Factors contributing to teachers’ successful implementation of IT

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Abstract It has become increasingly important for educators to examine successful ICT implementations with the aim of understanding precisely what makes them successful in teaching and learning. In this study, an analysis of data from qualitative case studies of four Canadian schools illuminates factors that facilitate successful ICT implementation. Findings suggest that informal ICT education, such as ‘just-in-time’ learning, is most influential. Furthermore, supportive and collaborative relationships among teachers, a commitment to pedagogically sound implementation of new technologies, and Principals who encourage teachers to engage in their own learning are viewed as highly useful factors.

Keywords: Canada; Case study; Computer; Collaboration; Constructivist; ICT-use; Innovation; Pedagogy; Primary; Schools; Secondary; Qualitative

Introduction

Information and communications technologies (ICT) are an important feature of Canada’s educational landscape. In 1999, computer-to-student ratios were 1:9 in elementary schools and 1:8 and 1:7 in lower and upper secondary schools, respectively and over 80% of schools had achieved Internet connectivity (SITESM2, 2000; Statistics Canada, 1999). But equipment and connectivity do not guarantee successful or productive use: implementing technology in education is complex, shaped by pedagogical philosophies, curricular requirements, and the proliferation of ICT in society at large. According to Marshall (2001), 57% of Canadian workers used computers at work in 2000, compared with 33% in 1989. Of these, almost 80% used them daily. This surge in technology use has led to demands that education achieve and maintain currency in ICT implementation, both to respond to and shape broader societal developments, and to address pedagogical issues related to technology. Given these challenges, it has become increasingly important for participants in education to examine successful ICT implementations with the aim of understanding their success.

The specific questions framing this inquiry were: What factors do teachers perceive as contributing to successful classroom implementation of ICT? and How do these factors act, and interact, to make their contributions? Consideration was given to aspects of teacher practice as such and in relation to broader educational issues: mandated curricula, pedagogical philosophies, and school communities. This
paper defines the **successful implementations** selected for study, describes the sources and structure of the data, and outlines the stages of the research and methods employed. The focus questions are then engaged using a two-pronged data analysis: a discussion of the factors that the educators interviewed perceive as either contributory or detrimental to successful ICT implementation, and an examination of the interaction of those often diverse factors within pedagogical practice. The paper concludes by asserting the importance of a multifaceted approach to ICT use.

**Methodology**

This inquiry investigated, through the analysis of interview transcripts, the subjective experience of educators as they negotiated the new and often rough terrain of ICT. It took a grounded theory approach: ‘*data collection, analysis, and theory stand in reciprocal relationship with each other*’ (Strauss & Corbin, 1998, p. 23). Following Kirk & Miller’s (1986) concept of synchronic reliability, responses were examined for relevant consistencies.

The interviews were conducted in 12 schools across Canada, selected (from 60 initially nominated) by a national panel of educators, educational administrators, researchers, government representatives, and educational technology experts (SITESM2, 2000), and deemed to be engaging in innovative pedagogical practices using technology (IPPUTs’). This analysis focuses on four schools that were chosen for the overall discursive and conceptual richness of their data. Interviews were conducted with teachers, Principals, school board administrators, teacher-librarians, technical support personnel and students. The tape-recorded interviews were transcribed and the transcriptions coded using ATLAS.ti software. Analysis was undertaken using the constant comparative method (Glaser & Strauss, 1967): the codes, situated in three overarching categories — *ways of learning, individual characteristics*, and *environmental factors* — were revised as patterns emerged. Those patterns were subsequently examined for consistencies and contradictions, both between interviews and across the four schools. The contextual background for the schools is outlined below.

**The schools**

*Ladyslipper* is a consolidated school for kindergarten to Grade 9 students, built in 1971 to amalgamate several one-room schools in an agricultural area near the capital of Prince Edward Island. The school population is middle-class and mainly of Anglo-Canadian, English-speaking heritage. At time of writing there were just fewer than 250 students and approximately 17 teachers at the school, which had a 30-computer lab and computers in many classrooms. Computer instruction begins in Grade 1. Deemed innovative for its curricular integration of ICT, Ladyslipper takes a ‘hands-on’ approach to skills acquisition and use, believing this will give students a lifelong advantage. While ICT is ‘not the whole programme’, Ladyslipper focuses both on technological skills and on learning *through* technology: students use the

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*IPPUTs are practices (1) in which [information and communications] technology plays a substantial role; (2) that show evidence of significant changes in the roles of teachers and students, curriculum goals, and/or the educational materials or infrastructure; (3) that show evidence of measurable positive student outcomes; (4) that are sustainable and transferable, and (5) that are innovative as locally defined. (SITESM2, 2000, section IV, p.3)

Internet widely for research; both staff and students use email. Ladyslipper has also undertaken initiatives in establishing relationships with its community, and in fundraising to fulfil its ICT mandate.

