Technology leadership for the twenty-first century principal

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Abstract *This paper examines current issues related to technology integration and provides a contextual framework with which school principals can undertake new leadership responsibilities in this area. Selected examples of successful technology integration are provided to inform current technology leadership practices. The leadership goals, competencies and responsibilities needed in order to achieve this preferred future are described. In the final section, the authors draw on professional experiences as researcher and teacher/leader to build and expand on a five-part leadership model currently in use by a large urban school district to interpret multiple dimensions of technology leadership for principals. Ways in which this framework can serve as a guide for school leaders as they develop technology competencies, implement professional growth plans, work with their community, and provide daily technology leadership, mentorship and advocacy for teachers in an elementary school are discussed.*

Introduction

Over the past 10-15 years, information and communications technologies have become commonplace in schools in Alberta, Canada. The provincial education ministry (*Alberta Learning*, 2000) mandates that all kindergarten to grade 12 students must be prepared to understand, use and apply technologies in effective, efficient and ethical ways. Technology integration is meant to be cross-curricular rather than become a separate course or topic in itself. Every classroom teacher is expected to use learning technologies to enhance student learning in every subject (*Alberta Learning*, 2000). Because of the gap between expectation and preparation, the role of technology in schools is receiving a great deal of attention. Principals and teachers face the huge task of reinventing schools and classrooms in a society that has been transformed by digital technologies, and many feel overwhelmed by the mandate to integrate computer technology into every subject and grade. Increasingly, school administrators are required to assume leadership responsibilities in areas with which they are unfamiliar, and for which they have received little training.

This paper explores some of the ways that the integration of technologies for teaching and learning has impacted the traditional roles and responsibilities of the school principal. New competencies that school-based administrators need to develop in order to be effective in their new roles as technology leaders are described in the context of a five-part model. An argument is made that technology leadership is much more than resource acquisition and

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management. Instead, we argue that technology leadership has multiple dimensions given the complexity of schools as learning organizations.

Current issues in technology integration

Beginning slowly in the early 1980s and increasing in the 1990s as acquisition prices dropped, computers have become highly visible in Alberta schools. Driven by pressure from other sectors to produce computer-literate graduates, and by the perception that without computer skills, students will be ill prepared for participation in the knowledge economy, most school districts have invested heavily in computer technology. In Alberta, school districts have been given provincial grants on a per-pupil basis to be spent on hardware, software and network infrastructure. The result has been an influx of thousands of modern computers into elementary and secondary schools in the province. Most buildings have needed to be rewired to allow Internet access. In some cases, classrooms have been reorganized to accommodate one or more computers. In other schools, labs have been set up in the library or in separate spaces devoted to computer instruction.

Despite government spending on boxes and wires, technology integration in North American classrooms has ranged from uneven at best to nonexistent in some cases. Ginsberg and McCormick (1998, p. 22) surveyed over 1,000 teachers in both effective and less effective schools in the USA. Teachers reported using computers for word processing or drill and practice, but "rarely were they fully integrated into the learning activities". Despite greater access to computer equipment and software, the gap between technology presence and use in high schools is wide – the presence of technology alone seldom leads to widespread teacher and student use (Cuban *et al.*, 2001). While there are positive examples of technology being used to support student learning and to foster positive changes in schools, predictions that computers would revolutionize public education have not materialized. Merely installing computers and networks in schools is insufficient for educational reform. Therefore, we ask, what can school leaders learn from research on obstacles that limit ICT integration, and how can they translate this knowledge into effective approaches for leadership? Barriers to technology integration are summarized into four themes:

(1) pedagogical issues;

(2) concerns about equity;

(3) inadequate professional development; and

(4) lack of informed leadership.

