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Computer implementation in education: Hearing the educator's voice

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COMPUTER IMPLEMENTATION IN EDUCATION: HEARING THE EDUCATOR'S VOICE

by

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Abstract

Computer technology is pervasive in education systems around the world. Although computers are now available in almost every school, that presence has not guaranteed the use of computers as part of the instructional repertoire of educators. This thesis is an investigation of the factors that affect implementation of computers from the perspective of educators across a school board.

Fifty-four randomly selected educators (37 elementary and 17 secondary) completed a written survey assessing computer access and use, predictors of integration, prevalence of barriers and supports, and, recommendations from the educators themselves. Results indicated that computers are indeed available and that educators are technology users who generally support the integration of computers. Those educators who are more comfortable with computers are more likely to integrate them in their teaching. Educators suggested that support is necessary in terms of computer hardware and software, technical assistance, classroom access, and human resources. Training, more specifically at the elementary level, was presented as a pressing need.

Educators also participated in focus group discussions. The qualitative data supported and expanded on the results of the survey. A great deal of affect accompanied the comments during the focus groups. Additionally, thematic analysis of the qualitative data resulted in the construction of a framework for future investigation of computer implementation and recommendations for policy. Within this framework, the educator is key to successful implementation, affected by both individual characteristics (time, pedagogy, training, familiarity with computers, and affect) and environmental issues (context of computers, support, curriculum, teaching level and student characteristics).

The interaction of these individual and environmental variables and how they affect computer implementation is the focus of future research.

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Presence of Computer Technology

The computer revolution predicted in the 1980's paved an information highway through the 1990's into the new millennium where state-of-the-art information and communication technology promises education for the masses at the click of a mouse. Interest in educational computing has "grown explosively" (Bromley & Apple, 1998) with "uncritical, popular attention" (Windschitl, 1998).

National and international statistics show that schools around the world are becoming increasingly well equipped with computer hardware (Collis, Knezek, Lai, Myashita, Pelgrum, Plomp & Sakamoto, 1996). The Second Information Technology in Education Study conducted in Canada (Statistics Canada, 1999), reported that, in 1999, there was one computer for every nine elementary students, one for every eight lower secondary students, and one for every seven upper secondary students in public and private schools. Internet accessibility has become almost commonplace, with close to 100 percent of secondary schools connected and 88 percent of elementary students attending a school that has Internet access for instructional purposes (Statistics Canada, 1999). The same dramatic increases have been paralleled in the U. S., where 95 percent of public schools were connected to the Internet, with one instructional computer with an Internet connection for every 9 students in 1999 (Greene, 2000).

The computer has been seen as a symbol of the quality of a child's education backed by the assumption that new technologies are an improvement and will make life easier for the educator (Bromley et al., 1998). Hardware has been purchased as part of a determined drive to "keep up" (Mckenzie, 2001), advance, and "prepare for the future"

with little empirical evidence as to its benefits (Bromley et al., 1998). It is imperative that we explore the impact of technology beyond its physical presence.

Effectiveness of Computer Technology in Education

Early debate surrounding the effectiveness of computers in education was generally polarized: the computer is inherently good and requires fine tuning only, or it is inherently evil and should be avoided (Bromley et al., 1998).

The "nay-sayers" of computers in education present equity issues surrounding gender (Comber, Colley, Hargreaves, & Dorn, 1997) and access (Sutton, 1991; Rocheleau, 1995) as arguments against current implementation practice. Concerns of social isolation and restricted interaction (Podmore, 1991) as well as suggestions that computers are developmentally inappropriate for young children have also been investigated (Zajonc, 1984). Fiscal restraint in education has also brought to question what must be sacrificed to finance computer purchases, specifically textbooks, school building maintenance, and staffing (Armstrong & Casement, 1998). Other research points to a lack of increase in achievement as evidence for the failure of computers to effect differences (Clark, 1994; Dalton & Goodrum, 1991). The Internet comes with a unique set of weaknesses to consider, ranging from the sheer volume of information to wade through to the availability of inappropriate, even pornographic, material (Grey, 1999). At the same time, the Internet is able to provide an infinite number of up-to-date resources in multimedia, hypertext format allowing for links around the world.

Supporters of computers in education point to the many advantages of computer-assisted instruction, not the least of which is motivation. The motivational power of computers for children, young and old, has been well-documented (Bergin, Ford & Hess,

1993; Heaney, 1992; Schofield, 1995, 1997). Research looking at social interaction has demonstrated that the computer, far from isolating students, actually brings them together in cooperative, mutually supportive pairs or groups (Eraut, 1995; Schofield, 1997; Sewell, 1990; Svennson, 2000).

Interaction between teacher and student has also been identified as a variable affected by the introduction of computers. Schofield (1995) reports a shift in the teacher's role to include more interaction and less whole group instruction when utilizing computers in the classroom. Teachers using a computerized geometry tutorial program increased the amount of time spent with students having problems, and when giving help, that help was more individualized and private. More objective measures of success commonly cited in support of computers in education are increased student achievement scores (Niemiec & Walberg, 1985), enhanced metacognitive skills (Collis et al., 1996), and creative tendencies (Collis et al., 1996). The speed and memory of the computer present an opportunity to decrease cognitive load and allow learners time and space for higher-order processing (Sewell, 1990).

Evaluation of computer technology in education has been conducted in the form of pilot projects in which a classroom is purposefully supplied with technology and then observed and evaluated. The Apple Classroom of Tomorrow (ACOT) program was designed under the premise of a computer for everyone (Scott, Cole, & Engel, 1992). Every teacher and student was given individual access to a computer at school and at home in 6 different schools across the United States. A "technical support" person was provided for each classroom and professional development was included at various points during the intervention. Conclusions from observational and descriptive analysis

included positive outcomes: students were empowered; they wrote more, faster and better; spontaneous peer teachers developed; students took initiative for learning; and, students learned basic skills at their own rate more efficiently.

Clearly, evidence regarding the implementation of computers is far from conclusive. There is research that supports, as well as questions, the implementation of computers in our education system. Rutkowska and Crook (1987) caution that computers are being implemented into the school system with little or no empirical base. Most studies do not include control or comparisons groups; effects vary according to population, teaching method and measure of success; and, the controlled nature of the interventions and investigations often prove to be artificial compared to the complex, ever-changing atmosphere of the classroom.

The educational focus and application of computers have changed and developed along with advances in technology. We have seen a shift from computers being seen as a topic of study in computer science and programming courses at a secondary level only (Bangert-Drowns, Kulik & Kulik, 1985) to a versatile tool that can be integrated into all aspects of the curriculum (Heaney, 1992; Pelgrum, 1992).

Recent opinion suggests that the computer is more than a tool to be used to improve traditional instructional methods and student learning. Hokanson and Hooper (2000) suggest that if the computer is only used as a tool, it is destined to failure; that it is, in fact, a cognitive medium that provides opportunity for cognitive growth. They go so far as to predict that computers may change how we conceptualize and evaluate intelligence, which would have a major impact on the nature of education. The Internet and the World Wide Web offer a novel learning environment that will require research

investigations at various levels to determine its specific impact on participants (Windschitl, 1998).

How computer technology is viewed and the purpose behind its utilization are important factors in evaluating the effectiveness of computers in education. Pelgrum (1992) surveyed 21 educational systems worldwide and found differences between elementary and secondary level schools. The most popular use of computers in secondary schools was still to teach programming and applications while primary schools used computers for both academic work and educational play in limited content areas. In 1994, Niederhauser and Stoddart surveyed teachers across one state and identified two discrete categories of beliefs. The computer was considered either a teaching machine used to present information, give reinforcement and track progress; or, a student learning tool used to collect, analyze and present information. Elementary teachers in this survey generally supported the former transmission-oriented view and used software compatible with those beliefs, whereas, secondary teachers favoured a constructivist approach with technology playing a key role in student-centred learning. A constructivist approach puts the individual child at the centre of instruction with the teacher taking more of a facilitating role in the construction of knowledge rather than giving information.

In a meta-analysis of evaluations of the effectiveness of computer-based education in secondary schools, Bangert-Drowns et al. (1985) concluded that positive effects on student achievement depended on the form of computer instruction used. Computer-assisted instruction (CAI), that is drill and practice programs, and computer-managed instruction (CMI), that is computers keeping track of student records and guiding students to information resources, resulted in significant improvements while

computer-enriched instruction (CEI), that is students being taught computer programming or computer simulations to improve concepts in other areas, did not.

Computers do not exist in isolation but are implemented into the ever-evolving, socio-cultural milieu of the education system. The effects of computers then cannot be considered in isolation either (Dalton et al., 1991). Variables specific to computers and the accompanying software, the structure and theoretical framework of the system into which they are implemented, and most certainly, the pedagogical beliefs of the teacher and the attitudes of all participants, will influence the implementation and degree of integration of computers in education.

High Access/Low Use Paradox

Although the empirical base for implementing computer technology into classrooms is by no means conclusive, there is no question that computers and information technology are present in our schools. Despite this presence, however, the evidence that this technology is being used effectively is not so apparent. Descriptive statistics reporting Internet connections and pupil/computer ratios tell us little about the quality and quantity of student and teacher interaction with computers. The uses and applications of computer hardware and software, as well as Information Technology, are diverse and the context in which they are implemented is complex and changing. In a U.S. nationwide survey, Rosen and Weil (1995) discovered that although computers were available in nearly every school, only one-half of the elementary classrooms were equipped with a computer and only one-half of teachers used the computers available for their own use.

Cuban, Kirkpatrick, and Peck (2001) report on a similar paradox in a year long study of two secondary schools that were identified as having "high access" to computer technology. Although the student/computer ratio was quite low, the actual classrooms were equipped with only one computer each. Only 4 of 13 educators interviewed said that they had modified their classroom in major ways. Most adapted technology to fit familiar practices and did not use the technology on a regular basis. The educators pointed to lack of time to find and evaluate software, as well as training that was seldom offered at convenient times, as reasons for a less than stellar integration of the high tech computers available to them within their schools.

