership in that the technical support structures that are required for laptop programs as well as the enormous monetary investments they require are likely to focus leaders' attention on implementation and instructional issues. In this paper I examine five case studies of team-based technology leadership in schools with laptop programs to analyze the teams' membership, focus, and practices, and the implications of these configurations for teachers' learning environments about technology-supported instruction.

Literature Review

At the majority of schools in the U.S., there is a team of people involved in leading the planning and support of technology uses. Nearly 80% of U.S. schools have a technology committee and technology support is, on average, provided by a team of 2-3 people (Ronnkvist, Dexter & Anderson, 2000). Team members typically include the principal and a technology coordinator, and nearly half the time (47%) the additional others included teachers

Principals' involvement with technology responsibilities at the school---establishing a technology committee and budget, personally using technology, spending time on and setting aside money for technology planning---positively influenced teachers' and students' classroom uses of technology, more so than technology infrastructure or expenditures (Anderson & Dexter, 2005). Technology coordinators focused on instructional support issues can establish direction for and exert influence on teachers' technology-enhanced pedagogy (Dexter, Seashore & Anderson, 2003). Teachers who assist the technology coordinator or serve as experts to or even collaborators with their peers nurture a sense of professional community at the school (Dexter, Seashore & Anderson, 2002; Ronnkvist & Anderson, 2001).

To achieve the best uses of educational technology in support of learning at a school it is likely its teachers will need opportunities and support for learning (Zong, Pugh, Sheldon & Byers, 2002). Research shows that this is a significant challenge; high-quality technology

support contexts are found in less than 15% of US schools (Ronnkvist, Dexter & Anderson, 2000), but when present supports teachers learning together about instructional uses of technology (Dexter, Anderson & Becker, 1999; Dexter, Seashore & Anderson, 2002). Bransford, Brown and Cocking (1999) synthesize the last ten years of research on learning and suggest four elements for effective learning environments, which can be applied to teachers' learning environments. They should be learner-centered, taking individual learner needs into account; knowledge-centered, directed toward developing deep understanding; assessment-centered, using assessment mechanisms to guide the learner; and community-centered, allowing for social processing of information. In terms of technology integration, this suggests that teachers need formal opportunities to learn that are appropriate for their starting point yet in-depth on what effective technology uses look like in their subject area, that they should receive feedback on their integration efforts and that this be bolstered by informal learning and support from a community of peers.

While this research establishes it is a team of people, probably including the principal, technology coordinator, and teachers, who will carry out technology leadership at a school and that such leadership will need to attend to the purpose of and access to the technology, as well as how best to support teachers learning to use it in classroom instruction, there is little knowledge of how these leadership functions and interactions should be shared and coordinated among the technology leaders. That is, who does what in such a way that teachers' instruction and student learning is supported by the presence of technology? Improved theoretical direction is needed on how leadership and resources optimally combine in utilizing technology to support teaching and learning goals. Refinement of the conceptual dimensions of technology leadership would help to address the challenge of optimally defining how technology leadership and resources interact.

There is increasing interest in how groups of individuals might work together in a school to lead a common goal. Chrispeels has referred to this phenomenon as "shared leadership" (2004); others have described groups of professionals working together as "learning communities" (DuFour & Eaker, 1998). Spillane and colleagues (Spillane, Halverson & Diamond 2001, 2004; Spillane, 2005; Spillane & Orlina, 2005) have used the phrase "distributed leadership," to capture how leadership consists of the practices of multiple leaders, and emphasizes how this takes place in "the interactions between leaders, followers, and their situation" (Spillane, 2005, p. 144). With its emphasis on leadership practices as influenced by the context in which they are set, distributed leadership allows for the technology infrastructure itself to become a part of the conceptual model of technology leadership and thus recognizes explicitly how the programmatic goals for technology will contribute to the definition and construction of the technology leadership practices. From this approach the emphasis of study are the tools, structures, and routines—or artifacts (Halverson, 2003, 2005; Halverson & Clifford, 2003)—of leadership practices that are created through various procedures and policies in order to accomplish programs or tasks.

The work to date on distributed leadership has been applied to instructional leadership (e.g., Camburn, Rowan, Taylor 2003; Goldstein, 2004), yet I was unable to locate a study of technology-supported instruction as the distributed leadership focus. Yet this topic is an excellent instance for further exploration of distributed leadership studies: the outcomes of leadership are clearly recognizable in terms of teachers' learning and their technology-supported instruction in classrooms, and it is nearly always carried out by a team of people. Technology leadership has distinct technical or operational as well as instructional components, as do most leadership issues. Thus, the impact of whom the leadership is distributed among and the influence of the

context on their practices is all the more evident. This cross-case analysis of these five case studies serves as one contribution of the application of distributed leadership to the study of technology leadership.

Data & Methods

All five schools included in this cross-case analysis had students in the sixth, seventh and eighth grades; we focused our interviews and observations upon teachers of those grades, although one school enrolled students from Kindergarten through the eighth grade and that school had considerably fewer students in grades 6-8 than the other four schools. The sites varied as to their location and the socioeconomic and racial make up of their student bodies. Demographic information about the five sites analyzed in this paper is provided in Table 1.

Table 1
Demographic Information for School Sites

School Name*	Level	Grades Served	Enrollment	District Type	Percentage Poverty[a]	Percentage Minority[b]
Fulton Middle School	Middle	6-8	1,017	Small Town	47.15	24
Shelby School	Middle	K-8	550	Rural	28	36.7
Lewis Middle School	Middle	6-8	890	Suburban	62.3	76.3
Lincoln Middle School	Middle	6-8	972	Urban	59.67	87.2
Jackson Middle School	Middle	6-8	551	Urban	21.9	54.7

[a] Free and reduced lunch percentage
[b] African American, Hispanic, Asian, Pacific Islander, American Indian, Filipino
*School names are pseudonyms.