Pedagogical issues

It is only now, with networked computers having arrived in most schools, that teachers and administrators are beginning to shift their focus from hardware,

wiring and skills acquisition to more fundamental questions of the role of technology in education. In his critique of the current state of educational technology, Kearsley (1998, p. 51) calls on educators to "develop a new conceptual basis for applying technology" – one that looks at how we think, solve problems, make decisions and interact using computers as tools. Educators are looking to the research and to images of successful ICT integration for an understanding of the relationship between technology, pedagogy and student learning. What can teachers and learners do differently or better with digital technologies than with present tools? How can computers and networks be used to meet the needs of the diverse learners in our school? How can teachers be supported in their uses of technology to enrich curriculum in meaningful, integrated ways? A major challenge for technology leaders is to support teachers as they explore and experiment with diverse ways to integrate technology in meaningful, challenging and authentic ways across the curriculum.

Concerns about equity

Technology integration in schools is inextricably bound up with issues of equity. In today's society, technological literacy symbolizes access to the high-tech job market, participation in the global economy, and success in the new information age. Public schools must be places where all students have opportunities to acquire the skills needed to fully participate in this new society. Unfortunately, the "digital divide" often separates our students along gender, socio-economic status and ethnocultural lines (NTIA, 2000). A recent report by the American Association of School Administrators (2001) found increasing inequities in both access and in ways computers are being used to educate children. Inequities were identified among students from poor families, minority children, girls, low achievers, students learning to speak English, children with disabilities, and youngsters who live in rural areas. According to Kearsley (1998), educational technology has yet to make a significant impact on learners with physical disabilities. Students who live in poverty are less likely to have computer access at home, an inequity that may be compounded by the inability of schools in lower socio-economic areas to raise sufficient funds to purchase new computers.

Computer culture has traditionally appealed to boys more than girls (Bain *et al.*, 1999; Brunner and Bennett, 1997). Gender inequity is evident in the under-representation of girls in high school computer classes, in post-secondary computer design and programming courses, and in information technology (IT) careers. A two-year national study (American Association of University Women, 2000) reported that girls make up only 17 percent of enrolment in high school advanced placement computer classes. At the university level, despite increased enrolment in other traditionally male faculties (engineering and medicine), this disproportionate trend has persisted in computer-related fields.

Despite evidence that women are using computers as tools for both work and recreation (NTIA, 2000), their participation in the growing IT sector of the economy still lags far behind males. A major challenge, therefore, for school-based technology leaders is to ensure that public schools are places where inequities are eradicated rather than exacerbated by the integration of technology.

Inadequate professional development

A significant impediment to successful technology integration is teachers' limited access to appropriate ongoing professional development. Many teachers have lacked meaningful opportunities to acquire the skills needed to meet the ICT outcomes. In many jurisdictions, including Alberta, technology funding has not been expanded to include staff development, leaving teachers largely on their own to seek out and finance appropriate professional development in the area of technology. Even when teachers take the initiative to enrol and participate, typical in-services focus on acquiring computer applications skill rather than technology integration strategies and project design skills. In many cases, teachers have had limited access to computers at school in order to practise or implement what they have learned. Computer skills learned in isolated in-services are quickly lost if they are not readily applied in teaching, or learned in a context that facilitates instructional design and planning. The response from many teachers has been to resist (either actively or passively) outside pressure to incorporate digital technologies into their teaching practice (Hodas, 1993) because of the paucity of meaningful opportunities to learn how to do so. A challenge for technology leaders is to provide responsive and flexible professional development opportunities that focus on technology integration and design, rather than computer applications alone.

Lack of informed leadership

Many principals have not been prepared for their new role as technology leaders, and have therefore struggled to develop both the human and technical resources necessary to achieve ICT outcomes in their schools. Very few principals have themselves used computers in meaningful ways with children, and therefore lack the requisite pedagogical vision and experience to guide teachers. Consequently, in many schools, informal leaders have emerged from classrooms, libraries and computer labs to take up the difficult task of planning for technology integration, and supporting distributed and often uncoordinated efforts by enthusiastic teachers. Unfortunately, technology planning has too often been limited to the goal of acquiring hardware and software. Schools have focused on purchasing equipment, setting up labs and wiring their buildings, without considering the substantial organizational and cultural changes that are necessary to support appropriate use of technology to enhance student learning. As a result, many schools have expensive computer labs that are

being used for typing, games and drill, if they are being used at all (Glennan and Melmed, 1996).