Earlier research (Cuban, 1998) suggests that there is a value struggle responsible for low use of technology. In a survey of 750 Stanford professors, 59 percent of the university educators said they never used a computer in the classroom, and only 8 percent said they used a computer often. Two out of three professors also cited lack of time to develop software as a barrier to use. Forty-five percent said that "they had no time to learn about classroom use of computers" and 70-90 percent said that they had not used the consultant that was available. Although lack of time was provided as a reason for low use of technology at the university level, Cuban suggests 3 alternative explanations. He proposes that the essence of teaching requires the "human touch" and that a need for person to person contact supersedes any computer-assisted instruction benefits. The purpose of schooling also brings into question the use of technology as preparation for the high-tech workforce. Education may also be the building of citizens which does not necessarily require an abundance of computer usage. Finally, Cuban points to an historical pattern of educators not being quick to "jump on the bandwagon" of fast-

changing technologies. Educators may be waiting for the use of computers in education to be substantiated.

Research looking at teachers' attitudes, confidence and enthusiasm toward computer integration suggests that there may very well be barriers to the successful implementation of computers across the education system. Although many positive outcomes were identified in the Apple Classroom of Tomorrow project referred to earlier, educators also identified issues that needed to be addressed(Sandholtz, Ringstaff, & Dwyer, 1997). The educators had initial concerns with management of the computers and expressed a need to gain mastery of the technology before using it in instruction. There was a developmental process to successful implementation that occurred over several years. The initial "entry" stage was marked by frustration and concerns over technical problems and resource shortages. Barriers to development of successful integration of the computer technology were identified as: limited access, technical problems due to lack of knowledge and malfunctions, and a lack of time. Instructional changes were seen only when a high degree of support was provided in the form of a coordinator; administrative support; time for learning; technical support; diminished access problems; and, a shared school vision. Educators needed to experience enough success with technology to displace their feelings of frustration and failure with technology in the initial stages of implementation. Sandholtz et al (1997) concluded that the long-term changes were a result of slow change, a need for educators to see success before committing to change, the rarity of contextual supports, and the slow shifts in the larger sphere of professional development in education. The ACOT project provided a

long-term picture of technology implementation in select classrooms. It is important to consider those same possible barriers in the context of regular classrooms.

Schofield (1995) identified a long list of attitudinal and organizational barriers in her study of computer use at a secondary school in the U.S. She listed these barriers as: the belief that computer use will add little benefit to current practice; disruption of the classroom's traditional social organization; lack of familiarity with computer hardware and software; threats to teacher's sense of competence and authority; computer anxiety; problems with training; resistance from teachers; lack of support; an overload on teachers; and lack of incentives, coupled with the presence of disincentives.

Rosen and Weil (1995) considered "technophobia" specifically, as an explanation for why teachers weren't implementing computers despite the increased availability of hardware. Computer experience was found to be the best predictor of computer anxiety although it was not the only one. Gender, teaching experience, computer availability and school district were also important predictors depending on the group of educators considered. Rosen and Weil suggested that early modeling of such computer anxiety can affect students. The attitudes of educators will affect the learning situation for their students. In a study of university undergraduates, Brosnan (1998) did find that being introduced to computers by a teacher rather than a friend or parent was related to increased computer anxiety. Approximately half of the participants had been introduced to the computer by a teacher, which was a greater percentage than any other type of introducer, including friends, family or employer.

The beliefs that a teacher, and subsequently students, hold about their own computer knowledge may be just as important as the actual amount of knowledge that

they possess. Anderson (1996) conducted a more detailed consideration of computer anxiety and concluded that "perceived knowledge" of university business students was a better predictor of computer anxiety than actual experience. The students' rating of their "perceived knowledge" of software programs was a better predictor of their score as measured by the Computer Anxiety Rating Scale than was the amount of experience they had with computers in terms of access and program experience.

Teachers report a lack of training as a barrier to computer implementation (Wood, Willoughby, & Specht, 1998). It follows that perceived knowledge would increase with training. Teachers' beliefs will affect their practice. They draw on their training and experiences to form those beliefs (Kristiansen, 1991; Niederhauser et al., 1994). If computer knowledge and training are not part of that experience, it is less likely that computers will be included in their practice. Even a good deal of experience may not provide the confidence that an educator needs in order to include computers in their instructional tool box. A complete faculty of secondary teachers surveyed by Woodrow (1987) strongly favoured computer instruction but were not still not confident enough to teach computer literacy despite the fact they had been key participants in implementing a computer applications program aimed at providing all students with the necessary skills to use the computer as a natural tool in their school work. A lack of confidence based on perceived inadequacy or expertise may be responsible for limited classroom introduction of computers and changes in student-teacher relationships surrounding computers. Students are often more confident about computers than their teachers (Kristiansen, 1991).

Research identifying these possible barriers to implementation of computer technology as a potentially valuable learning tool has been limited, often using single school samples (Armstrong & Casement, 1998; Schofield, 1995). Considering the financial investment as well as the rapid pace and scope of the implementation of computer technology, it would be wise to pause for reflection on the process and what is happening with the key players (Gersten, Chard & Baker, 2000). There needs to be empirical evidence to explain what works and what doesn't work with computers in the educational system. The "prevalence of faddism and the failure to utilize empirical research as a foundation or core for reforms continues to plague education" (Gersten et al., 2000, p. 453). It is important that researchers supply knowledge of "best practice" and innovation using computer technology, but these findings need to be generated and refined with significant input from practitioners (Gersten & Baker, 2000).

Educator's Role

The effects of the computer itself (Bangert-Drowns et al., 1985; Sewell, 1990) and the software used (Clements, 1995) have been investigated but there is less research that specifically explores the role of the educator in the implementation and use of computer technology. Teachers ultimately determine whether and how computers will be used (Mercer & Fischer, 1992). Becker's investigation (1993) of decision-making related to instructional uses of computers found that most schools had policy independent of higher authority but different schools and individual educators varied from one another moderately or a great deal in topics, programs and organization of class for computers. Schofield (1995) suggests that often teachers' decisions lead to low levels of use. In

order to gain a true picture of computer implementation and actual use in classrooms today, teachers' voices must be heard.

Current research addresses several of the variables that may affect computer implementation and its results in relation to teachers who are using computers. In her study of educators in two secondary schools, Schofield (1997) identified a shift in the teacher's role as one of three significant social impacts of computer use in the classroom, the other two being increased student motivation and greater positive peer interaction. Teachers using computers saw themselves as facilitators. They interacted with students more and did fewer whole group lessons. Is a child-centred, interactive teaching style a product of the computer use or are computer users a different breed of teacher? Support for the latter is found in Becker's research (1994). Becker identified exemplary computer-using teachers via questions on a national survey that examined goals for computer use, student use of computers, and the role of computers in the classroom and compared them to other computer-using educators. In comparison to those educators that did not fit in the exemplary category, the educators identified as exemplary spent twice as many hours personally on school computers, had more formal training in computers, had more teaching experience, more post-graduate education and were more likely majors in math, science, social sciences or humanities rather than education.

Schetz and Stremmel (1994) explored computer implementation based on a Vygotskian framework, acknowledging "the critical role of an adult or more skilled partners in task performance and knowledge construction" (p. 18). Preschool children who were part of a Head Start program aimed at improving conversational skills were placed in one of two computer-assisted learning conditions: software alone or software

with teacher enhancement. Those children who used the software with teacher enhancement, that is, children who were required to verbalize their responses to an adult while using the software, demonstrated greater verbal expression of the words and concepts learned. Although computer software was selected to fit the needs of the child, the role of the teacher remained critical in providing language enrichment for these preschoolers.

The teacher is key to establishing an environment from which the benefits of computers are derived. Clements (1995) considered word-processing and children's writing. Word- processing software can enhance the creative writing process, but only if the teacher sets up a learning environment that supports writing as a collaborative, recursive process and software is chosen that is consistent with those themes.

The role of the teacher is still important at a secondary level. Computer science teachers who were part of a computer intervention functioned more as coaches than lecturers when teaching in a computer lab as compared to a regular classroom setting (Schofield, 1995). Teachers found less need to maintain strict control over behaviour and did not always feel the need to "be the expert." The relationship between the student and teacher changed to include more interaction. The teacher's instructional philosophy, in this case a constructive approach, was a more important determinant of the use of software than the software itself (Schofield, 1997).

The fundamental teaching philosophy and style of the teacher will determine his or her response to and use of computers. A teacher's attitude will also ultimately affect a child's experience or non-experience with an educational tool such as the computer (Sutton, 1991). "When teachers begin to view computers as valuable teaching tools,

children become excited about learning, and computer activities begin to replace traditional curricular units or activities " (Haugland, 2000, p. 14). Papert (1999) agrees that the teacher's role in the integration of technology is vital. Computers will not have a significant impact on the education of young children until educators integrate computers into the curriculum.

Practitioner's Voice

After reviewing recent research and reported government statistics, it is safe to assert that there has been widespread introduction of computers within the school system. However, given the rapid advances and changes in application of computer technology, research supporting effective and efficient integration of the computer, as an instructional tool or learning medium, is not well established. There have been recent investigations, mostly at the secondary level, into possible barriers to computer integration in high access schools (Becker & Ravitz, 2001; Cuban et al., 2001; Schofield, 1995). The findings from these studies point to the educator as the key to implementation of computer technology beyond the organizational and environmental barriers. The educator's knowledge, skill and philosophy are determinants of their instructional methods (Staub & Stern, 2002).

Wood, Willoughby and Specht (1998) reported results from a survey of early childhood education centres that identified a lack of training and expertise as one factor hampering the introduction of computers in these centres, despite a high level of interest in the implementation of technology. It is important that we obtain evidence describing the current situation of computers across the education system—access to technology, use of computers, barriers and supports to implementation, and who the computer users are. It

is important that we hear from the key players at all levels in any efforts to identify the factors involved in the implementation of computer technology.

In recent years, qualitative methods have been used successfully to gain insight into the philosophy and pedagogy of educators. Pressley and Beard El-Dinary (1997) were successful in identifying challenges to implementing comprehension strategies instruction through interactions with various groups of teachers. The insights they gained from their qualitative studies led to the design of a quantitative, comparative study. Gersten and Baker (2000) conducted an exploratory search for impacts of language practices via work groups composed of researchers and practitioners (teachers). Guided propositions were used to stimulate discussion and additional questions were mailed to participants. The participation of the practitioner strengthened the validity of the interpretation that em rged and developed an important link between practice and research (Strauss & Corbin, 1994).