Each case's site visit involved a team of four researchers working at the school site for one to three days. These days were used for conducting interviews with the principal, one or more technology coordinators, other administrators relevant to the school's laptop program, four to six teachers, and several students in these teachers' classrooms. In addition, the researchers at each site observed one to three classrooms and created observation notes. All interviews were recorded and transcribed. Researchers also collected relevant site documents. The data sources are summarized in Table 2.

Table 2
Summary of Interviews and Observations

	Teachers Interviewed and Observed	Administrators and Technology Leaders	Students Interviewed
Fulton Middle School	3 individually interviewed and observed (Science /Math, Math, English), Teacher Focus	Superintendent, Director of Technology, Principal, Technology Coordinator	Student Focus Group

	Group		
Shelby School	2 individually interviewed and observed (6th grade/Tech skills, Science) Teacher Focus Group	Superintendent / Principal, Technology Coordinator	Student Focus Group
Lewis Middle School	6 individually interviewed and observed (Science/Math, Math Science /Math, Science / Math, Science, Humanities (Social Studies and English), Teacher Focus Group	Laptop Project Director , Director of Information Systems, Principal, Technical Support Specialist, Staff meeting observed, Tech Core meeting observed	Student Focus Group
Jackson Middle School	4 individually interviewed and observed (English, Math, English/ Gifted and Talented, Science)	Assistant Superintendent of Secondary Instruction, Director of Technology, Principal, Library Media Specialist, Technology Support Specialist	Student Focus Group
Lincoln Middle school	3 individually interviewed and observed (Science, Math, English)	Assistant Superintendent of Secondary Instruction, Director of Technology. Principal, 7th Grade Vice-principal , Technology Support Specialist, Technology Committee Meetings observed)	Student Focus Group

All interview transcripts and documents were analyzed with a structured coding scheme that was derived from the conceptual framework for the study. This scheme contained seven main coding areas. The first was about the innovation or reform itself and is designed to capture information about the 1:1 computer to student program, the history and scope of that innovation, including its goals and origin, the curricular/subject areas involved and its instructional organization. This allowed us to compare programs on the basis of their purpose and intent to improve the quality of instruction. A second code area is about the school itself and allowed us to organize information about the site, including background information on and the demographics of the school and its community. With this code we also tagged pertinent information about the school culture, its leadership, and any external relationships the school established to aid their technology implementation. This group of codes allowed us to capture relevant meso-level information about the school's setting and how together they helped to create a favorable context for the classroom uses of technology.

Another set of codes focused on the technology and the technology support present at the site. These codes supported our analysis of the vision for technology and the specifics of what

the site has put into place, how it is kept working, and how teachers are prepared for its use. The next two sets of codes focused on students and teachers and their roles, practices, and outcomes. Together, these codes support the description and analysis of the classroom-based teaching and learning with technology. The final two sets of codes allow us to capture the elements of the site that contribute to the sustainability and transferability of its innovation. We differentiated between elements of the innovation itself, the classroom, school, and district components. These two codes were often used in conjunction with other codes.

The author coded all of the interviews from the schools reported upon here. Codes were assigned to sections of transcripts with the qualitative analysis program NUD*IST NVIVO. This program allows any length of the segment of text to be coded with as many codes as the analyst sees fit to apply. After all coding was complete the NVIVO program was used to gather all text segments from that site's transcripts into a report for each code. These reports were then analyzed to determine the main points and themes within each code area. The points from the codes "about the school", and "technology and technology leadership" provide the basis for the findings presented in this paper.

In addition to the qualitative data collected, we asked all teachers at the five school sites to complete a 23-item survey asking them about their uses of the laptops, the technology leadership and support environment at the school, and the teachers' sense of professional community about technology use. Descriptive statistical analyses on survey data were carried out using SPSS to determine the extent to which data recorded in observations and interviews generalized to the individual school site. Those data are not reported upon here but are drawn upon for the case reports for each school (c.f. http://ubiq.edtechcases.info)

Findings

At each school the team of technology leaders there created a system of technology leadership practices that followed from their vision for and the distribution of the laptops among teachers and students, and was expressed through various artifacts, including technology staff members' assigned roles, committees, and professional development opportunities. The system employed at each school varied, as did its impact.

Fulton Middle School

At Fulton Middle School the main goal of its Laptop Access Program is described by the Superintendent as "instant access anywhere for any student at any time." The district initially purchased laptops that they distributed to every eighth grade student, but when they were financially unable to expand that distribution model to other grade levels they then concentrated the laptops onto carts. Now, teachers of any grade can check out a cart of laptops and roll it into class so as to provide all the students with a laptop. If all the school's carts were in use at the same time, about one-third of its students would have a laptop to use.

The district's technology leaders are the Superintendent and the Director of Technology. The technology leadership needs are mainly technical in nature, which is in keeping with the tone of the main goal of its Laptop Access Program. The Director of Technology and the Superintendent meet as often as they deem is necessary, and the Director of Technology meets once a month with all of the district's school-based technology coordinators to train them to use tools so they in turn can train teachers at their school, and to offer help or information with

technical issues the coordinators face in their buildings. The director's staff members also offer some after-school classes on different pieces of software that teachers from any school in the district can choose to take.