In addition, school administrators have had to make difficult decisions regarding equipment purchases, wiring and networking. In the absence of an understanding of how hardware choices and deployment scenarios seriously impact student learning, principals have often relied on advice from technicians. The result, in many cases, is a restricted, locked-down approach to school networks that is meant to protect the machines from the teachers and students. Innovative and exciting uses of computers for collaborative projects are impeded or completely blocked by closed network structures. Instead of opening up opportunities for learning, restrictive networks serve as barriers, impeding use by both teachers and students. In schools where principals are unprepared to manage the complex issues around ICT networking, pedagogical judgments tend to take a back seat to financial and technical considerations.

Potential for effective ICT integration

Despite the many barriers to ICT integration described in the previous section, there are numerous examples of successful technology integration in Canadian and international schools to draw on in a search for answers to guide present leadership and pedagogical efforts. In many of these cases, technology has served to trigger deeper educational reforms.

Thomas and Knezek (1991) summarized the results of a national (American) survey of 240 professionals who were demonstrated leaders in the areas of technology and school restructuring. Characteristics of school restructuring were clustered into five categories:

(1) changes in learning experiences;

(2) teacher roles;

(3) curriculum;

(4) organizational leadership/structure; and

(5) governance/funding.

Change is needed in all five areas in order to constitute school restructuring rather than just school reform. Yee (1999) studied leadership in ICT-enriched schools in the USA, Canada and New Zealand. The case studies included rich descriptions of effective integration of technology in diverse settings. Students were observed working collaboratively using a variety of ICT tools. Teachers learned ICT skills alongside their students and encouraged students to learn from each other. Students who had previously experienced very little success in school displayed greater self-confidence and in some cases assumed leadership roles through the use of ICT. In these schools, technology integration was part of a shift in power relations, control of knowledge and traditional school organization.

A successful model for technology integration and engaged learning is the Galileo Educational Network. This professional development initiative began in three Alberta elementary schools in 1999 and has since expanded to more than 18 schools in seven rural and urban school jurisdictions in 2001/2002. Evaluations of the Galileo Educational Network initiative indicate that the approach has positively impacted district and school leadership, teaching practices, and student learning in significant ways (Jacobsen, 2001, 2002). Galileo promotes innovation in leadership and teaching practices and the organizational structures that support them. Technology integration is seen as one way of achieving the larger goal of transforming teaching and learning. Success is measured in terms of student engagement in authentic learning projects, continued demand for Galileo services, and stakeholder satisfaction. Information technology is integrated in a seamless, transparent way through careful inquiry project design, implementation and evaluation. Professional development is intensive, responsive to individual needs and contexts, and is offered on-site in a timely fashion. Leaders and teachers at all levels of the school jurisdiction are involved in developing and supporting technology-enabled learning environments for children.

Common themes associated with effective ICT integration

Successful experiences with ICT integration can provide important lessons for educational leaders who are anxious to achieve similar results in their own schools. Increasingly, research is providing evidence that ICT integration, under certain conditions, can positively impact student learning and can facilitate school reform initiatives. The seemingly diverse examples of successful practice have five key elements in common:

(1) student engagement;

(2) shared vision;

(3) equity of access;

(4) professional development; and

(5) ubiquitous networks.

Student engagement

An unwavering focus on student engagement in authentic learning experiences, supported by the use of appropriate technology, characterizes successful practice (Means and Olson, 1995). Learning extends beyond the classroom walls through online collaboration, research and communication, sometimes with experts in the field. Students pose their own questions to guide research. The teacher's role changes from one who controls the dissemination of knowledge to that of a wise mentor who supports students as they construct their own meaning. Collins (1991) summarized the changes in teaching and

learning that have occurred in classrooms where computers are being effectively integrated: a shift from whole class to small group instruction, from lecture to coaching, from teachers working with better students to working with weaker students, and from competition to cooperation. Collins placed these changes in the context of a larger movement from a didactic to a constructivist view of teaching. Riel (1994, p. 454) envisioned "engaged learners working cooperatively with others on projects designed around interdisciplinary themes". Thomas and Knezek (1991, p. 269) described "learning environments that are student-centered, placing increased responsibility for learning on the learner".