Qualitative research practices have also been heralded in the study of technology implementation. "Because technology, when used to its best advantage, helps reshape roles for teachers and learners and encourages new and different types of interactions in the classroom, qualitative approaches should be considered to investigate these phenomena" (Windschitl, 1998, p.31). A qualitative approach allows for discovery of, rather than verification of, theoretical positions (Windschitl, 1998). Open-ended narrative work allows for the teacher's voice to be heard without pre-determined bias from selected questions or political agendas. Frank, uninhibited discussion assists in discriminating factors that contribute to the success or failure of an educational innovation (Wong, 1997).

The current study utilizes qualitative methods by gathering educators in focus groups and hearing their thoughts and concerns regarding computer implementation in education. A comprehensive picture of computer implementation is further developed using a quantitative survey of computer use, experience and access.

Purpose of Current Study

The research reviewed above establishes the presence of computer technology in schools but presents questions as to its effective integration. The importance of direct involvement of a cross section of educators has been established. Possible barriers to successful implementation of computers have been identified, specifically at the secondary level.

The intention of this research project is not the development of a template for technology implementation but development of a framework for examining issues affecting successful integration of computer technology in elementary and secondary classrooms from the educator's perspective. The following general research questions will guide the analysis and interpretation of the information the educators provide.

1. What is the current state of computer use and access in Ontario elementary and secondary schools?

2. What are the barriers and supports surrounding computer implementation in elementary and secondary schools?

These two questions will be addressed using a survey that explores teaching experience, pedagogy, professional development, computer knowledge and comfort, computer use, and specific classroom examples.

3. What do Ontario elementary and secondary educators see as the relevant issues surrounding implementation of technology?

Answers to the final question will be developed from focus groups conducted with small groups of educators in order to provide a safe environment in which to express concerns and provide insights into what is working and not working with up to date computer innovations and implementations. The issues revealed in the focus groups will serve as a guide to future research and policy directions.

The purpose of the research is to develop a picture of computer implementation in education: what computers are used for, whether computers are used as a stand-alone activity or an instructional tool, where they are used, what integration of technology means to individual educators and specific teaching levels, and what, if anything, still stands in the way of successful implementation.

Method

Participants

A total of 54 educators (37 elementary and 17 secondary) from a mid-sized Canadian city completed a written survey and participated in one 60-minute focus group. There were 32 female and 5 male elementary teachers and 8 male and 9 female secondary teachers. Ages ranged from 25 to 61 years of age ($M = 40.5$, $SD = 9.17$ years). The majority (85.2%) of participants held an undergraduate degree, 11% held a graduate degree and 2% held a college diploma. The majority of the participants had been teaching for several years ($M = 13.32$, $SD = 8.37$, ranging from 1½ to 31 years).

Sampling Procedure

A random sample of 144 potential participants was drawn from a list of all educators employed by the school board in the previous year (74 elementary school educators and 70 secondary school educators). Of these potential participants, some of the educators were not available to participate due to illness, death, retirement and maternity leaves. In addition, among the remaining secondary participants, some of the educators could not be contacted and hence, were unable to be involved in the study—contacting elementary school teachers was not a concern. Among elementary school educators, 39 of the potential participants who were still teaching agreed to participate, representing a response rate of 61%. A lower response rate of 31% was achieved with the secondary school educators due to major difficulties in contacting potential participants at their respective schools. Caution must be expressed in seeing the secondary panel as representative of their population since a much smaller portion of the secondary pool agreed to participate in the study. It is possible that secondary educators that are not responsible for direct computer instruction did not see their participation as worthwhile.

The school board's Research Committee contacted the principals of potential participants. Principals were informed that the school board would cover the cost of providing an occasional educator for the participants' absence.

Materials

Participants completed one 6-page survey comprised of 3 sections: demographic information (including age, gender, total years teaching, and highest level of education), an assessment of computer use, and, an assessment of personal opinions, philosophies and pedagogical beliefs (see Appendix A for a complete survey). The computer use

section was composed of 16 forced choice (yes/no) questions regarding computer access and use, both at school and at home (e.g. "Do you have a computer at home?" and "Do your students use a computer in your classroom?"). These questions were followed by 3 short answer questions regarding amount of time spent on a computer and professional development experiences. Two questions assessed comfort level with computers using a 5-point Likert-type scale, where 1 represented "very at ease/very enthusiastic" and 5 represented "very ill at ease/not at all enthusiastic". The last question asked participants about their awareness of a school computer plan and who developed the plan.

The third section of the survey contained a mix of forced choice (yes/no) and open-ended, short answer questions to assess participants' pedagogical philosophies and instructional methods, some directed specifically at technology and some at more general pedagogy (e.g. "Does the integration of computer technology fit within your personal instructional approach(es)/orientations" or "Please identify the approach(es) that you take to instruction").

Completion of the survey was followed by the focus group. Participants were reminded that their participation would be anonymous. Focus groups were video- and audio-taped and later transcribed.

Procedure

Potential participants were contacted by telephone at their school (See Appendix B for telephone script). Once verbal consent was obtained, a mutually agreeable date was set for their participation in a focus group. A confirmation letter was sent to the participant following oral consent by telephone (See Appendix C). Participants attended one of 13 sessions held in small rooms at the school board education centre. The average

focus group contained 4 members, however, due to illness and scheduling difficulties, 2 sessions involved only 1 participant. Each group was composed of educators from only one instructional level (elementary or secondary). Educators were welcomed, reminded of the confidentiality of their responses and asked to begin with the individual survey, which took approximately 30 minutes to complete. The same survey was used for both elementary and secondary educators.

Once all members of the group had completed the survey, the researcher initiated the focus group after turning on the audio- and videotape recorders. Educators were reminded that the tapes were only going to be used for transcribing the discussion and that all responses would remain anonymous.

The researcher then initiated discussion by inviting participants to share their experiences, ideas and concerns regarding computer technology in education. In most cases discussion was initiated and continued by participants. On a few occasions one or two prompts were provided. Prompts included reference to the survey questions, particularly with respect to computer equipment use and availability, whether and how computers are used in the classroom, parental involvement, and student experience. Focus groups were terminated after a 60-minute interval.

Results

Both quantitative and qualitative techniques were used to analyze the data. Quantitative analyses were conducted on the forced-choice and scaled items from the survey. Qualitative analyses were used to assess the open-ended survey questions and the focus group discussions. The quantitative analyses are presented first, followed by the qualitative analyses.

Quantitative Data Analysis

Computer Use and Access. Overall, most participants indicated that they had a computer at home (94.6% and 94.1%, elementary and secondary levels respectively) and that they used that computer (91.9% and 94.1%, elementary and secondary levels respectively). Home computers are used extensively for personal (93%) and school-related tasks (94.4%) (See Table 1 for a summary of all yes/no questions).

One hundred percent of secondary educators indicated that they used a computer at school for school-related tasks, with only half (52.9%) using the school computer for personal tasks. The elementary educators indicated less use of a school computer (86.5%) than secondary school educators, but similarly, they used the computer more for school related tasks (86.5%) than personal tasks (32.4%).

In addition, about a third of the educators (27% and 35.3%, elementary and secondary, respectively) indicated that they had access to computers outside the home and the school. However, when educators were asked to indicate the amount of time (in minutes per week) spent on computers at home, school and other environments, only one participant, a male secondary educator, reported any time spent on a computer at a location other than school or home. Analyses, therefore, were conducted only for home and school locations. A 2 x 2 x 2 repeated measures ANOVA was conducted to compare the amount of time spent on a computer at home and at school, as a function of gender and teaching level. Location served as the within subjects variable. There was a significant main effect for location, $F(1, 50) = 19.00$, $p < .001$, such that a greater amount of time was spent at home ($M = 222.32$ minutes) than at school ($M = 128.52$ minutes). No other main effects were significant; however, teaching level approached significance,

$F(1,50)=3.526$, $p=.066$. The mean amount of time spent on computers each week for secondary educators ($M=266.39$) was higher than for elementary educators ($M=188.56$). There was also a trend towards an interaction between gender and level that would qualify a main effect of level, $F(1,50)=3.663$, $p=.061$, such that the mean amount of time female elementary educators spent on computers each week ($M=113.13$) was less than for all other educators (male elementary educators, $M=264.00$, female secondary educators, $M=270.28$, and male secondary educators, $M=262.50$).

Within schools, computers were most often located in libraries/resource centers (91.9% and 100%, elementary and secondary respectively) or in labs (83.8% and 94.1%, elementary and secondary, respectively). Among secondary educators, 58.8% had access to computers in their classroom and 58.8% in a pod work area, whereas only 45.9% of elementary educators had computers in their classrooms and 24.3% in pods.

Although educators indicated a high presence of computers in both libraries and labs at their schools, student use in these locations was lower than reported availability. In the classroom, however, there was a 100 percent correspondence between reported availability and computer use by students in the secondary classrooms with a similar pattern in the elementary schools, (45.9% reported availability and a 40.5% reported use by students) (See Figure 1).

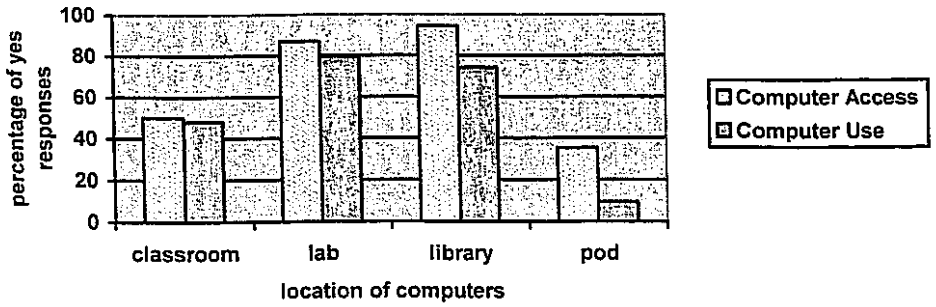

Figure 1. Computer access and actual student use by location in school.

When educators reported that computers were available in the classroom, they also reported that students used those computers. In most instances, the computers located in labs were also used by students. Available library computers were not as frequently identified as being used by students. Many of the library resource centres, however, most likely contain some computers used by library personnel only. The largest difference between access and use of computers was in pods, or shared work areas. Although 35% of educators had computers available in pods, less than 20% reported that those computers were used by students (See Figure 1).