There are technology leaders at the school level who follow very closely the direction from the district's technology leadership. The school leaders are two full-time classroom teachers who serve as technology coordinators and troubleshoot computers and aid teachers with other technical supports they require; they are paid a stipend for this extra duty, which they complete during their prep hours or before or after school. The principal described herself as involved with technology leadership to the extent she meets regularly with the technology coordinators, but she said she is not actively pushing for technology use by the teachers. This was a conscious decision on her part, as she felt it was not fair to push teachers to use technology when she could not provide adequate support and training for them to do so. There is not a technology committee at the school.

The teachers at Fulton Middle School who were interviewed recognized that while their building's technology coordinators were doing the best they could considering that they were also teaching full time, they wanted more help at the school so as to speed up the response time for technical problems. As one commented, "You have to fill out a paper and wait until they get around to whatever." Another concluded, "I think we've learned that we've got to do it ourselves if you want to make it work." Most of the interviewed teachers and the principal felt that there was an inadequate amount of instructional support for teachers to learn how to integrate technology into the teaching of their subject areas. During the teacher focus group, several teachers expressed frustration that what they needed was someone to show them how to use the computers to teach their content, not just how to use the hardware and software. When one teacher stated, "If I want to know something, I just teach it to myself," several others nodded in agreement. A few teachers indicated that they had a colleague who was knowledgeable about technology use in their content area and exchanged some ideas with them.

The effort to provide technical support to teachers at Fulton Middle School appears to have distracted its technology leaders from focusing on integrating technology to support instruction. The principal stated that she had backed off promoting the integration of technology to her teachers, and the technical coordinators reported spending the majority of their time on technical rather than instructional concerns. In interviews and the focus group, the school's teaching staff did not report having engaged in school-wide discussions about the laptops and their uses in the classroom. Overall, in this school and district the technology leaders focus mainly on technical issues, as there seems to be unmet needs in this area and the goals of the laptop initiative are mostly stated in terms of laptop access for students and teachers using technology for administering tests or accessing email.

Shelby Union

In the one-school Shelby Union School District, the official purpose for the laptops was focused on providing computer access to students. The superintendent began the laptop initiative with the idea that it was important to provide a tool identical to the parent's so the child would identify with business and the marketplace and could use that tool any time that they needed to. At Shelby, the parents were encouraged to buy their sixth grade student a laptop. About half of the parents of sixth graders each year did so; in addition, the school also has a half dozen laptops that could also go to classrooms to provide about a two-to-one ratio of student to laptop access for the students whose parents had not purchased them their own laptop.

The two technology leaders are the superintendent and a now full-time technology coordinator. They described their main technology leadership practices as keeping parents aware of and investing in the laptop program, providing technical support for the laptops and network infrastructure, and training the sixth graders on and working with sixth grade teachers about the operation of the laptop and its software. This emphasis on access and computer literacy is congruent with the stated purpose for the laptop program. Because of its small size, the K-8 school did not have an official technology committee. The superintendent explained that the whole staff meets every Thursday and that the technology coordinator usually makes a technology presentation the first Thursday of each month.

The full-time technology coordinator provides the technical support for the Shelby Union School's teachers' integration of technology into their classrooms. As needed, the superintendent aids him in providing technical support and gives input or guidance on technology-related administrative matters. All of the teachers we spoke to concluded that the technical support they receive is very good and indicated that the technology coordinator responds to their requests for help on the same day, and often nearly immediately. In the teacher focus group, the sixth, seventh, and eighth grade teachers concurred that they were lucky to have a full-time person dedicated to technological support. As one teacher put it, "This is a luxury that we have here at this school."

Although the technology coordinator is designated an instructional support person, he, the superintendent, and the teachers all reported that the majority of his time is spent providing technical support or completing administrative tasks related to the school's technology. The technology coordinator also felt there were limits to how much he could suggest to teachers in terms of new things they could do in their classroom with technology:

> It is hard to walk into a classroom when the teacher's been teaching for 30 years and say, "Hey, I've got a better way for you to do this." And their attitude is "Well, I bet you do, but this works just fine for me. Thank you very much."

He explained that his main approach to instructional support is to talk with teachers informally to find out what they are doing and to let them know that he is available if and when they would like his help. Teachers we spoke to indicated that they were aware that they could call upon him at any time to help them with an idea or implementation. In the focus group, the teachers reported that that they did call upon him about once a month, and that several times a year he called them together to show them a new program or technology integration possibility.

During the teacher focus group, the teachers indicated that they did talk with one another about instructional issues, and that this sometimes included a discussion of technology or showing each other some computer product that they had created. One teacher explained that the small size of the school affected how often and with whom they shared information. He said that he and the one other teacher at his grade level get together at lunch almost every day, but that since he covers language arts for the whole grade level and that other teacher covers science, there really isn't anyone else with whom to discuss language arts ideas. Another teacher added that when they talked about teaching, "We talk to each other about surviving, either content-wise or skill-wise or discipline or whatever."

Lewis Middle School

At Lewis Middle School the district's main technology leaders are its director of information systems and the ClassConnect (i.e. the name the district gives its integration efforts) project director; they set the overall tone and direction for the district's technology infrastructure

and its uses. In 1998 the district placed in all of Lewis Middle School's classrooms desktop thin client machines (network PCs lacking local diskette or CD-ROM storage devices that run off of centrally located and maintained servers) at a two-to-one student to computer ratio. The thin client approach reduces hardware technical support costs. The thin client approach at this school originated as a part of the district-wide initiative to create a sustainable, reliable computer network so as to use computers both to support student achievement of basic skills and to enrich student inquiry. In the 2004-05 academic year a pilot program began that was designed to further make this possible through one-to-one student to computer access on a continual basis. At the time of our visit half of the school's sixth and all of the school's seventh grade students had a tablet-style laptop thin client that they could use all day at school and take home with them seven days a week.