Cohen (1997) observed how technology-rich classrooms differed from traditional ones: social interactions among students and between teachers and students were more fluid; learning was seen as a more natural process; gifted students sought to make deeper connections when using the computer; technology affected the way content was explored.

Shared vision

The introduction of technology is accompanied by opportunities for staff, students and parents to develop a common vision and shared purpose that includes, but is not limited to, the integration of digital technologies. Bennett (1996, p. 60) stressed the importance of a "well-defined mission that describes technology's place in education". Kearsley and Lynch (1992) suggested that users of technology must have a fundamental belief in the value of innovation or the innovation is doomed to failure. Teachers must have opportunities to study, observe, reflect, and discuss their practice, including their use of ICT, in order to develop a sound pedagogy that incorporates technology. Leaders "communicate their vision by how they spend their time, what they talk about, what problems they solve first, and what they get excited about. In every act, leaders reinforce the values they hold and the vision they hope to achieve" (NCREL, 2000, p. 5).

Equity of access

Successful ICT integration promotes the inclusion of all students and teachers in a way that honours diversity and respects differences. ICT opportunities are available to all students, rather than being seen to be a "male" activity, or one that is most appropriate for gifted students. Effective ICT use respects individual learning styles and offers choice, while encouraging students to select activities that challenge stereotypes.

Skilled teachers are sensitive to individual preferences as well as to potential inequities resulting from prior experiences with digital technology based on gender, culture, ability and socio-economic background. All students in the school experience appropriate, equitable access to technology, not restricted by the skill or interest of their teacher.

Effective professional development

Effective integration of ICT requires support for ongoing, timely professional development that focuses on teaching and learning and includes many opportunities to use ICT. Teachers are not expected to utilize tools and processes for which they have no training. There is a range of opportunities to learn new skills, and opportunities to collaborate with other teachers. Effective professional development includes coaching, on-site in-services, individualized instruction, observation of ICT integration in practice, and self-directed learning (Jacobsen, 2001, 2002). School leaders who are committed to ICT integration support teachers in their individual growth plans and build opportunities for collaboration between colleagues with similar goals.

Ubiquitous networks

Schools that have successfully integrated ICT work towards the development of ubiquitous networks, which allow digital technologies to be available whenever needed and where collaboration is facilitated not impeded. Ideally, technology is transparent to the users. When students need to search the Internet, networked computers are readily available and access is effortless and unblocked. The network supports file sharing so that students can collaborate on projects. Tools for preparing presentations, analysing data, mapping concepts and communicating with others are available whenever and wherever they are needed. Distributing computers in classrooms encourages their use as tools throughout the day, as opposed to keeping them in a lab setting, which may reinforce the attitude that computers are "add-ons", not central to the daily work of teaching and learning. Some schools have developed creative ways of maximizing the use of technology. Mobile workstations may be wheeled into classrooms as needed; alternatively, teachers open up their classrooms to any student needing an available computer. In this way, traditional organizational structures and physical boundaries have adapted to accommodate technology.

Integrating theory and practice: leadership development

The five common elements identified previously can be translated into aims for technology leaders. In each of the areas the principal can and should play a key role. A framework for analysing the principal's role as technology leader is provided by the Calgary Board of Education's (2000) *Leadership Development Program*, which outlines core competencies, personal attributes and role responsibilities for school-based leaders. The document does not attempt to delineate specific skills for technology leadership. The role responsibilities serve as a starting point for developing the present model for school-based technology leadership. In this section, five role responsibilities as they relate to achieving the aims of ICT integration are developed:

(1) student engagement;

(2) shared vision;

(3) equity of access;
(4) effective professional development; and
(5) ubiquitous networks.