Support and Integration of Technology. Both elementary and secondary educators reported having attended about 2 professional workshops dealing with computer technology ($M = 2.1$, $SD = 2.41$ for elementary, and $M = 2.8$, $SD = 2.33$ for secondary). There were no significant differences between levels, $t(51) = .93$, $p > .36$.

Most educators indicated that their school supported the integration of technology for students (88.9%) and for educators themselves (90.7%). However, the majority of educators were not aware of a school computer plan at their institution (75.9%).

A 2 X 2 ANOVA using gender and teaching level was conducted to assess the degree to which educators incorporated the use of computer technology in their lesson

planning. There was a significant main effect for level, $F(1,54) = 8.53, p < .005$, with secondary school teachers incorporating technology more often than elementary school teachers. Elementary school teachers indicated that they "sometimes" (M=2.70, SD =.91) included computers in their planning whereas secondary teachers reported planning to include computers "often" (M = 3.8, SD = .97). There was no significant effect for gender.

A multiple regression analysis was conducted to identify variables that might predict integration of computers in the classroom. Integration was defined as an aggregate of three questions concerning integration (i.e., "do you believe in integration of computer technology for children in your division"; "do you see computers as an integrated part of the curriculum"; and, "when you are planning a unit, do you assume that computer use by students will be part of your instructional plan"). Nine variables were entered into the equation, including age, gender, total years of teaching experience, amount of time spent on computers at home and at school, and four aggregated measures assessing computer access, computer use, comfort, and support (See Table 2 for variables included in aggregate measures).

There were significant correlations (p<.001, corrected for multiple comparisons) among several of the variables, specifically, the integration and comfort scores (r = .503); aggregated use and comfort scores (r = -.465); and, the educator's time spent on computers at school and the aggregated use score (r = .435) (See Table 3 for complete correlation matrix).

Table 3

Intercorrelations Among Possible Predictors of Comfort and Integration Measures

Measure	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Comfort	--									
2. Integrat.	-.503*	--								
3. Age	.045	.307	--							
4. Gender	.095	-.043	-.101	--						
5. Yrs.Exp.	.065	.347	.885**	-.125	--					
6. TimSchl	-.400*	.291	-.063	-.260	.115	--				
7. TimHom	-.361*	.375*	.157	-.328	.180	.412*	--			
8. Access	-.294	.238	-.075	-.149	-.091	.200	.316	--		
9. Use	-.465**	.377*	.189	-.230	.189	.435**	.276	.378*	--	
10. Support	.022	.005	-.143	-.110	-.083	-.176	.011	.081	-.115	--
11. P.D.	-.148	.200	.209	-.368*	.273	.328	.371*	.073	.058	.020

Note: 1.Comfort = Aggregated comfort score, 2. Integrat. = Aggregated integration score, 5. Yrs. Exp. = total years teaching experience, 6. TimSchl = Time spent on computer at school, 7. TimHom = Time spent on computer at home, 8. Access = Aggregated access score, 9. Use = Aggregated use score, 10. Support = Aggregated support score, 11. P. D. = Professional Development for computers, n = 54

*p<.01, **p<.001.

The simultaneous regression analysis indicated that comfort score was the sole variable accounting for a significant amount of variability in integration, $R^2 = .466$, $F(9,42) = 4.08$, $p = .001$, such that educators who reported a greater comfort level with computers were more likely to believe in and support integration of computers in their classroom.

Ease and Enthusiasm. Two 2 X 2 ANOVAs were conducted to assess ease with computers and enthusiasm for computers as a function of gender and teaching level. In both analyses there was a significant main effect for teaching level, $F(1,54) = 5.17$, $p < .03$ for ease and $F(1,54) = 6.86$, $p < .01$ for enthusiasm. Secondary educators reported more ease and greater enthusiasm for computers than did elementary educators (See Table 4 for means and standard deviations).

Table 4

Means for Ease with and Enthusiasm for Computers

	Mean (Standard Deviation)	
	Elementary	Secondary
Ease	2.30 (1.08)	1.41 (.62)
Enthusiasm	2.35 (1.09)	1.48 (.72)

Note: Scores are based on a 5-point scale, ranging from 1 (very at ease/very enthusiastic), 3 (neutral), to 5 (very ill at ease/very unenthusiastic).

A multiple regression was conducted to explore possible predictors of ease and enthusiasm for computers. The ease and enthusiasm scores were combined to create an

aggregated measure of "comfort" with computers. Six variables were entered into the analysis: age, gender, number of computer workshops attended, and aggregated measures of use, access and support (see Table 2 for specific questions included in aggregated variables).

"Aggregated use" emerged as the sole significant predictor, $R^2 = .164$, $F(1,51) = 10.006$, $p < .003$, such that an increase in computer use score was related to higher levels of reported comfort. The correlation between the aggregated comfort score and aggregated use was significant, $r = -.465$, $p < .001$ (See Table 3 for complete correlation matrix).

Qualitative Data Analysis: Open-Ended Survey Questions

The qualitative data analysis was conducted on the open-ended survey questions and the focus group interactions. In all cases, participants were identified only by participant number and teaching level. All personal names, school names, or identifying information were replaced with asterisks to maintain anonymity.

The open-ended survey questions were completed prior to the focus group sessions to allow participants to record their experiences and opinions without influence from other group members. The open-ended questions were intended to stimulate thinking about technology in the classroom.

There were 12 open-ended questions. The section of the survey dealing with computer use included one open-ended question. The question asked participants to list the forms of professional development in which they engage. The remaining 11 questions were in the final section of the survey and inquired about: school support for computer integration; the educator's instructional approach related to computers; the educator's

perception of how computers would fit in an ideal classroom; current enhancing and inhibiting factors; examples of challenges and positive experiences educators have had with computers; suggestions for what could change to make the situation better; and, factors that influence whether or not computers are included in planning.

All responses for each question were collated and then an open-coding procedure was used to identify themes that emerged for each question. Two researchers simultaneously read all the responses to identify a preliminary set of themes that emerged from the participants' statements. Original phrasing was incorporated as much as possible. The transcript was then re-read to refine and elaborate on coding categories as needed. All discrepancies and revisions were resolved through discussion. Using this procedure, the two raters identified the themes, theme labels, and definitions for each question. The same set of themes was used to code both elementary and secondary responses.

Apart from identifying and describing each theme, the prevalence of each theme was also assessed to get an overall picture of how frequently each of the themes was discussed. The number and percentage of responses endorsing each of the themes was recorded for each question. A complete list of themes and frequency percentages are included in Tables 5 to 12.

The theme labels, definitions, and examples for each open-ended question are listed in order of prevalence for elementary educators. The description of the coding themes and examples for each question are followed by a brief descriptive summary and comparison of elementary and secondary responses.

Training and Professional Development (P.D.). Eight themes emerged from the responses to the question: "In what other forms of professional development do you engage?"

1. Discussion with Colleagues: reference to talking with colleagues, communicating amongst educators in person or on-line, or asking a colleague for advice informally, e.g., "discussion with colleagues".

2. Conferences: mention of any specific conference or general reference to attending conferences, e.g., "conferences – CATC by the Water (last summer)".

3. External Sources: reference to external sources of professional development in the form of journals, books, videos, and websites, e.g., "journals, books".

4. In school Workshops / In-service: mention of workshops, in-service sessions and formal meetings that are offered within the school for staff development, e.g., "staff development in staff meetings".

5. Courses: reference to courses as training, either on-line or in person, e.g., "university courses".

6. General Workshops: mention of workshops without reference to where they are offered or by whom, e.g., "workshops".

7. Board Workshops/Training: mention of workshops that are offered by the School Board, e.g., "board workshops".

8. Others: this category refers to responses that do not seem to fit within any other category, e.g., "teaching methods".

Descriptive Summary of Training and Professional Development. The majority of responses were captured by 4 categories among elementary educators (78.2%) and 3

categories among secondary educators (78%). Both elementary and secondary educators indicated that "Discussions with Colleagues" (25 % for elementary and 31% for secondary) and "Attending Conferences" (21% for elementary and 31% for secondary) were the most frequent forms of Professional Development in which they engaged. "External sources" (such as books, journals, and websites) were the third most important contributor of Professional Development at both levels (16.9% for elementary and 17% for secondary). "In-school Workshops" were listed by a smaller portion of the elementary participants (15.3%) as another form of P.D., although "In-school Workshops" were not mentioned by any of the secondary educators (See Table 5 for complete list of frequency percentages).

School Support for Integration. After participants had answered yes or no to whether their school supports the integration of computer technology, the educators were asked to briefly explain their response. Overall there were 6 themes that explained school support and 4 themes that explained a lack of support.

The responses explaining support were categorized under the following themes:

1. Supportive/Favourable attitude, endorsement: mention of support that comes from attitudes and policies in the school and/or Board that encourage use of computer technology, e.g., "Our school believes that most, if not all of the students will need to apply some sort of computer knowledge in their future career choice".

2. Accessibility for students: computers and/or computer assistance are made available for students in labs, classroom, library, work pods, etc., e.g., "students have a large amount of access to computers in my school".

3. In-service at school: workshops, seminars, courses offered at school over lunch hours, after school, in meetings, e.g., "have had whole school training sessions on implementing computers within the classroom".

4. Equipment and resources: mention of the quality and/or quantity of equipment in the school in terms of computer technology and peripherals; mention of hardware or software that is available and/or reliable, e.g., "we have high quality computers & software made available to both students and teachers".

5. Knowledgeable colleagues and students/Accessible support staff: mention of people (teachers, students, librarians) who are experienced or knowledgeable in computers; reference to sharing with colleagues; colleagues who are willing to assist, e.g., "junior students as helper/mentors for younger learners".

6. Organized computer committee: reference to a committee specifically set up to consider/support issues of computer implementation and use, e.g., "We have a CATC committee that meets regularly..."

The four themes explaining lack of support were as follows:

1. Equipment problems/lack of computers: reference to technical difficulties with machines or software, not enough computers provided, e.g., "The computers are there but the access is limited".

2. Lack of expertise: knowledge base/education is not available, e.g., "unfortunately their own expertise is quite limited".

3. Rapid change: implementation is too rapid, can't keep up with pace, e.g., "We have more material updates before we know what we have".

4. Limited time: time is not available on the computers or for training, e.g., "We have computer-literate teachers but some really struggle to find the time to integrate well..."