The innovative thin client set-up and the range of expected classroom uses of technology creates a need for very strong technical and instructional leadership practices, and these are tightly coordinated. The district's technical leadership is spearheaded by the director of information systems, its instructional leadership by the ClassConnect project director. These two district directors report that they frequently engage other administrators in discussions and planning for educational technology at this school as well as throughout the district. This coordination is also reflected in the standard district approach of piloting new technical innovations so their kinks can be worked on in authentic instructional settings. The principal of the middle school also reported that he saw the technical innovations and support they received from the district office as being related to instructional goals and teachers' feedback on what was working and what was still needed and evolving in what he described as a "R & D format." The district leaders connect at the school level with a group of technology leaders called the tech core team.

At Lewis Middle School, the tech core team includes the principal, assistant principal, and four classroom teachers. It is the teachers on the tech core who regularly present technology uses and concerns to their peers at staff meetings. As a part of their responsibilities, these teachers also occasionally offer classes to other teachers after school, for which they are paid a stipend.

The principal and teachers we interviewed felt that the technical support provided at the school was excellent. One teacher observed that "the turnaround is really excellent," and others gave instances of how most technical issues were resolved very quickly. In addition to the district-based technical support for the thin clients, the school has one on-site full-time staff member for technical support whom they hired by dedicating school resources from Title I and other funding sources. A couple of teachers reported that having this person on-site reduced the likelihood that any technical issue would interrupt their classroom instruction. One teacher noted that the technical support person's being able to physically show up in the classroom to deal with problems such as a jammed printer meant she could continue to focus her attention on instructing her students.

Support for instructional uses of the technology was also provided at both the school- and district-level to help teachers learn to operate and integrate educational technology. At the start of the school year, for example, the district offered a 2-day optional but paid training event that was attended by nearly 80% of the district staff. Most technology staff development opportunities offered by the school were usually embedded into the workday or provided on an informal basis. Usually the teachers who made up the tech core led these sessions, presenting

information or demonstrating standard district software applications during meetings of the staff or providing help to teachers one-to-one as they asked for it.

Many of the teachers we interviewed also described an informal sharing of ideas and resources with their peers as they sought help on how to integrate software into their pedagogy. Each teacher we spoke to mentioned some way that he or she had met or otherwise communicated with other teachers about how technology could be used to support teaching and learning. The teachers in the one-to-one tablet laptop program started the school year with weekly meetings that later became monthly meetings. The whole school staff met regularly as a group, and frequently technology was a topic at these meetings, but teachers described getting most of their technology integration ideas from one another by email or reviewing each other's class agendas. One teacher in the one-to-one tablet program described this as a very organic process, indicating that for many teachers, using and collaborating about technology was a regular part of their culture. Another teacher working with the tablet laptops reiterated that the sharing of ideas flows via email, but also by regularly catching each other in the hall for quick exchanges.

All of the teachers in the school are required to have a class website, and most use it to post daily agendas. This allows any teacher to examine how and how often their peers are using technology. A number of teachers stated that they had particular colleagues whose website they checked regularly and that they would follow up with those individuals if they saw an intriguing idea and wanted to replicate or build upon it. For example, one teacher in the tablet program stated that "I know everybody watches my website to look for stuff, and then they call me. . . . It is that kind of thing." She recounted that recently she had also checked out another teacher's site because she knew that the teacher had gathered some resources on tsunamis; as she put it, "I wanted to see what kinds of things she dug up before I go digging." The teachers recognize that compiling lesson ideas and resources in digital form aids in sharing ideas and makes it easy to build upon and modify them. This same teacher reported that when she moved from teaching seventh to eighth grade, the teacher who replaced her took her whole website, used it as a beginning point for her own, and then changed it to suit her own needs. At the same time, one of the teachers in the tech core told us she tried to be judicious about how much to talk about or send out information about technology and uses to her colleagues. She recognized that not everyone had the same level of interest in using technology, and that to maintain their interest in what she did send, she had to select only the most useful and high-quality websites and ideas to share.

Jackson Middle School

Jackson and Lincoln Middle Schools are both within the Harrison School District. The one-on-one laptop programs at both schools receive strong leadership from the district level. The superintendent decided to implement the laptop program to enhance the curriculum of each core class to increase student academic performance and to provide students with equitable access to technology and technology skills in preparation for the workplace. Both schools have about the same number of laptops but due to Jackson's smaller enrollment this allows all 7th & 8th Grade students to have a laptop, which they use throughout the day in their core subject areas and can take home seven days a week. At Lincoln there is a team of about 100 laptop students within the 6th, 7th, and 8th grades. These students too can use their laptop throughout the day in their core subject areas and during weeknights can take the laptops home for use.

At the district level, the administrators with instructional responsibilities and those with technology responsibilities work together closely. The director of technology said she collaborates on a regular basis with the director of professional development, and the specialists for the core content areas and electives who make up the instructional team. All of these individuals report to the assistant superintendent of schools.

In addition to the Dell- and Apple-certified technicians at the district office handling the major repairs, the central technology department at the district office trains and prepares the building-based technical support staff to handle the simpler troubleshooting and repairs. Professional development on integrating technology is available through both the school and the district office. A robust series of professional development offerings is coordinated by the district office, the majority of which are about operating various software programs and integrating those into their instruction. Many of these courses are offered online using an online course management tool called BlackBoard.