Figure 1 is a visual representation of the principal's role responsibilities and goals as they relate to the process of integrating technology.

There are five role responsibilities identified in the *Leadership Development Program* document:

(1) leader of learning;
(2) leader of student entitlement;
(3) leader of capacity building;
(4) leader of community; and
(5) leader of resource management.

Throughout this section, we weave experiences observing and applying this model in several elementary schools, and identify both limitations and possibilities inherent in this leadership model. The school, identified as Roland

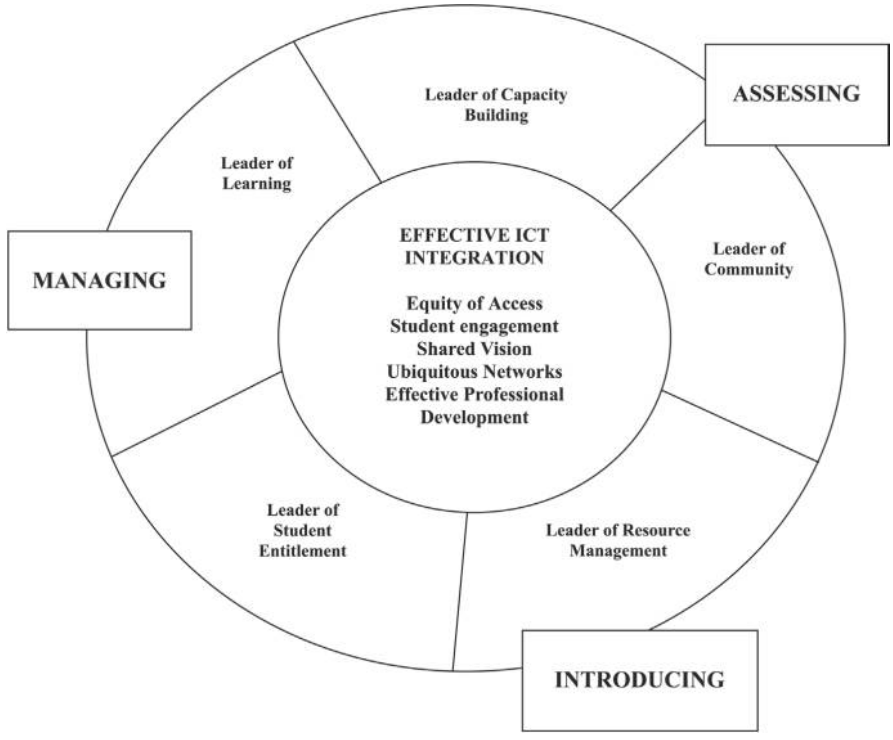

Figure 1.
Role responsibilities and goals of technology integration

Bennett Elementary is actually a composite of these collective observations and experiences.

Roland Bennett Elementary has over 500 students from kindergarten to grade six. Up until the 2001/2002 school year the ICT Program of Studies (*Alberta Learning*, 1997) was taught by a technology specialist in a centrally located computer lab. Classroom teachers did not integrate technology into their core curricula. The technology teacher tried wherever possible to develop lessons that related to classroom units, but teachers were not involved in either the planning or delivery of ICT lessons. In 2001/2002, with a new administrative team in place, teachers were given the opportunity to plan and teach alongside the technology lead teacher who was also the assistant principal. The principal, an experienced educator committed to quality learning for all students, was sceptical about the role of technology in elementary school curricula. Despite reservations, the principal remained open to the possibility that ICT might provide motivation and encouragement, especially for reluctant learners. With the assistant principal providing direct technology leadership, the principal continued to ask challenging questions that kept staff focused on student learning. This environment provided an excellent starting point in which to apply the ICT leadership model first-hand.

Leadership roles and responsibilities

Leader of learning

Table I summarizes essential goals, tasks and outcomes to be undertaken by principals as leaders of learning. In this role, the principal must demonstrate a thorough understanding of the ICT Program of Studies, especially of those outcomes that relate to higher-level skills. The *Alberta Learning* (2000) ICT Program of Studies organizes learner outcomes in three categories:

(1) processes for productivity (P);

(2) foundational operations, knowledge and concepts (F); and

(3) communicating, inquiring, decision making and problem solving (C).