*Ravine Public School*, a kindergarten to Grade 6 school\(^*\) in one of the poorest socio-economic areas of Toronto, Ontario, serves a culturally diverse population of about 400 students, of whom over half speak English as a second language. Its innovative ‘Triad Curricular Structure’ involves the 12 teachers and approximately 250 students in Grades 4–6, with teams comprising the teacher-librarian, computer specialist and a classroom teacher collaboratively interconnecting particular aspects of curriculum through classroom, computer lab, and library instruction (Lotherington *et al.*, 2001). The structure integrates all areas of the curriculum. Facilities at Ravine include a combined library/20-computer lab, and at least two computers in each classroom (a pupil-computer ratio of 5 : 1). The Triad is part of Ravine’s mission to combine high quality programs emphasising numeracy, literacy, and social responsibility with a wide range of computer skills. Co-planning and co-teaching, timetabled into the school schedule, are cited by everyone as crucial factors in both the Triad’s success and the staff’s collaborative mind-set.

*Main Street Public School* is also in Toronto, in a mixed-income neighbourhood of high-rise apartments and single-family dwellings, just outside an urban industrial pocket. Most students live in low-cost rented accommodation. Main Street serves approximately 400 kindergarten to Grade 5 students. Given the needs of the mainly ESL population, principles of equity — inclusive curriculum and global perspective — are central to the student-centred, technology-focused program. Informing the school’s work is its vision of a dynamic, relevant and equitable learning environment that uses ICT to enhance achievement and to prepare students for life as Canadian and global citizens. The current innovation involves student collaboration using ICT, along with cooperative learning practices, to develop their talents and skills in marketing, sales, public speaking, design, administration, entrepreneurship, writing and editing. At Main Street facilities include 40 Internet-accessible computers in the Learning Resource Centre and at least four per classroom, as well as 45–50 laptop computers for teachers, students and parents.

*Wildrose Elementary School* had, in 1999–2000, 21 staff and 437 students from kindergarten to Grade 8. Located in a rural area outside a major Alberta city, nearly all its students are from upper-middle-class families, and the community is largely homogeneous both linguistically and culturally. Wildrose’s pedagogical orientation is toward student-directed and inquiry-based learning: a constructivist direction central to which are principles of risk-taking, experimentation, autonomy and engaged learning. This approach is enthusiastically supported by most of the school community. At Wildrose, while ICT is understood as an integral aspect of the shift toward greater learner autonomy and inquiry-based work, its use is subordinate to the development of authentic, collaborative, and student-directed learning. Most classrooms have one computer; about 60 more are available in a very large room and two adjacent areas in the centre of the school.

\(^*\) In the Canadian education system, children enter grade one in September of the calendar year in which their sixth birthday falls. Prior to this, they may attend kindergarten for either one or two years, depending on the jurisdiction.

Findings

Ways of learning

Typical ICT teacher education in the form of isolated instructional sessions on hardware or software use can be significantly limited, because it acts as a vehicle for ‘simply providing knowledge to teachers and [does] little to help transfer the skills to actual classroom implementation’ (Browne & Ritchie, 1991, p. 28). Responses from the teachers in this study appear both to corroborate Browne and Ritchie’s assessment and to extend it to other formal learning methods — informal learning (Internet surfing, reading, or interactions with family and friends; on-the-job discussions; and collaboration with peers and/or students) is overwhelmingly perceived as more useful by those who have engaged in it. Wildrose teacher Paul, for example, finds courses and workshops ‘dry, without purpose, without meaning.’ For him, ‘It’s the dialogue that makes all the difference. It’s not the presented things.’ His colleague Emma similarly values ‘the just-in-time learning . . . [that] happens in the hallway, or the staff room, where someone [helps me learn what I need to know].’