Within Jackson Middle School, the technology leadership team includes administrators and staff members who are primarily responsible for technology and for instruction. This technology leadership team meets with the district director of technology and her support staff members a few times a year at the school as needed in order to coordinate the district's systems and the school's needs. The principal is involved in that she brings technology opportunities to the teachers and, as necessary, encourages them to take advantage of them, but the two library media specialists and their part-time assistant as well as a full-time technology support specialist carry out more specific duties, like technology professional development in both instructional and technical matters. The department chair from each content area is a representative on the technology committee for the school, and two retired teachers have worked part-time on specific tasks related to the laptop initiative.

Technology leaders' interactions about integration issues originate mainly from the school, through established meeting structures for each curriculum area and course. The technology leaders of the school strive to send the message to the school staff members that they are talented teachers, the laptops are a valuable tool, and that they trust good things will happen with them in the classrooms. Sometimes the technology committee would call for a meeting of the full faculty (even though sixth graders do not have individual laptops, all teachers teach at least one eighth grade class) so that the staff could come to a consensus on managerial issues such as a procedure for keeping the laptops charged, how to collect the laptop fees paid by parents, and so forth.

The principal said that once some element of the school's technology direction has been set, other technology leaders step in to work out the specifics with the teachers. She described how, as the building's overall leader, she relied a lot on email to communicate information and on her technology staff and instructional leaders to work out specific details with the teachers. One of the media specialists, during an interview with her and the principal, described the principal as having a strong ability to motivate her staff: "Talk about a motivator. . . . We joke about a deer being stuck in headlights!" They both described the staff as exceptional, a group of leaders and self-starters. Thus as technology leaders, the interactions of the media and technology support specialists with teachers were mostly about making learning opportunities known to them or responding to their requests for information.

The instructional leaders' technology leadership interactions occurred mainly in the context of weekly department meetings, where they would either bring technology topics to the agenda or take input from teachers about technology and bring it to the school's technology

committee. Several of the teachers interviewed reported that they didn't feel pressure to use the laptops in any particular way, or perhaps even at all, but rather that they were trusted to use their best pedagogical judgment. One math teacher shared that while she used the laptops as much as possible, the principal "has not given us any direction as far as how much the laptop is to be used. We decide on how we are going to utilize it as individuals in our classroom."

When teachers need technical support in their classroom or for their own or their students' laptops, they first contact the building's technology support specialist. The full-time specialist responds herself to the majority of the technical issues and is seen by teachers as absolutely essential for the success of the laptop program. If she has to be absent, the principal asks for a district technical support staff member to come to the school in her place. All of the interviewed teachers spoke highly of the quality of her support and how she was always available by email and phone or through her open-door policy. The school also had a remote observation and control program that she could use to look at the desktop of any computer in the school, which also supported her in troubleshooting problems with the computers.

Within the school, the technology support specialist and the media specialists also offer opportunities for teachers to learn how to operate various hardware and software. In addition, the two media specialists at the school provide instructional support to teachers for using the Internet as part of their job as information and reference specialists. Teachers can fill out a reference request slip and the media specialists will search the web to locate resources appropriate for them to use in class. The teachers described this as very helpful, because it has saved them a lot of time in finding reliable, appropriate web resources to use in class.

The interviewed teachers all said that the majority of the support they received for using specific software to support the teaching of their subject area either came from their department peers or they had to locate information on their own. They wished for more help in locating and utilizing software and web resources specific to the classes that they teach. The central office had provided help with the online textbooks and supplementary resources in the form of a part-time support teacher who was assigned to this and the district's other laptop middle school. Yet using full-time access to laptops well and frequently requires a depth of support within each content area that is not yet provided in the district's instructional support structures.

In an interview, the principal said that when she started this magnet school, an aspect of her vision for how the school would operate was that all the teachers from a department would have the same 90-minute class period free. This common planning time was designed to allow teachers to talk about instruction across their subject area. For example, she believed it could facilitate their coming to a consensus on particular software or resources they wanted to request and becoming familiar with each others' ideas and resources for integrating technology into particular lessons or units. One English teacher described how different colleagues had become known for a collection of materials and sharing resources, noting, "We all have our go-to people." Teachers in the same department who teach the same grades have classrooms near one another, and their proximity serves as a catalyst for a lot of informal sharing throughout the day, or "hallway talk," as one teacher described it. The teachers' email accounts and the school's shared server space support the teachers' exchanging information and resources. For example, the math department has formalized their sharing process even further by forming Learning Clubs. One day a week they meet according to the course they teach, which allows teachers to compare specific teaching ideas and resources, including technology, for that specific curriculum. And one day a week the teachers in the department meet as a team and discuss items of interest or concern to the whole group.

The school provided teachers with help in the management of the technology, including procedures for inventory and the investigation of theft, damage, or loss. Teachers were able to contribute to the creation of these procedures, as many were worked out at the technology committee meetings. While the teachers have to actually carry out the inventory in their classrooms, the technology support specialist takes responsibility for communicating to parents regarding their responsibilities and coordinated the required parent workshop. The technology support specialist is also in charge of monitoring that students are using the Internet appropriately.

Lincoln Middle School

Within Lincoln Middle School, the technology leadership team includes administrators and staff members who bear primary responsibility for technology and instruction. The principal is involved and is joined by the assistant principal for the seventh grade, whose extra responsibilities for the laptop program at the school earns him the title of technology principal. The school also has one full-time and one part-time technology support specialist, who together provide technical support and keep the school's servers running. The two media specialists' involvement in technology leadership is to provide professional development opportunities for the teachers as well as more informal integration support. One teacher from each of the sixth, seventh, and eighth grade four-teacher laptop teams serves as a representative on the laptop initiative technology team. Like at Jackson, the same two retired teachers have worked part time on specific tasks related to the laptop initiative.