It is tempting to focus on P and F level outcomes; however, it is in the third area, the C level, that the richest learning experiences occur. As instructional leaders, principals must continually focus and refocus teachers on these higher level outcomes.

At Roland Bennett Elementary the administration team frequently learns alongside teaching staff. After-school technology in-services are well attended, partially owing to the fact that the principal communicates value by always attending. Technological expertise is recognized and capitalized on, with teachers taking turns mentoring and being mentored according to their individual talents and learning needs. The staff utilize an electronic distribution list to communicate about workshops or meetings as they

Goals	Tasks	Outcomes/indicators of success
To encourage teachers to reflect on and continuously improve their practice	Develop personal ICT skills Model technology use in presentations, electronic communication of daily bulletins	Evidence of increased student engagement in authentic learning
To provide meaningful learning opportunities for all – teachers, students, support staff and parents	Encourage risk-taking, reward innovation Provide timely professional development opportunities for staff Through teachers' professional growth plans, encourage collaboration, action research projects	Increased ability of students to solve problems, communicate effectively, organize and manage inquiry Improved ICT skills – self, staff and students
Improved student ability to solve problems, collaborate, and use technology to support the construction of knowledge	Organize professional development events that focus on teaching and learning, both with and without ICT Purchase substitute teacher time for professional development Arrange visits to ICT-enriched schools Purchase software which maximizes learning opportunities Discuss the use of technology when preparing individual program plans for students Require teachers to include ICT outcomes when preparing long-range plans	Evidence of increased integration of ICT in core curricula

Table I.
Leader of learning

become available. Administrators, teachers, support staff, parents and students are actively engaged in both learning and teaching.

The experiences of Marianne, a veteran teacher who is also a novice ICT user, typify the deeper changes in teaching and learning associated with technology integration. Initially Marianne dreaded her time "teaching computer class". Her confidence as a teacher was undermined by the expectation to integrate ICT. She gradually increased her participation in planning sessions and took a few tentative steps in teaching with computer classes. She became a most enthusiastic proponent of ICT. Her comment about grade six students, "you just have to show them once and they do it... you just

have to let go, and let them do it," indicated a fundamental shift in instructional practice.

Leader of student entitlement

Table II summarizes essential goals, tasks and outcomes to be undertaken by principals as leaders of student entitlement. In this capacity, the principal addresses significant issues of equity of access to technology for all students. This includes ensuring that every teacher provides age-appropriate opportunities for students to develop technology skills. The principal is sensitive to issues of gender, economic background, ethnic and language differences and systemic barriers that affect students' use of technology.

For students with special needs (those with learning/physical disabilities, emotional/social needs, or gifted students), teachers prepare individual program plans, which outline specific modifications to program content

Goals	Tasks	Outcomes/indicators of success
To ensure equitable access to technology resources and learning opportunities for all students	Ensure that enrichment opportunities are available to all students, not select groups Raise equity issues in discussions about teaching, learning, ICT	Percentage of students successfully achieving the ICT outcomes
To use technology in ways that support democratic principles	Offer access to computers before school, over the lunch hour, and after school Host technology in-services for parents who may not have computers at home Purchase software that is free of bias and appealing to the majority of students Raise teachers' awareness of language that perpetuates stereotypes Discuss the use of technology with teachers as they prepare individual program plans for students with identified learning needs Develop procedures so students can access technology throughout the building when required	Participation of both girls and boys in technology club or leadership groups Increased use of computers before, during and after school Students with special needs using computers and taking leadership roles in technology Individual program plans include ICT components

Table II.
Leader of student entitlement

and/or instructional methods. As they review these plans with teachers, principals can encourage the creative use of ICT to meet special learning needs.