Descriptive Summary of School Support for Integration. A large majority of the elementary educators (70.1%) and almost all of the secondary educators (92.7%) indicated school support for computer implementation. Participants indicated that support came in the form of "supportive or favourable attitudes" (19.3% of elementary and 21.4% of secondary), "accessibility for students" (14% of elementary and 35.7% of secondary), and "equipment and resources" (10.5% of elementary and 21.4% of secondary). "Knowledgeable colleagues and students" and an "organized computer committee" were also mentioned by both levels of participants but less frequently (8.8% was the largest percentage). In addition, 14 percent of the elementary educators identified "in-service at school" as an important support. Secondary educators did not include "in-service at school" in their lists of supports.

Thirty percent of the elementary educators indicated lack of support in their explanations, but only 7 percent (which was one participant) of the secondary educators did so. Elementary educators characterized lack of support for computer implementation with the four themes defined above. The two most prevalent themes were "lack of, or problems with, equipment" (14%) and "lack of expertise" (8.8%) (See Table 6 for a complete list of frequency percentages).

Compatibility with Instructional Approach. Educators were asked to indicate whether or not computer technology was compatible with their pedagogy by answering the question "Does the integration of computer technology fit within your personal

instructional approach(es)/orientation? (Explain)." Responses were initially coded as "yes", "no" or "conditional" and the content within these categories was then organized under several recurring themes, as follows:

Yes

1. Tool to complement teaching/instruction, fits with specific subjects: computers are referred to as a tool that enhances instruction, complements teaching style or is useful for specific subjects or tasks, e.g., "Computers fit well into the instruction of core—English and math."

2. Provides variety, specific to learning style: reference to adding variety to instruction using the computer, benefits of computers for specific learning styles, e.g., "I try to find/provide many ways of learning for different styles of learners. The computer provides another avenue of learning."

3. Attitude/Motivation: comments that describe the attitudes of students regarding computer use or the motivation it may provide, e.g., "Computer is one 'centre' that the children look forward to."

4. Allows for independent work/use of skills: mention of using the computer to practice computer-related skills or the independence the computer may provide, e.g., "They can handle many of the games independently."

5. Up to Date information/research: comments that indicate the use of computers for up to date, recently released information and/or using the computer for research, e. g., "I use a lot of research assignments in which the use of a computer is a necessity."

Conditional

1. Need resources/equipment, financial support, knowledge and experience: the explanation describes some use of computers or a desire to use them but includes qualifiers that list or state needs that must be fulfilled for that to happen, e.g., "It could, problem is the limited availability of computer lab."

2. Depends on task, children's abilities, teacher's style: the explanation refers to some characteristic of the task, the children or the teacher that may or may not support the integration of computers, e.g., "depends on the subject, with graphing, we do graphs in ClarisWorks."

3. For Play: mention that the computer is used only for play or games in some domains, not always, e. g. "...the computer is used mainly for games to support literacy and numeracy.... I do not use the computer to teach directly other topics to the children."

4. Low priority: describes some support for integration of technology but sees it as a low priority, e.g., "I think it's a good idea but it's low on the priority list presently."

No

1. Teacher doesn't feel trained: lack of support for integration of technology is related to inexperience or lack of training/ability on the teacher's part, e.g., "I do not have necessary background/do not feel that I am an expert..."

2. Can't replace human interaction, teaching of basics: demonstrates concern that computers can not offer necessary "human interaction" or can not replace some instruction, e.g., "It cannot replace the 'human touch' that enables emotion to lead kids higher and stronger."

3. Insufficient equipment, unreliable resources: explanation refers to an inadequate amount of equipment or resources that are unreliable, e.g., "...our central server is very unreliable."

4. Too much support required, lack of experience: computers are described as requiring too much support, or reference to students' lack of experience, e.g., "...I find it difficult with the early primary because they have more difficulty working independently."

Descriptive Summary of Compatibility with Instructional Approach. The majority of elementary educators (81%) indicated that computer integration fit within their personal instructional approach, however, 19 percent also indicated that computer technology did not fit within their instructional approach.

Reasons for the elementary negative responses included teacher characteristics ("doesn't feel trained", 28.6%); equipment problems ("insufficient or unreliable", 28.6%); lack of support, ("too much support required", 14.3%); and, philosophical differences ("computer can't replace human interaction", 28.6%).

Of the 81 percent of elementary educators that indicated a fit, 32.4% of those were conditional in that "resources and equipment" were needed (50%); it is task or student dependent ("depends on task or children", 30% and "only for play" 10%); or, it is seen as "low priority" (10%). Those who saw it as more clearly fitting into their philosophy (i.e. the non-conditional "yes" responses) reported it as "a tool to complement teaching" (48%) and related to student learning in that "it provides variety" (24%), "allows for independent work" (12%), and "improves attitude and motivation" (16%).

The secondary educators were unanimous in stating that computer integration does fit within their instructional approach. The computer was referred to as a tool to complement teaching and as a resource that provides current information. Although 100 percent of secondary educators responded with an affirmative answer to the question of fit, 29.4% of them made their "yes" conditional upon the task or students, or a need for resources and equipment. Half of the responses included comments about using computers as a tool to complement teaching. Another 31.3% of the responses reported it to be useful as a source of up-to-date information and research resources. The remaining three comments described computer technology in relation to students, in that it provides variety, allows for independent work, and improves motivation (See Table 7 for a complete list of frequency percentages).

Ideal World. When participants were asked to consider an "ideal world" and outline how they envisioned computer technology within their classroom or educational program, individual elementary and secondary educators provided a variety of visions. The responses were captured by the following 10 categories:

1. Accessibility in the classroom: mention of access to computers available in classroom, e.g., "An average classroom (30 students) should have at least 4 computers available for the students."

2. Human resources/Support for instruction, trouble shooting, technical problems: mention of people for instruction or technical assistance; human sources of information, e.g., "Lab with qualified computer instructors..."

3. Use computer as a tool to enhance instruction with a variety of activities: mention of using the computer as a tool to enhance instruction rather than as a subject,

using it to enhance or expand instruction with a variety of activities, e.g., "I would like to use the internet to a greater extent for research purposes."

4. Equipment and supplies/Computers and peripherals: reference to a greater number of computers or peripherals, up-to-date equipment, and additional technology, e.g., "Printers and scanners in each class..."

5. Accessibility in pod or lab: mention of access to computers in a lab or pod, e.g., "I would like greater accessibility to our lab."

6. Integration across curriculum: expresses a desire for using computers across curriculum in various subjects, e.g., "Programs to help integrate mathematics strands to computers and everyday life."

7. Accessibility in general: mention of access to computers in general, e.g., "Students would be able to access school work from home and vice versa"

8. Information resources: assistance available in the form of books, journals, etc., e.g., "a guide could be written that gives suggestions on how a computer can be used for the different concepts using the Ontario Curriculum."

9. Time to share/plan: mention of time for sharing with colleagues and planning computer activity, e.g. "Time to share ideas with other teachers."

10. Individualized learning/special education: reference to using computer technology for special education, individualized instruction, e.g., "My students who had great ideas but poor writing skills would have computers with the capabilities of typing on verbal command."

Descriptive Summary of Ideal World. Elementary educators conceptualized an ideal world using several different themes. Although one theme captured one quarter of

the responses, the remaining responses were spread across an additional nine themes. Responses from secondary educators were captured by only nine themes, with two of those themes capturing almost half of the responses (45.2%).

The ideal world for elementary educators would include a greater number of computers in the classroom (25.3% of elementary responses). Accessibility in general (5.5%) or accessibility to computers in a lab or pod (8.8%) were also mentioned but less frequently. There was a relatively equal distribution of comments regarding support in the form of human resources (15.4%); use of computers as a tool to enhance instruction (14.3%); and, equipment and supplies (11.0%). A variety of other aspects of computer implementation were mentioned in less than 10% of responses: integration across the curriculum (7.7%); information resources (4.4%); time to share/plan (4.4%); and, individualized learning and special education (3.3%).

Secondary educators indicated that accessibility to computers was a critical part of their ideal world, but in a more "general" sense (22.6%) than described by elementary educators. "Accessibility in the classroom" (16.1%) and "accessibility in the pod or lab" (9.7%) were specified less frequently. Using the "computer as a tool" was also a frequently reported aspect of an ideal computer implementation at the secondary level (22.6%). The "actual equipment and supplies" were referred to in 12.9% of the responses. Less than 10% (in fact only 1 or 2 responses) referred to "information resources" (6.5%); support in the form of "human resources" (3.2%); "integration across the curriculum" (3.2%); and, "individualized learning and special education" (3.2%). Time to share and plan was not mentioned in the secondary responses (See Table 8 for a complete list of frequency percentages).

Current Situation: Enhancing Factors. The following list of fourteen themes was used to code all responses to the question, "What currently enhances your implementation of computer technology in the classroom?"

1. Human resources/Support: reference to assistance or support from a person or persons in terms of supervision or knowledge; mention of students, educational assistants, colleagues, parent volunteers, librarians, colleagues, computer committee, family, e.g., "pairing up with older children helps to teach them to use some program" or "supportive, creative and computer literate librarian".

2. Access--Lab: reference to computers being present for use or available for scheduled access in a lab setting, e.g., "access to whole class computer lab".

3. Student characteristics: characteristics of the students related to their attitudes and interests, e.g., "patience of students".

4. Software: reference to software and programs for computers in terms of quality, quantity and appropriateness, e.g., "the wide range of software".

5. Teacher characteristics: aspects specific to the individual teacher, such as their knowledge base, confidence, comfort level, interest, e.g., "my confidence level-willingness to take risks".

6. Not enhancing: comments suggest that there is little or nothing enhancing current implementation of computer technology, e.g., "Not much, since I do not have a computer in the room."

7. Teacher education: mention of help and training at various levels (workshops, in-service, internet) that indicate education or development of knowledge, e.g., "Help is available within the school for teaching new uses for computer technology."

8. Access--General: reference to computers being present for use or available for scheduled access without mention of a specific location, e.g., "the availability of the computer".

9. Access--Classroom: reference to computers being present for use or available in the classroom, e.g., "a stand alone in my classroom".

10. Internet access/Networks: reference to Internet access or connections to a network system (i.e., file server), e.g., "internet hookups on all computers".