This team meets on a monthly basis with the district director of technology and members of her support staff. Their interactions are often focused on managerial issues---a discussion of what is working, what isn't, and what to do about it. One example of the topics discussed at these meetings was how to manage keeping a large number of laptops charged throughout the day when the classrooms don't have sufficient power outlets. Together the committee has also worked through how to manage the inventory process and how to communicate to parents about lost items and hold them financially responsible for replacing them. By using this meeting as the primary means for working together to find solutions to such problems allowed bringing district resources and knowledge to bear upon the situation and ensured that the context of the site and the teachers' perspectives were considered.

When teachers need any technical support in their classroom or for their own or their students' laptops, they are to go online and fill out a work order that is submitted to the building's technical support specialists. The full-time specialist or her part-time colleague evaluate the request and respond to the majority of the issues regarding software, networking issues such as printing and connecting to the Internet, and minor repairs such as replacing a keyboard. The goal for a turn-around time is 48 hours, but it is often faster. If a repair requires that the computer go to the Dell- and Apple-certified technicians at the district office, it is sent in to them and the teacher or student can check out a loaner laptop so that instruction can continue with minimum interruption. The impetus for using online work orders to submit help requests was to reduce disruption in the halls, as previously students would have to walk their computer down to the technical support staff members' office area. The teachers interviewed reported that the technical support specialist would come to their classroom and help them immediately with small requests, such as help with an Internet connection, thus allowing the lesson to proceed.

Their interactions about integration issues occur through both additional interactions to share curriculum and instruction information and the established meeting structures for each

curriculum area. The district's instructional specialists provide laptop-specific integration support to these dozen laptop teachers, in addition to the professional development offerings coordinated by the district office. The administrators in the district and school also support the management of the laptops in the school and in the homes, which allows the teachers to focus on learning to integrate technology. The 12 teachers in the laptop program include only one grade-level teacher per subject area. Thus, most of the support provided by the district office content area specialists to these teachers occurs on a one-to-one basis.

The interviewed teachers indicated that occasionally the laptop teachers shared ideas that crossed grade levels or subject areas, but usually they asked district personnel when they wanted help or searched out resources on their own. With only one team of core subject area teachers per grade level participating in the laptop initiative, much of the instructional support they do receive is on a one-to-one basis, which addresses the individual teacher's questions but reduces the interactions and professional community that can develop among teachers when they face similar instructional challenges.

One teacher reported that these monthly meetings sometimes also include sharing information on best practices, but that technology leaders usually dealt with instructional concerns through other kinds of interactions. The Lincoln teachers interviewed reported that they felt that the district technology leaders were available to help them whenever they needed assistance and that, often without the teachers' asking, they brought them new resources to try. A math teacher on a laptop team described the benefits of the district's math specialist's knowing how technology could support instruction. She had turned to the math specialist when she first started on the laptop team and reported that the specialist was "very helpful" and that "we get wonderful direction" from her. Departments at Lincoln Middle School have one teacher serve as an instructional leader who meets with all the district's instructional leaders and the specialist for their content area once a month. Not all instructional leaders are at schools with laptop programs, but nevertheless content-area specialists sometimes include information at these meetings about how to use technology to support instruction.

Across the school, the teachers at each grade level have the same 90-minute period free. Four of the five days they meet as grade-level teams, and the fifth day they meet in content teams with the teachers of the same course at the same grade level to coordinate their teaching for the upcoming week. The principal explained that a course's grade-level team members are expected to collaborate on creating the week's lesson plans and turn a copy into her, and then all keep to that plan over the next week.

While keeping lessons in step forces a shared vision for a grade-level content area's curriculum, having only one of those teachers teaching students with laptops limits the development of a shared vision among that same group of how technology can specifically aid the instruction of that content area, let alone the exchange of materials and practices. Within a given grade-level laptop team, however, the teachers meet formally almost daily, teach near one another, and share the same lunch break, which gives them ample time to share general technology-supported pedagogical practices. For example, the science teacher reported that although he and the social studies teacher on his team each teach different topics, they did exchange ideas about how to use the laptop and a video projector to deliver class notes to students.

That each participating laptop teacher teaches a different content area at a different grade level appears to limit a shared vision for how ubiquitous computing can support the teaching of content. However, the interviewed teachers did assert that all the laptop teachers are united in

how to approach the management of the laptops and that they share and build upon one another's technology-supported pedagogy as they can.

Discussion

Artifacts that Contribute to Community-centered Learning Environments for Technology

Together the laptop vision and the related laptop distribution model create the context or situation for the technology leadership. These two parameters also establish which teachers are to be members of the professional learning community about the laptops' effective uses, and they can be considered artifacts of technology leadership.

At all five schools because of budget constraints the laptops were not distributed to the entire student population. However, in the schools with a curriculum and student achievement orientation to the laptop program's purpose, among the participating students the access to a laptop was constant throughout the school day and extended beyond it into the student's home. Further, at Lewis Middle School and at Jackson and Lincoln middle schools in the Harrison school district, the other students in the schools still had computer access through, respectively, the desktop thin client machines in classrooms, or through additional carts of laptops. At Fulton and Shelby, it appears that as a result of their vision for the laptops being in terms of providing students access to laptops they chose to not allow specific groups of students constant access to laptops at the expense of others who had no access at all. Yet, during interviews with all of the district administrators who initiated the laptop programs at these five school schools none of them made an explicit connection between the access versus instructional orientation of the vision for their laptop program and its distribution model. Perhaps where school leaders expect to have significant curricular uses of the laptops and see student achievement increase as a result, they are inherently drawn to a distribution model that provides more constant access for the participating students.