At Roland Bennett, the biggest challenge in this role lay in dealing with teachers who were unwilling or unable to provide meaningful ICT experiences for their students. While a few teachers quickly became enthusiastic about incorporating computers into their teaching, many others were resistant. Equity of access was ensured through creative timetabling. Each class was scheduled into the computer lab for one 45-minute period each week. During this time, the classroom teacher instructed her students on her own. However, once a week, each grade group was provided with common planning time along with the technology lead teacher. These half-hour planning sessions were used to develop ICT lessons that linked directly to the ongoing classroom program. Often the teachers used the time to rehearse the lesson, which built confidence for those who needed it.

Throughout the first year of using the new ICT leadership model, many teachers have gone from being reluctant to enthusiastic users of technology. The computer lab is never idle. In fact, the increasing demand on resources has prompted a call for computers in classrooms – positive evidence that access is now limited by teachers' increased use of the technology rather than the constraints of infrastructure.

Leader of capacity building

Table III summarizes essential goals, tasks and outcomes to be undertaken by principals as leaders of capacity building. In this role, the principal acts as a positive change agent. Working with staff and/or a technology committee, s/he oversees the development of a vision for technology implementation. As informal leaders emerge on staff, the principal acts as a mentor or coach. Capacity building extends to developing potential ICT leadership among parents and students, as well as school staff. If successful, the whole school community takes ownership for the change process.

At Roland Bennett, as is the case in many schools, technology decisions had been made by one or two "resident experts". As teachers increasingly assumed responsibility for teaching the ICT curriculum, they began to seek opportunities to collaborate and to share in decision making. Halfway through the year, a focus group was convened to meet with a district technology specialist to discuss progress. It was readily evident that a significant shift had occurred, from grudging compliance to enthusiastic questioning, risk-taking and student-focused concerns. As a result of that meeting, four teachers developed a proposal for funding an action research project aimed at developing a school-based technology integration plan. Clearly they had assumed responsibility in an area that was previously seen to be the purview of technologists, not teachers. Shared technology leadership was supported by the school principal.

Goals	Tasks	Outcomes/indicators of success
To develop a shared vision for the use of ICT in learning	Involve all stakeholders in visioning, goal setting Encourage mentoring/ coaching among staff	Teachers, parents, students and support staff report increased opportunities for participation in decision making
To develop leadership capacity in all members of the school community	Involve support staff in decision making and ICT training Establish a technology committee with representation from parents, business, students and staff	Evidence of increased leadership responsibilities by students, parents and teachers
To establish a climate that encourages risk-taking, creativity and collaboration	Encourage collaboration within grades, between grades, with the community for teachers and students Promote risk-taking and learning in teachers and students Communicate individual and collective achievements to the school community Support and encourage emerging informal leaders	

Table III.
Leader of capacity building

Leader of community

Table IV summarizes the essential goals, tasks and outcomes undertaken by principals as leaders of the community. In this capacity, school principals have three main objectives:

(1) to involve the community, including parents and business partners, in achieving the goals of technology integration;

(2) to communicate the schools' accomplishments and challenges to the community; and

(3) to extend student learning beyond the walls of the school.

For many schools, including Roland Bennett Elementary, technology committees have been struck to oversee ICT implementation. Parents often bring a wealth of technology experience based in business environments to the decision-making process. At Roland Bennett, parents have been actively involved in technology decisions for many years. Under the previous administration, the centralized lab was established. Thousands of dollars from

Goals	Tasks	Outcomes/indicators of success
To gain community support for ICT integration	Explore business partnerships to support technology initiatives	All stakeholders report adequate communication exists with the school
To involve parents in the decision-making process	Host ICT information or education events for community	
To use technology to improve communication between school and community	Host technology in-services for parents who do not have computers at home Include parents on school improvement and/or technology committees	Parents understand and support school technology initiatives
To extend students' learning beyond the school into the community and beyond	Develop a school Web site to profile student work, explain school goals, post calendar of events, facilitate feedback or questions Develop telecollaborative projects, e-mail relationships, distance learning opportunities for students Get students involved in global issues Encourage creative, flexible patterns of computer use to maximize student access	Number of "hits" on the school Web site Students' involvement in telecollaborative projects