Teachers’ preferences do not prove conclusively that informal learning and mentoring are intrinsically more valuable than courses and workshops. But it was noted that the just-in-time, co-constructed collaborative learning the respondents prefer embodied some of the characteristics of Gilmore’s (1995) model, set out in an exploration of Makrakis’s (1991) study of learning partnerships between computer and classroom teachers. This consists of an ongoing ‘coaching’ approach to ICT training believed to result in a more substantial transference of learned skills to classroom practice. Because it takes place in the context of teachers’ immediate curiosity, needs or desires, this need-to-know approach to constructing ICT knowledge and skills transforms teachers into active knowledge builders possessing substantial autonomy regarding the specific skills acquired. For Browne and Ritchie, this is significant, since ‘to facilitate classroom application of technology skills introduced during an in-service, the teacher needs to not only encode the information . . . but also achieve a level of autonomy and confidence in using the material with students.’ (Browne & Ritchie, 1991, p. 30)

Individual characteristics

Another type of informal learning experience respondents found beneficial consisted of learning from students: ‘[The] person who was the biggest help to me was one of my Grade 7 and 8 students,’ says Anita, Principal at Ravine. The resultant shift in teacher-student boundaries has significant implications for the understanding of teacher professional development. But this shift requires teacher comfort and confidence — one of many individual characteristics contributing to successful ICT implementation. Others examined include educational backgrounds, ICT skills and experience, beliefs and goals concerning technology, and resistance to ICT.

Educational background, experience & skills. At the time of the interviews, respondents’ experience as educators ranged from under five to over 30 years. Nearly all had bachelor degrees; some had or were working toward graduate degrees, in fields of study from astronomy and French literature to music and sociology. Many had taken additional qualifications courses in special education, principalship, library science and guidance. The interviews reveal a striking (though not universal) absence of ICT specialisation, but a wide range of exposure to ICT, experience and...
skills. For example, despite her current proficiency (as designated ‘computer teacher’ at Ravine the past five years), Lorraine reports: ‘I didn’t know anything about computers when I started teaching.’ At the other end of the experience-skills continuum is Ladyslipper’s Pierre, who explains: ‘For the past 15 years I’ve been involved in computers in schools...as a technical supervisor and [in] classrooms [with] computer technology.’ While no consistent overall relationship between teaching experience and experience with ICT was found, suggesting that success in technological implementation does not stand in a one-to-one relationship with the experience, skills or education of those engaged in it, some teachers saw this range in ICT experience or familiarity as an obstacle to collective staff advancement and a further rationale for ‘just-in-time’ learning; at Ravine, Grade 4 teacher Darlene relates, ‘[E]verybody is at such different levels . . . You go to something at lunch on how to use [the] Internet and some people have no idea . . . [ICT learning] has to be exactly where you are or you’re not going to learn anything.’

Beliefs and goals concerning ICT. Throughout the interviews, ICT is frequently spoken of as a tool, with connotations, however, ranging from Vice-principal and teacher Pierre’s view — ‘more than a tool’ — to Grade 6 teacher Daniel’s assertion: ‘I see it as a tool. I don’t worship it, it’s not a god, I’m not genuflecting at the altar of technology . . .’ Most individuals’ perceptions fall between these extremes: if ICT is a tool for them it is an important one. Indira, a Principal, sees it as particularly useful for students ‘who have difficulty with learning,’ while for Wildrose teacher Emma it ‘provides . . . a level playing field.’ For others, like Ravine’s Belinda, it is a source of information that is ‘immediate and the answers are there for us,’ while for Elsa, at Ladyslipper, it gives students ‘confidence, and . . . the preparation to go on with their lives.’

While the teachers clearly recognised the need for both skills acquisition and curriculum integration, they are not uncritical of ICT. For Paul, technology was ‘not more important than the things that have always mattered most to human beings’ — in fact, it can be ‘isolating [. . . and even] detrimental because it’s missing the human component of relationship.’ Yet he also believed ICT can offer students ‘a possibility . . . to be part of an authentic community that’s not age discriminatory, that’s not unnaturally biased.’ Lynne, from Main Street, also voiced ambivalence: while believing that ‘the most important thing is to set children up for success in whatever way it takes’, and appreciating how ICT had allowed equitable access to the study of music (her specialty) for those of her students who cannot afford to buy instruments, she nevertheless articulated concerns about the potential impact of an overemphasis of technology on motor and language skill development.

The ambivalence exemplified in the comments of Paul and Lynne reflects teachers’ search for balanced ways to use technology to improve both teaching and learning. Although Cuban contends that ‘many teachers may sense how the introduction of machines into classrooms endangers those intangible, highly prized rewards that count so heavily’ in their work (Cuban, 1986, p. 90), the teachers in this study not only sensed how computers, used judiciously, might augment both tangible and intangible rewards of all kinds, but were prepared to engage in the practical and theoretical work of determining wise and appropriate use.