The vision for and the distribution pattern of the laptops to students together determine the nature and scope of the technology leadership needs. In all cases a large number of laptops creates technical support and management needs. But the more specific the laptop program's vision for student achievement or a curricular focus, the more specific are the instructional supports that are needed. It is the teachers of the students with the laptops who need this instructional support, and so the numbers of students per grade level with laptops creates a situation where teachers either do or do not have a peer who teaches the same subject matter with whom they can collaborate.

At Shelby, because of its small size, and at Lewis and at Lincoln because of its distribution model there is only one teacher per grade level per content area who has students with laptops; although at all three schools they have content and grade level peers with some access to technology. At Fulton and at Jackson the teachers do have peers teaching the same subject matter at the same grade level; however at Fulton the teachers must chose to check out the laptops for their students and the cart's home (storage) base is in the English teachers' classrooms at each grade level, which makes it a bit harder for any two content area teachers per grade level to co-plan and implement a laptop-using lesson.

At all the schools the teachers interviewed mentioned how they did learn of technology use ideas often in very informal conversations with their peers. Often it was as simple as talking in the hallway during passing time, or before and after school. This hallway talk is very typical of all school environments, but the vision and distribution model for laptops together can provide

the impetus and proximity for the hallway talk to be about the laptops and their instructional uses.

Artifacts that Contribute to Knowledge-centered Learning Environments for Technology

The vision for the laptop program implies the depth of the technology integration knowledge the involved teachers are to develop, and as a consequence the number of technology leaders who are needed to support this knowledge development, and the sorts of roles and actions they should play and take. While the technology support personnel are themselves a part of the technology leadership team, the degree to which their support duties facilitate the teachers' technology integration knowledge development can be considered a technology leadership artifact, as instructionally oriented support personnel contribute significantly to such knowledge development.

All five of the schools had some involvement from a building principal and/or vice-principal, and had some level of staffing for technical support. In keeping with their more curriculum- and student achievement-oriented visions for their laptop programs Lewis, Jackson, and Lincoln middle schools all had strong involvement from the instructional and technology district-level administrators. In both of these districts administrators from these two areas work together closely to align resources and goals. But at the three schools with an instruction-oriented vision for the laptops' purpose--Lewis, Jackson, and Lincoln--there were a greater number of technology leaders overall, and these additional leaders' role focus was on developing teachers' knowledge about the integration of technology (see Table 4). Staff members with instructional support duties resulted in professional development opportunities for teachers, and the more the number of staff the more often these opportunities to learn were held, and at the school site.

Table 4
School-based, Non-Administrative Technology Leadership Team Members

	Staffing Level	Focus of Role
Fulton Middle School	-2 Part-time, Technology Coordinators paid as an extra duty to work during prep hour, and before and after school	-Mostly provides technical support and infrequently presents professional development or provides integration support
Shelby School	-1 Full-time Technology Coordinator	-Mostly provides technical support and occasionally presents professional development or provides integration support
Lewis Middle School	-1 Full-time Technical Support Specialist -4 Part-time, Tech Core teachers paid as an extra duty for after-hours work	-All technical support -All instructional support, through regular faculty meetings and presentations
Jackson Middle School	-1 Full-time Technology Support Specialist -2 Full-time Library Media Specialists and 1 Part-time Assistant Library Media	-Technical and integration support -Instructional support: presents professional development, assist

	Specialist -2 Part-time retired teachers as Technology Specialists	with Internet integration, serve as an expert -Instructional support correlating textbooks to integration efforts, develop parent training
Lincoln Middle school	-1 Full-time and 1 part-time Technology Support Specialist -2 Full-time Library Media Specialists -2 Part-time retired teachers as technology specialists	-All technical support -Instructional support: assist with integration, serve as an expert -Instructional support correlating textbooks to integration efforts, develop parent training

Further, the teachers involved with the laptops mostly named as technology leaders these non-administrative personnel, such as the technology coordinators at Fulton and Shelby, the tech core members at Lewis, and the technical support and media specialists at the other schools. Because the teachers' technology interactions appear to occur mostly with these non-administrative technology leaders, it suggests that the more these staff members are present to support integration, the more an instructional focus is presented and reinforced to the teachers. These staff members then contribute to the effectiveness of teachers' technology learning environments directly through their core work responsibilities. Thus the specific duties of their positions are artifacts of technology leadership.

Artifacts that Contribute to Learner-centered Learning Environments for Technology

While technical support needs being covered is critical and instructional support is necessary, the quality of that instructional support can be examined in terms of how directly it is correlated to the teachers' content area needs. Three main technology leadership artifacts helped create a more learner-centered learning environment for teachers in that learning needs more specific to their teaching assignment could be met. The first was more content area specific responsibilities assigned to the instructional support personnel, and the second was an electronic means for sharing teaching materials among teachers, and the third was direct input to leaders through representation at the technology leadership meetings.

At all five schools the degree to which they could offer instructional support more tailored to an individual's teaching responsibilities was in direct relation to the number of instructional support personnel for technology on staff. This more specific level of instructional support occurred mainly at Jackson and Lincoln middle schools, which are both in the Harrison School District. At Jackson, for example, a regular activity for the two and a half media specialist positions was to respond to teachers with appropriate websites for students on requested topics. Many teachers remarked on helpful this was. More so than at Jackson the teachers at Lincoln middle school availed themselves of the district personnel assigned to help teachers effectively use the online textbooks, and to support the curriculum.