Table IV.
Leader of community

government funding and parent fund-raising initiatives were used to establish a "state-of-the-art" lab. However, as the instructional model shifted from technology as a special subject to a more fully integrated ICT instruction, the lab quickly became insufficient, which necessitated spending thousands of dollars to wire and outfit the classrooms with computers. School council members argued that technology had already received enough attention and they were very reluctant to spend more, given the many needs in other areas. It fell to the principal and assistant principal to establish priorities for spending that reflected long-range technology goals, overall school improvement plans and improved student achievement. Once these links were clearly established, the request for funding to extend computers into classrooms was honoured. Without securing community support, the school would have been unable to achieve its goals.

Leader of resource management

Table V summarizes the essential goals, tasks and outcomes undertaken by principals as leaders of resource management. In this capacity, the principal is responsible for managing the resources necessary for technology integration. This encompasses developing priorities for spending, which directly support the goals of the school's technology plan. It also includes such fundamental decisions as wiring, location of computers in labs or classrooms, and developing guidelines for the purchase of hardware and software. Resourceful principals will explore many avenues for acquiring technology resources, including fund-raising, government and university grants, and business partnerships. Yee (1999, p. 195) described this quality as "entrepreneurial networking".

Goals	Tasks	Outcomes/indicators of success
To provide students and teachers with the technology resources necessary for achieving the ICT outcomes	Develop a technology plan that includes a plan for purchasing, maintaining and replacing equipment Wire the building for a distributed network, including wiring each classroom Minimize the use of filtering and security software that can restrict students' ability to locate information and download necessary software	Students and teachers are able to access technology resources as needed Students are able to save, download and share files readily
To develop a computer network that supports inquiry and collaboration	Encourage safe Internet use and monitor students' activities on computers Ensure that all equipment is serviced regularly	Equipment is in good working order
To ensure that equipment is available to teachers and students whenever it is needed	Set up file-saving and file-sharing privileges so that students can collaborate readily Provide each teacher with a networked computer Investigate purchasing agreements and maintenance contracts Seek out donations of high-quality equipment	Teachers are using digital technologies for record keeping, lesson planning and communicating

Table V.
Leader of resource management

Having a clear vision for technology is essential in order to make wise purchases that will sustain the ICT program for several years. Computer equipment is expensive and can rapidly become obsolete. Many school districts have developed ever-greening plans that provide for the inevitable upgrading or replacing of computer equipment. The principal, as leader of resource management, must understand how to use all technology resources for student learning, including using older equipment, which may be adequate for many ICT outcomes.

Conclusion

The arrival of digital technologies in schools has impacted the roles and responsibilities of principals in significant ways. ICT has triggered demands for systemic changes in public schools necessitated by the shift from the industrial age to the knowledge economy. Inevitably, teachers and principals feel the pressure to change, and must find ways of implementing and sustaining technological innovations in classrooms.

This paper raises some fundamental issues in technology leadership for principals, and provides a model to guide positive action. The added roles and responsibilities for principals as technology leaders require a commitment of time and resources, both for individual leaders and for school districts. If school principals are to effectively inspire and lead a staff in integrating technology across the curriculum, then professional development opportunities must be available for principals to develop these skills and dispositions. The need for ongoing leadership professional development to do with technology has major implications for graduate programs, system level programs, and the provision of mentorship opportunities. Ongoing research is needed to understand the evolving role, competencies and dispositions towards technology and learning that principals require in order to be effective technology leaders, and how these are best developed and supported in practice. School districts must provide adequate, ongoing, intensive professional development for school leaders and teachers in the area of ICT implementation and management.

It is understandable that principals often feel overwhelmed by the expectations inherent in their new responsibilities. Many assistant principals, technology lead teachers and others are currently performing many of the tasks outlined in this paper. However, if ICT implementation is seen as part of a deeper school reform movement, then principals must play a key role and be given meaningful opportunities to develop the skills and dispositions necessary for leadership in the current educational milieu.

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