Resistance to technology. Hodas identifies structural concerns, fear of technology, and fear of the loss of authority as factors in educators’ ‘technology refusal’,
contending that ‘computers in schools are anathema to [educators’] notions of what schools ought to do with and for children’ (Hodas, 1993, p. 14). While teachers in this study viewed ICT in less extreme terms, resistance was nevertheless articulated, here by Charlotte, who teaches at Main Street:

A lot of people don’t want to go out of this school for professional development because it goes right over your head . . . I know people are reluctant because they’ve gone to one or two and they said that they didn’t understand anything.

Ladyslipper’s former Vice-principal initially contended that ‘there was never, ever resistance’, but later acknowledged hesitation, moments when ‘teachers wanted to justify or to be assured that the time they were injecting into technology was not taking away from the language arts . . . or the math they had to cover.’ Further, consistent with Hodas, other respondents articulated resistance as fear — ‘[that the computer is] going to blow up, or [that] they’re going to erase something, or . . . do some sort of damage that’s going to cost a lot of money’ (Richard, Ladyslipper) — and as frustration: ‘[Teachers] want the kids to do this database and make this chart or something and half the computers don’t work or the printers don’t work. They can only tolerate so much of that . . .’ (Lynne, Main Street). Resistance to ICT thus constitutes a complex set of connections between individuals, technology, and the social, political and material environments.

Environmental factors

‘Environment’ is defined here as the web of relations between teachers, supervisors, technical support personnel, students, governments and the community at large.

Logistics. Time and equipment were the most frequently mentioned obstacles to ICT implementation. Simply, when these were lacking or in short supply successful implementation became difficult. There was never enough time for teachers. Thus, while they appreciated their own and their colleagues’ resourcefulness, they named the need for — and shortage of — targeted technological support as key concerns. Ladyslipper’s Kate viewed colleagues as ‘essential, because there is nobody else . . . [Support is] not provided at the Department level’. At Ravine, Arielle noticed that ICT support was ‘centred in high schools . . . [which] is a real disadvantage to elementary schools . . .’ and Main Street’s Fung Lee stated, ‘I think schools should have technicians’. Still, all four schools were successful at implementing ICT despite the time/equipment issues, often having found creative and positive ways to address them: planning and teaching in teams to make extra time for learning, using simple programs on slower computers with students needing more time, and keeping ‘spare parts’ handy for repairing broken hard drives. Crisis intervention was built into this ‘just-in-time’ approach. Further, the teachers emphasised the importance of Principals as advocates in a period of fiscal restraint and ever-increasing demands on educators. Central to Main Street’s success, according to library teacher Rex, was:

‘a kind of permission and the freedom to just sort of explore, and recognition that you need time to do things well, [along with] tangible examples of support.’

Community both within schools and between schools and the families they served, began with the Principals’ leadership. At Main Street, Indira describes her style as ‘a very open door policy’. Rex concurred:

‘[The] atmosphere is very relaxed with administrators who give you an opportunity to basically experiment and explore and you don’t have to be perfect . . . allows us to be risk takers, to make mistakes . . .

At Ravine too, Laura saw good leadership as ‘being allowed to do your own thing with encouragement to improve’ and at Wildrose, statements made by both Principal and teachers revealed their relationship as collaborative and mutually supportive of learning. Camilla says:

‘The Principal is certainly responsible for everything that happens, although . . . [we] share things, everything, school visioning, supporting teachers, supporting children.’

Like effective leadership, the importance of collaboration cannot be over-estimated: teachers need each other — for team teaching and planning, technical problem-solving assistance and learning. Although each school had specific pedagogical goals informing and supporting technological implementation, all had in common a philosophy of collaboration driving ICT implementation.

At Ravine, linguistic, social and cultural equity were concerns: the community included new Canadians whose ‘language and educational backgrounds may provide limited exposure to the kinds of communication and literacy practices expected and valued by the school’ (Lotherington et al., 2001, p. 142). The school conducted initiatives such as ‘Internet nights’ to improve school/home communication and to impress upon the community the importance of education.

Similarly, at Main Street technology was described in terms of equity and opportunity. The students, from minority cultures and lower socio-economic backgrounds, ‘lack lots of experiences.’ ICT was seen as providing opportunities for connecting with knowledge and the larger world. A further focus was on gender equity; opportunities were provided for girls to engage with technology in ways that, given their home cultures, might not otherwise occur.