11. Technical/Trouble shooting support: mention of help available to maintain and trouble shoot computer technology, people to answer questions and solve problems, mention of equipment that is maintained, e.g., "The availability and willingness of trained people to answer my questions, share ideas and experiences and trouble shoot for me. I need 'at the site and moment of need'. "

12. Hardware: reference to the capabilities of the computer technology. e.g., "level of technology available at my school is fairly good"

13. Financial resources: reference to funding or financial support of some kind, e.g., "support of the administration and Board towards directing more funding toward computers".

14. Access--Library/Resource centre: reference to computers being present for use or available for scheduled access in a library resource centre. e.g., "Having a library resource centre available".

Descriptive Summary of Current Situation: Enhancing Factors. Educators indicated a great variety in what it is that currently enhances their implementation of computer technology. Fourteen themes were necessary to capture all of the stated

factors. However, responses included ten common factors for both teaching levels. The three most frequent descriptions of enhancing factors were the same for both elementary and secondary, and accounted for over half (52.2%) of the elementary responses and 43.2 percent of the secondary responses. They included "human resources" (24.5% for elementary and 16.2% for secondary); "access to a lab" (18.1% and 16.2%, respectively); and, "student characteristics" (9.6% and 10.8% respectively). A substantial portion of secondary educators also mentioned 'access to a computer in the classroom" (10.8%) and "Internet access" (10.8%) as enhancing factors.

There were a large variety of additional responses from both elementary and secondary educators in terms of the types of things that were enhancing the implementation of computer technology, including teacher characteristics and education, access to computers and the Internet, software, and technical and financial support. However, individually these each accounted for a small portion of the responses (less than 10% each).

In addition, a portion (7.4%) of elementary responses stated that currently there was nothing enhancing the implementation of computers in their classroom (See Table 8 for a complete list of frequency percentages).

Current Situation: Inhibiting Factors. A reciprocal question was included in the survey to investigate inhibiting factors. The responses to the question "what currently inhibits your implementation of computer technology in the classroom?" were as varied as the "enhancing factors" listed in the previous question. Fourteen themes were extracted.

1. Hardware limitations/incompatibility: references to machines that don't work, problems with the level of technology or compatibility between types of machines or systems, e.g., "lack of working printer in lab" or "not all the computers are the same & therefore they don't all have the same programs on them".

2. Lack of time: reference to a lack of time or insufficient time, e.g., "preparation time for lessons is limited".

3. Lack of knowledge: reference to limitations based on lack of knowledge or skills regarding computer technology, limited training, e.g., "very few staff members have extensive computer knowledge".

4. Insufficient number of computers: reference to an insufficient number of computers rather than access or availability concerns, e.g. "not enough computers in the classroom" or "not enough working computers in the lab".

5. Access to computers--In the classroom: reference to limited access to computers due to unavailability within the classroom, e.g., "I have no computers in my classroom."

6. Access to computers--In a lab: reference to limited access to computers related to a lab outside the classroom, e.g., "limited access to our lab".

7. Curriculum expectations: reference to overload in curriculum, expectations that hamper implementation of additional technology, e.g., "We are also swamped under so much curricula."

8. Human resources: concerns regarding support in terms of supervision, technical assistance and qualified instructors, e.g., "lack of trained/qualified instructors to provide daily support to staff & students."

9. Software: reporting problems with lack of software or lack of knowledge regarding appropriate programs, e.g., "finding programs/sites that are applicable".

10. Financial resources: limitations based on funding or money, e.g., "$ to print often".

11. Lack of resources: general statements about a lack of resources that don't make specific references, e.g., "lack of resources" or "not enough resources".

12. Physical environment: reference to difficulties that arise due to the physical set-up of classroom or lab, e.g., "small room--hard to share".

13. Internet/Network access: reference to problems with Internet access or network connections, e.g., "poor internet access--slow".

14. Student characteristics: reference to characteristics of the students that hamper implementation in terms of their ability, skills or limitations, e.g., "student work speed is often very slow" or "student sabotage".

Descriptive Summary of Current Situation: Inhibiting Factors. Three themes captured almost half of the responses from the elementary educators. The most frequently stated theme among the elementary educators involved "hardware limitations" (17.4%). "Lack of time" (15.7%) and "lack of knowledge" (12.2%) were also important barriers to a large portion of the elementary participants.

Lack of computer access was reported as a barrier by elementary educators in terms of an "insufficient number of computers" (8.7%) and problems with "access to computers in the classroom" (7.0%) and in the "lab" (7.0%). The remaining eight themes accounted for less than 10% of the total responses in each case. They included "curriculum expectations", "human resources", "software", "financial resources", "lack

of resources", "physical environment", "internet/network access", and "student characteristics".

A large portion (over 50%) of the inhibiting factors mentioned by secondary educators included material resource issues: hardware limitations (20.5%); software (4.5%); financial resources (15.9%); and insufficient number of computers (11.4%). Another 18.2 percent of responses included reference to access difficulties ("access in the lab" 9.1% and "internet/network access" 9.1%). The secondary responses did not emphasize a "lack of time" and "lack of knowledge" to the degree that the elementary educators did. In fact, none of the secondary educators reported "lack of knowledge" as an inhibiting factor. A portion of the secondary educators did report a "lack of time" (9.1%); however, it was mentioned less frequently than in the elementary panel. The rest of their responses were spread across similar categories, accounting for less than 10 percent each: "student characteristics", "human resources", and, "curriculum expectations" (See Table 10 for a complete list of frequency percentages).

Suggested Action. Following the inquiries into what was currently enhancing or inhibiting the implementation of technology, participants were asked to consider "what could happen to make the situation closer to ideal?"

The 12 themes that emerged from the responses are as follows:

1. Education and training, development of teachers' skills: reference to workshops, conferences, courses and less formal training or development of skills and knowledge of computers on the part of educators. e.g., "more computer teaching workshops" or "having a computer teacher in the building".

2. Equipment and software: reference to additional computers, up-to-date

equipment and software, no specific reference to where they should be, e.g., "more computers in our school".

3. Computers in the classroom: specific reference to the computers being in the classroom, e.g., "Have more computers in the classroom."

4. Time for planning, time to share ideas: reference to time for talking, planning, evaluating with colleagues or alone, e.g., "release time for planning integrated lessons"

5. Technicians, technical assistance: reference to a person whose job it is to maintain and trouble shoot the computers, help in setting up and fixing systems, e.g. "technician support (weekly)".

6. Funding, money: reference to funding or government assistance in terms of committed dollars, e.g., "funding for projects like E-mobile".

7. Reduced expectations in other areas, smaller classes, time for computers in the schedule: reference to the increasing workload and an expression of the need for reductions in class size and curriculum expectations, as well as a need for more time for computers, e.g., "less material to cover in other areas".

8. Attitude, policy, guided direction: reference to a need for a vision, goals and positive attitudes regarding computer implementation in schools or at a more general level, e.g., "a province-wide vision for computer technology"

9. Computers in the lab: specific reference to the computers being in a lab, e.g., "a lab for whole class instruction and investigation".

10. Special Education: reference to support in the special education area, e.g. "provide adequate special education support".

11. Documents: reference to support in the form of guides or documents regarding

computer implementation, e.g., "a document outlining what skills and how to implement them would be great".

12. Applied use: reference to simply more use of computers in an applied setting, e.g., "more applied use of power point presentations".

Descriptive Summary of Suggested Action. Three of the themes accounted for more than 60% of the elementary responses. More than one fourth of elementary responses requested "education and training" (25.6%)—the most frequently stated response. Close to another quarter (24.4%) suggested that material resources in the form of "equipment and software" were needed. "Access to computers in the classroom" was the third most frequent response (13.3%). However, "access to computers in a lab" was included less frequently (3.3%). The remaining responses accounted for less than 10% each, many of which included different forms of support: time for planning and sharing ideas; technicians; funding; reduced expectations; supportive attitude and direction from administration; special education support; and documents.

Four themes captured a majority of the secondary responses (76.2%). Secondary educators indicated a similar, but stronger, request for material resources, including "equipment and software" (28.9%) and "financial support" (26.3%). They also listed education and training, but this category was mentioned with less frequency at the secondary level (10.5%). A "supportive attitude and direction" from administration was also reported in just over 10 percent of responses (10.5%). The remaining suggestions were varied but few, including "computers in the classroom and lab", "time for planning", "technicians", "reduced expectations", and, "applied use" (See Table 11 for a complete list of frequency percentages).

Factors Influencing Decision to Integrate Computers. The final open-ended question in the last section of the survey asked educators to identify factors that made them decide to integrate the use of computers when planning a lesson or unit.

Again a variety of responses resulted in several coding categories. The following 9 themes were used to code the responses:

1. Characteristics of the lessons/process, outcomes, purpose: reference to the content of material to be taught, the learning process or goals of the task or activity; questions regarding the "fit" between computer technology and the activity, e.g., "I only use the computer for lessons directly related to computer skills" or "a natural fit".

2. Access to and availability of computers and peripherals: consideration of how many computers are available, whether labs can be booked, and, any other hardware or access that might be necessary, e.g., "access to a computer—can we book the lab?"

3. Time: reference to time in terms of time available and time needed, e.g., "do I have the time to work thru program and develop a framework?"

4. Software: reference to the availability and appropriateness of programs, e.g., "availability of related software"

5. Human resources—assistance, supervision: consideration of support required in terms of staff or volunteers to support students, teachers, and the activity itself, e.g., "man power--I can't supervise 27 children alone!"

6. Curriculum expectations: consideration of expectations or results in relation to the curriculum, e.g., "what expectations can be reinforced by computer use?"

7. Teacher characteristics—ability, comfort level, and knowledge: reference to characteristics of teacher, such as ability, prior knowledge and comfort with technology, e.g., "my comfort level with the technology".

8. Student characteristics—attitudes, interests, and knowledge: reference to the consideration of the student characteristics, related to their attitudes and interests, prior knowledge and ability, e.g., "prior knowledge of students".

9. Does not consider computer integration: comments that indicate computer technology is not typically included in lesson planning, e.g., "I do not plan on the use of computers other than possibly have the students type up their work to hand in or display."