At several of the schools the technology itself supported teachers sharing materials in a digital format, which then made it easier for them to adapt existing materials to their own needs. Shared servers with storage space for teachers and email supported transferring materials among

teachers. This was illustrated at Lewis, where teachers' class web pages contained grade-level appropriate and content area specific materials in a format that made them easy to access and modify. The shared server space at Jackson also facilitated sharing among teachers.

Laptop teachers as members of a school's technology committee or having representation at meetings concerning the laptops is also an artifact of technology leadership in that it increases the likelihood that teachers would have direct input to technology leaders regarding their learning needs. Lincoln and Lewis provide the most explicit examples of this. At Lewis the tech core teachers attended specific technology leadership team meetings where they were able to give their input to administrators; then they also presented regularly at faculty meetings where they could gather input from their peers. At Jackson and Shelby the school faculty meetings regularly had technology as a topic, which provided a predictable schedule and forum for the whole staff to offer their input regarding technology integration and implementation at the school.

Summary

Altogether, it appears that the schools with an instruction-oriented vision for their laptop programs create a more compelling setting for technology integration through strong technology leadership practices. Artifacts such as technology vision influence the makeup of the community that comprises the teachers' learning environments. It also influences the number and job roles of the technology staff members, another artifact of technology leadership practice, and these staff in turn have an impact on the depth of knowledge teachers are to develop regarding technology and its integration and the support they have in this work. Artifacts such as the alignment of internet and computer-based resources with the curriculum, and membership on the technology committees are additional representations of the technology leadership practices at a school, and can contribute to how learner-centered a teacher's learning environment might be.

At Fulton Middle School and at Shelby School the district leaders initiated their laptop programs in terms of providing computer access to students, and did not include in their vision strong curricular or pedagogical components. This in turn drove what committees, meetings, and communication processes were deemed necessary, which further defined the nature and degree of teacher involvement. In both schools the technology leadership practices by the primary technology leaders did not require the explicit involvement of teachers on how technology can support instruction. As a result, in both cases only teachers who were most interested in integrating technology into their classrooms did so; it appeared that the leaders' perceptions of a lack of wide-spread interest by teachers about integrating technology reinforced their approach of responding to willing and enthusiastic teachers without engaging the rest of the school's teachers in technology. In effect, these schools' technology leadership practices made it relatively easy for teachers to choose to opt in or out of classroom technology integration.

In contrast, at Lewis Middle School and at Jackson and Lincoln Middle Schools in the Harrison School District the technology leaders defined their purpose for the laptops in terms of student outcomes, which necessarily included curricular and instructional concerns. The district leaders set up structures, routines, and tools that more often involved teachers and were focused on teaching and learning issues.

Conclusion and Implications

The cases presented here support the notion that technology leadership should be considered a school characteristic: It is shared by a team of people and its results are school resources like technology access and support. The distributed leadership model posits that "leaders act in situations that are defined by other's actions" and that in a situation its "routines, tools, and structures define leadership practice" (Spillane, 2005). This conceptual model for leadership practice therefore emphasizes how the educators' purpose for technology will determine its set-up and then the technology set-up will encourage or discourage, or enable or constrain what leaders and teachers do concerning its leadership. These five schools illustrate this recursive effect.

Considering school technology leadership as a school characteristic and applying a distributed leadership model to technology leadership practices emphasizes the significant influence of the leaders' purpose for the technology. These cases show how without a strong instructional focus technology implementations can get reduced to a struggle to keep up adequate access and technical support. The technology's purpose symbolizes the leaders' ideas about how technology can support the nature of learning. The technology's purpose influences what artifacts, structures, routines and tools the technology leaders put into place, which further represents in a more detailed way their conceptions of the appropriate role and involvement of technology coordinators, teachers, and students, and the value of any of these groups as technology leaders. These elements then influence the follower's actions, which in turn influences and shapes the situation in which the technology leaders act. Thus, these findings underscore a long-standing admonition that leaders must have a vision for technology but provides nuance to that by illustrating the recursive effect between the situation and the what, how, and why of technology leadership practices.

These findings contribute to the theoretical directions for technology leadership by illustrating how an emphasis on artifacts of technology leadership illustrates concretely what it is, and how and why it might be done, as well as how that work might be distributed across the team's members. For technology leaders an implication is that more explicit recognition should be given to the power of a vision and that it perhaps should be expressed in a more coherent fashion, such as how a logic model is meant to help its authors connect program activities and resources to expected results (c.f., Julian, 1997; Patton, 2002). That is, by from the start laying out the inputs, activities, and outcomes implied within the technology vision it might better align the nature and amount of technology purchased with the necessary support for its effective use. Further, if technology leaders were to set as a main goal of technology support the creation of effective learning environments for teachers it would serve as a generative concept, suggesting what to do and providing a lens for the evaluation of program activities. For example, in these schools the learner-centeredness aspect of the teachers' learning environments about technology integration was weak, but none of these schools substantively supported any assessment-centered components: there were no formal peer coaching processes, or the development of model practices so that teachers could get feedback and support on their integration work.

Further research is needed about technology leadership for all sorts of configurations of technology implementations, but for the demanding environment of laptop initiatives in particular. A productive line of research might include the various membership configurations of technology leadership teams and the optimum authority and expertise levels within them. A distributed leadership lens and a focus on key technology leadership artifacts might serve as

productive tools for recognizing technology leadership team members' cumulative efforts and their coordination and quality.

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