Ladyslipper’s ICT philosophy focused on technology as part of ‘relating to the child’ — meeting individual learners’ present and anticipated needs by teaching skills to keep them current with ICT. The school, whose goals included integrating ICT throughout the curriculum, and balancing technology and traditional academic work in ways the community demands, exposed students to the outside world through projects that involved using technology to share their work.

At Wildrose the overarching goal was developing meaningful learning relationships among students, community and environment. Here, revisioning ICT use was part of an ongoing ‘evolution of understanding of teaching and learning’, further explained as the work of imparting to teachers, students, and the community — which initially resisted the implementation — a ‘deeper understanding of how technology is a tool for learning . . .’. Skills acquisition was seamlessly integrated into pedagogical practices.

Although the schools studied differed in their pedagogical goals, ICT objectives and actual practices, they shared a deep commitment to community and a conceptual understanding of ICT as increasingly useful for their communities. Still, ambivalence concerning many facets of education persisted in the communities the schools served. Couture refers to the work of teachers as that of ‘receive[ing] and interpret[ing] the calls for an increased emphasis on technology within a social milieu that is ambivalent about their work’ (Couture, 1992, p. 141). These four communities were no exception; here, however, community resistance had been and continued to be addressed through actions grounded in the schools’ philosophical commitments, both to ICT as a worthwhile component of education and to an ongoing philosophical inquiry into its usefulness. It was their commitments that made these schools strong.
Conclusion

While the cases related here reflect the participants’ diverse experiences, backgrounds, ages, learning styles, attitudes and beliefs, each is a story of success. Multiple factors affecting the implementation of new technologies have been explored: modes of learning, characteristics of teachers-as-learners, and ideological issues in schools and communities. While there is no single sufficient condition for success with technology, the narratives reveal a set of necessary conditions that, although differently articulated, are remarkably consistent across the four schools. Soloway et al., in a paper presented to the US’s National Commission on K-12 Science and Math Education concerning current educational challenges, enumerate ‘Three Ts of Elementary Education’ — tasks, tools, and time — as necessary to support teachers and teaching in their efforts to ‘integrate technology into the daily fabric of their instructional practices’ (Soloway et al., 2000, p. 15). Mapping their concept onto this Canadian analysis, the factors contributing to schools’ success seem to be computers, commitment and community.

Teachers can neither teach computer skills nor integrate ICT into curricula without having at their disposal computers that work. Clearly, a lack of appropriate material resources inhibits learning and causes frustration and resistance in school communities. Further, appropriate full-time technical support and significant opportunities for teacher education in ICT use are as necessary as up-to-date equipment if teachers are to move toward curricular integration and meaning-making. Moreover, the evidence of this study points firmly toward informal and ‘just-in-time’ learning as most useful for teachers.

These findings suggest that the relationship between teachers’ ICT skills and successful implementation is complex and not obviously predictive: attitudes, philosophies, communication, and access to skills training are also contributing factors, which both inform and are implicated in the notion of commitment. The teachers were engaged in teaching technology and in the practical and theoretical work of thinking about technology in ways that informed their practice. They were committed to student learning, to finding creative ways to implement technology, and to an ongoing critical inquiry into all aspects of ICT that was grounded in a further commitment: serving the needs of the larger communities from which their students came and to which they returned after the school day.

The communities served by the four schools had unique needs and particular ways of relating to their educators. The schools worked continually with questions of equity, privilege, language, and community support, and with philosophies of pedagogy informed by the characteristics of their communities; each has found ways to negotiate the gaps between the work of education and community perceptions of what that work ought to be. Here, commitment and community are interwoven.

Community also manifested itself within each school in multiple ways — in collegial support, in collaborative learning, and in administrative encouragement. These processes function on many levels from ‘ongoing and sustained dialogue and discussion about what [ICT] means and what matters’ at Wildrose to Ravine’s Triad, comprising structured collaboration and continuous communication among teachers. They were reinforced by the enthusiastic support of the Principals, whose work in community building further allowed technological innovation to progress in an atmosphere of shared commitment.
Perhaps what made these four schools successful can best be synthesised using Becker’s notion of personal investment (Becker, 2000). At Wildrose, Ladyslipper, Main Street and Ravine the investment was twofold: in ongoing individual development, and in the school community. Both the relevance of knowledge and skills, and the ways they are acquired — through ongoing collaboration in all areas of school life — reinforced the notion of the schools as fully participatory, heterogeneous communities of individual learners. It is these learning communities, their cultures formed and informed by all the practices, relationships and philosophies of their individual members, that facilitate and carry out the work of technological implementation as they engage in the teaching, learning and inquiry that unite the interests of the individuals and the communities they serve.

References