Descriptive Summary of Factors Influencing Decision to Integrate Computers. A large majority of the responses in both teaching levels were captured by five themes. Three of these themes were common to both elementary and secondary educators while the fourth major theme varied between the two levels. Nearly one quarter of elementary educators (24.7%) and nearly one half of secondary educators (43.8%) consider "characteristics of the task" to be a critical issue in deciding whether or not to integrate computers in a lesson or unit. Not surprisingly, "access to computers" was also a major consideration during planning (21.5% for elementary, and 21.9% for secondary). Time was mentioned by both elementary (14.0%) and secondary educators (12.5%) as a consideration. The secondary educators reported that "curriculum expectations" was equally as important (12.5%), while elementary educators reported "software" to the same degree as time (14%).

Elementary educators identified a variety of other factors that are considered, including "human resources", "curriculum expectations", "teacher characteristics", and,

"student characteristics" (The largest percentage for any of these categories was 9.7% for human resources). One of the elementary educators indicated that he/she does not consider computer integration when planning a lesson.

In the secondary level responses, the remaining responses were also varied but less so than the elementary responses. Teacher characteristics and software accounted for less than 10 percent each (See Table 12 for a complete list of frequency percentages).

Qualitative Data Analysis: Focus Groups

Thirteen focus groups were conducted at the school board's administrative building. The groups were composed of educators who taught a variety of grades and subjects and who had varying amounts of experience in teaching. The educators appreciated the opportunity to be heard and expressed a desire to make a difference with their input. The dialogue was descriptive and uninhibited, with all participants taking an active part in the discussions and genuinely listening to each other. Other than the 2 sessions with only one participant each, all but one of the groups used the full hour with very little intervention by the researcher.

Discussion was usually initiated by participants offering brief synopsis of what was happening with computers at their particular school. There was comparison and contrast amongst schools in terms of resources, both material and human, that were dedicated to technology. Educators shared ideas and helpful hints and many took practical application information away with them. There were a good number of day-to-day stories shared during the discussion, both success stories and accounts of disaster. This portion of the discussion was often very emotional and appeared to be an opportunity for colleagues to vent frustrations and celebrate successes.

Frequently, a group would focus on a particular topic and explore it in depth before moving on, for example, computerized assessment procedures and the technical challenges involved, the introduction of new iMac computers with no disc drives and the resulting problems, and the establishment of networked labs with a central server.

Computers were not discussed in isolation but were related to the context in which the educators were teaching. Current events set the tone for discussion in several of the groups. Secondary educators referred to the new curriculum that had recently been released by the government and the effects it was having on time for planning and computer instruction. The elementary panel were struggling with the elimination of library resource personnel and what that meant in terms of support in the form of supervision and computer knowledgeable staff.

The atmosphere of the groups was generally supportive of computer technology in theory, but included animated discussion of the many barriers to successful implementation. There were re-occurring expressions of frustration, exasperation and anger from educators who wanted to integrate technology but did not have the resources, skills or time. Some of the elementary groups included discussion as to whether computer use is even appropriate for younger children. The secondary groups expressed more emotion regarding material resource inequities, and a mismatch between the curriculum requirements and what was actually possible.

The audiotapes for each focus group were transcribed verbatim. The videotapes were used to clarify any unclear portions. All personal names, school names, or identifying information were replaced with asterisks to maintain anonymity. Thirteen transcripts were analyzed (8 elementary and 5 secondary).

Thematic analysis (Boyatzis, 1998) of the focus group transcripts resulted in a two-layered coding system, which captured both the content of the discussion and the affect with which the content was discussed. That is, the content layer considered and coded what the educators were saying, while the affect level identified the emotion that accompanied that topic of discussion.

The final coding system consists of six major content themes (support issues, teacher issues, content/access issues, student issues, computer hardware and software problems, and, external/other issues). Each of these major categories contained several more specific sub-categories. The second layer of the coding scheme identified the affective component of the discussion as positive, negative, neutral, or complex (i.e., positive or negative statement with a qualification or explanation included).

The development of the final coding scheme was initiated by the independent, open coding of two secondary transcripts by two principal researchers. Participants' language was used as much as possible to produce a "data-driven" coding scheme (Lincoln & Guba, 1985). The resulting categories were compared and any additions or discrepancies were resolved through discussion between the two coders (Boyatzis, 1998). This preliminary set of categories was used to code an additional transcript. Any novel categories were added to the preliminary coding scheme. The detailed, data-driven categories were then re-read to identify emerging themes and linkages between categories (Lincoln & Guba, 1985). To protect against "projection" and to ensure reliability of the coding scheme, an explicit code of theme labels, definitions, and examples was developed (Boyatzis, 1998).

As the transcripts were being coded using the content themes, it became apparent that a large portion of the discussion was laden with affect. The affective component was not being captured effectively by the content category coding. At this point, the transcripts were re-read and "blocked" into sections of related discussion and general affect by the principal researcher. The discussion was readily divided into chunks of conversation that focussed on one idea, generally with one or two speakers per block. Each block was then coded according to affect as well as content. The affective themes included positive, negative, neutral and complex categories. This two-layered coding scheme was then used to code four transcripts independently. Codings for content and affect were compared for each block in the transcripts between the two raters with a resulting reliability of 89% agreement (Boyatzis, 1998). All transcripts were then coded in their entirety using the established themes for content and affect. The final coding scheme is described below.

Content Level Themes

The initial layer of the coding scheme was the content themes. These themes described the content of the group discussion. This level captured "what" the educators wanted to say. Six major themes or patterns were identified with more specific sub-categories within each one. The major themes included support issues, teacher issues, context and access issues, student issues, computer hardware and software problems, and external or other priorities.

The six major themes along with the specific categories within each theme are presented with theme labels, definitions, examples and a brief summary of the prevalence of each theme.

i. Support Issues: The largest portion of the discussion in the focus groups concerned support issues (37.4% of the elementary and 35.1% of the secondary). More specifically, support was discussed in several different forms, including people, things and ideas, resulting in 4 sub-categories within support issues: human resources; material resources; training/professional development; and administration, board or parental support.

a. Human Resources: Support issues were discussed in reference to the presence or absence of people or their positions. Specific personnel or roles discussed included technicians, computer contacts or administrators, computer experts, and librarians. More general reference to human resources was made in regard to a need for supervision and reductions of class size.

> "... and the librarian was supporting little mini enrichment groups across the grades and so now, as you say, what's going to happen... The library is closed for half the day. It does, and then you can't go in there without supervision to these computers." (elementary)

> "So you all had a site administrator?...A teacher, like, I think they get two periods." (secondary)

b. Material Resources: The majority of discussion coded as material resources included references to the presence or absence of material resources in terms of equipment, software, programs, and systems. Educators also made frequent reference to the allocation and distribution of resources in terms of equipment and financial support. Internet resources were included under this category as a material resource.

> "So eventually I think we ended up with two or three, so there's an iMac sitting there but you don't have enough and no money to buy them..." (elementary)

> "Now we have a home page also and I think it's fantastic that they have access to all of those data bases that like, InfoTrac, and Discovering Authors and all of these databases that they can do their assignments from." (secondary)

c. Training/Professional Development: This category included specific references to the presence or absence of training programs or opportunities, evaluation of those programs, and/or discussion of a need for training as a support for implementation and use of computers.

> "Same thing even with conferences. I mean hundreds of dollars. I'd love to do some of them but they're not paying for me to go." (elementary)

> "I think, I mean, I think the school board over the years has done a great job at offering courses on software, learning software packages and stuff, um. I know I've, over the last, you know, 5-10 years, I've taken probably 20 or 30 courses on software just to learn it and I mean when new stuff came out, you learn it and you kind of get a starting point that you can then go from to kind of discover on your own and you know that stuff. I think the school board's done a good job from that area." (secondary)

d. Administrative, Board or Parental Support: Quotes coded under this category made reference to the presence or absence of support for computer implementation in general or specific ways from government, administration or parents. Communication among administration, departments and teachers regarding computers was also a topic of discussion included in this category.

> "Ha, but the major frustration being though that although the curriculum and the government are asking us to do all these wonderful programs and I believe in the validity of that, but they're not keeping up with their end of the bargain and providing us with things that are workable with the classes that ya have. Ya, so if you wanna know..that's that." (elementary)

> "Again, it's just the, I don't know, lack of foresight or something. Whoever started this in the beginning, to plan this whole, where they're being used and how, the crossover, rather than ....a grand vision that wasn't implemented very well...yeah, grand vision." (secondary)

Prevalence of Support Theme. A large portion (69.6%) of secondary support codings fell under material resources. For the most part, secondary educators described

well-equipped labs but there appeared to be glaring inequities between some schools and amongst departments within schools. Only 19.6% were human resources issues and generally included comments about technical assistance personnel and site administrator that seemed to be disappearing.

Elementary educators spoke less about material resources (48%) and more about human resources (28.5%) than secondary educators. Their discussion of human resources included requests for additional supervision of young students in labs and the loss of librarians who were often the computer "experts". The discussion in this category made it clear that having an educator within the school who was knowledgeable and enthusiastic about computers was a catalyst for school-wide integration.

Training and professional development was a larger portion of the support issues category for elementary educators (18.7%) than for secondary educators (5.8%). Secondary educators talked about specific training and didn't see this as a major barrier while elementary educators noted the need for training in trouble shooting and specific applications of computers in the classroom. Although they were saying that training was often cost and time prohibitive, there were also several comments about in-service available at school from colleagues. (See Table 13 for complete list of frequency percentages).

ii. Teacher Issues: Approximately one third of the transcript codings were teacher issues (31.1% of the elementary and 29.5% of the secondary). Issues at this level primarily concerned or were related to teachers as individuals or to their role and position as educator. Quotes described the content and pedagogy of the educator's teaching as well as their own individual skills, characteristics, philosophies and training as they relate

to technology. Within the teacher issues theme there were 4 sub-categories: , philosophical and pedagogical issues, characteristics of teachers, curriculum, and digital divide.

a. Philosophical and Pedagogical Issues: This category included references to beliefs of how computers fit or do not fit within teaching and learning. It also included opinions as to whether, when and how computers should be used. References to the computer as a tool were part of this subcategory. Teaching methods, strategies and examples of computer-related activities were also included.

> "...there is just so many different...It (computers) adds another dimension" (elementary)

> "Yeah. Get bio's, get any specs on the movie that they can get. So it's a really useful tool in terms of accessibility of information for me because of course I teach English so I don't use it in the same way that you would use computers but, um..." (secondary)

b. Characteristics of Teachers: This category included references to the skills, knowledge, comfort, and experience level of teachers who do or do not use computers. Statements that referred to the time or interest an individual teacher spends with computers were included here.

> " I mean, I can turn one on, I can send e-mail, I can write an essay on it, I can write letters with my kids, but if you're asking me to fix something, you're barking up the wrong tree." (elementary)

> "I find myself, um, anxious to use a computer, but at the same time I'm very much a...user...I'm not as familiar with computer technology, with the background." (secondary)

c. Curriculum: This category included references to curriculum guidelines and expectations and references to the "new curriculum". Discussions surrounding "too much stuff to fit into the curriculum" are also included here.

> "...you teach math and you teach other things and you get curriculum that's very clearly laid out, they give you sample lessons in it and things like that but as far as computers are concerned, I've found that there is very little." (elementary teacher)

> "And I would say that's a general problem, just as a teacher-librarian and seeing all different subject areas, one of the major complaints is, again we'll talk here about the government and curriculum, is that it is so content-driven, ... as a result a lot of things that were extremely worthwhile to do, including giving your classes time to say go work in a lab or go work in the library on an assignment, the teachers aren't doing it anymore..." (secondary teacher)

d. Digital Divide: Specific references were made to a division in terms of computer experience and/or expertise between teachers or between teacher and student.

> "...what about the teacher, who, their link isn't very good, like their link doesn't have anything on it, it says 'hi'..." (elementary)

> "No, we have one unit that's available for the whole school and the beauty of it is not too many people know how to use it so the people who do know how to use it can get, you know, fairly easily, and, uh, now the kids, I think the kids maybe even book it out more than the teachers do. Especially the senior level kids for more independent studies and that kind of stuff." (secondary)

Prevalence of Teacher Issues Theme. Approximately half of the teacher issues discussion included philosophical and pedagogical issues (46.5% elementary and 56.9% secondary). Educators were often discussing their views of how computers fit within their pedagogy. They often gave examples of how they used computers in their instruction. A variety of uses were noted: for word processing only, for play, for specific computer skill instruction, as a resource of information, for simulations, for presentations, and others. There was some debate as to whether and how computers should be integrated with

arguments regarding developmentally appropriate tasks for children and loss of traditional, basic skills. Skills and characteristics was a more common topic of teacher issue discussion within elementary focus groups (30.9%) than the secondary groups (19.7%). The elementary educators spent more time discussing their own individual experience with technology. It was a more personal issue than it was for secondary educators. Some elementary educators related a lack of confidence in their own computer knowledge and stated that as a barrier to including it in their planning. The secondary educators talked about curriculum and how computers did or did not fit within the content they were teaching. The issues seemed to be less about who the educator was and more about what they were teaching at the secondary level.

iii. Context and Access Issues: Discussion topics that were coded into this category referred to issues surrounding the context in which computers were used. There were also issues surrounding the access to the computers in these contexts.

a. Context of Computers: This category included references to the set-up and consequences of where computers are used (i.e. in a lab, classroom, pod, library).

> "See, so they couldn't decide whether to take those 10 computers out and put one computer in every classroom or to leave them all there. So, I don't know whether there was a vote or, I don't know what happened. But all the computers are um, all networked in the same, into the same thing, so when one's down, they're all down, or something like that." (Elementary)

> "Now nobody's facing you, everybody's spinning around and I mean, the classes next year, our classes are going to balloon again, and uh, I mean this year it was great, I had small classes, you were able to do a lot with them. Next year, again, and when you want, if you get computers in your classroom, now the students are shut off from the teacher unless you've got such small classes that they can work in one part of your room and then you can move them to doing something else in the other half of your room. But some schools have really teeny rooms, I mean if you were at **** you wouldn't be able to do it because the rooms are so small." (Secondary)

b. Access to Computers: Discussions in this category revolved around the ability or lack of ability to book labs, find time in the schedule for computer use and generally gaining "access" to computers and software.

> "The thing is it's difficult to book in times for your class to use the computer lab because there are so many classes and ah, there will be times in the year when for example the grade 3's are all doing that learning how to type thing." (Elementary)

> "I usually go on Waterworks probably around 10:30 at night. I go on at home and I read it...the house is quiet and...ya, get the kids to bed and stuff and you can get on and you can just do it from home. But there are teachers that go on at school, um, when they're on lunch or whatever. I mean it's great if you're ah, if you're going to be away you can send your lessons through it, ..." (Secondary)

Prevalence of Context and Access Theme. Both elementary and secondary focus groups discussed context and access issues to the same degree. Eleven percent of the elementary discussion and 10 percent of the secondary discussion was devoted to this category. The elementary educators expressed both access to computers (55.2%) and the context in which they are used (44.8%) as relevant topics of discussion. The secondary educators had a much greater amount of conversation about access to the computers (76.9% of the category) than where they were actually located. The secondary educators frequently mentioned getting access to computers in labs as a necessary component of their instruction and that access was not always available. The elementary educators more frequently discussed wanting access to computers in their classrooms and explained the difficulties of moving a class of young children to a lab for computer instruction.

iv. Student Issues: Direct reference to students and computers were also made but to a lesser extent than the support and teacher issues. The quotes regarding students were divided among 3 more specific categories.

a. Motivation, Knowledge and Skills of Students: This category included discussion about the knowledge and skills that students have or need, as well as their motivation, opinions, and feelings surrounding computer use. Teachers also made comments about differences and difficulties related to the developmental stages and characteristics of students.

> "They all have video games, mind you, and so they view a computer as an extension. It's just a videogame and, um, as far as knowing anything that they're doing, they don't. It's just random play..." (elementary)

> "...you'll go around and my students will say, 'I can't find anything', and they're doing a Yahoo search and I'm like, because you already have 10 links, 'Did you try one of those?' 'Well, no, I just went to Yahoo.' A lot of them, their Internet search skills are really weak. They don't know how to focus." (secondary)

b. Sabotage: Some discussion included problems related to vandalism or "sabotage" of computers by students. Reference to "hackers" or students interrupting the operating system were included here as well.

> "That would become dangerous in my school because I have kids who could hack into it and change it." (elementary)

> "...we had 2 weeks this year where some student at our school, ... I think it was board wide, where some student had set up...a dialing, set up a program where the, the board's computers were being dialed by some phone number at light speed." (secondary)

c. Digital Divide: Specific references were made to a distinction among

students according to computer access and/or computer skill. Differences were also identified in some cases between the computer systems students used at home and those available at school in terms of quality and Internet speed.

> "And that's probably something that needs to be taken into account. Not all kids have computers at home so maybe we should be focusing more on computer use at school rather than rely on the opportunities that they might have at home to use it. So to put more time into usage of computers at school." (elementary)

> "And they're always complaining about how outmoded our computers are at the school compared to the ones they have at home." (secondary)

Prevalence of Student Issues Theme. The motivation, skills, and characteristics of the students sub-category captured the majority of discussion of this theme in both teaching levels. Educators at both levels sang the praises of children who were knowledgeable and enthusiastic about computers. They also noted that the computer skills of students often surpassed that of the teacher and that students were often used as peer teachers. The elementary educators, however, did discuss a digital divide between students (24.5%) more than secondary educators (7.3%). Of interest, this digital divide extended beyond the typical differences that exist among students. The educators acknowledged a divide between the level of technology available at school and the level available in the students' homes. Sometimes it was the school that was disadvantaged, and educators indicated that students were frustrated with the level of technology they had to work with at school compared to what they had in their homes. Overall, there was very limited focus on sabotage by students.

v. Computer Hardware, Software and System Problems: A relatively small percentage of the focus group discussions related to problems with computer hardware, software or systems (7.9% of elementary and 9.7% of secondary). Issues discussed at this

level concerned not the presence or absence of resources but problems using those resources in terms of malfunctions, compatibility, and change. The problems and concerns were further analyzed into 3 sub-categories.

a. Malfunctions: Educators reported a number of problems and frustrations with equipment breakdowns or "glitches" in the operating systems or Internet functioning.

> "...we only have maybe 10 computers and two of the computers are hooked up to scanners so when you turn them on they just never turn on or there's never a time when they're all up and running and we've been having problems with them." (elementary)

> "We have computers in all the shops and other rooms but we have as you're experiencing, once a week the server goes down and takes out 3 or 4 classrooms at the same time...that is if the power doesn't go down completely!" (secondary)

b. Compatibility: Specific references were made to problems arising from incompatibility of equipment and/or software. Educators reported problems with computers that were not all the same. Characteristics unique to specific computers were also mentioned as specific problems with hardware and software.

> "Maybe that means that some of the secretaries need to have some additional training too. The first year when I was at *****, the first year I was there I did it all on IBM and something happened on the merge and I had to do my entire report card. So, um, since then I've done it on my Mac at home. But there are people who are still doing it on their IBM's and it is not a problem." (Elementary)

> "I bought a book by mistake at ****** on keyboard shortcuts which was really dumb. I'll never use it because the keyboard shortcuts for Corel and the keyboard shortcuts for PageMaker, they're not the same, and Adobe isn't the same, in Adobe, PageMaker, and Illustrator. That's another frustration too but that's programming." (Secondary)

c. Pace of Change/Outdated Equipment: Some problems were identified

as being related to the pace of change in technology and the presence or use of outdated equipment or software.

> "And then as soon as you've taken that course that software is outdated. I've taken several and gotten pretty happy about what I'm doing with this particular software, and the next thing you know that won't load on this computer anymore." (Elementary)

> "I use the...actually I use the library resource centre for any computer work that I do. I have one computer in my room, it's a stand alone with a dot matrix printer attached to it so it's virtually useless, um, if we had a better printer we could actually use the computers..." (Secondary)

> "Like, it's all nice to have this, like you say, we want to have every child have a computer but if it's not a high-end and you don't have the software, they are not going to use it. I have a son at home and he has to have a new computer every year. He's in his fifth year at (university) , you know, you just shake your head." (Secondary)

Prevalence of Computer Hardware, Software and Systems Problems Theme. The malfunctions sub-category was the most frequently coded in this theme for both groups (48.8% for elementary and 53.2% for secondary). Frustration with unexpected and regular breakdowns was expressed in most groups. Educators were experiencing shut-downs of entire operating systems as well as individual computers. It was noted that malfunctions were a huge barrier to planning and integration. Educators related stories of weeks of planning and entire lessons going to waste because of breakdowns during class or loss of computer files. Although there was extreme frustration regarding this topic when it was discussed, it was not as major a focus of discussion as might be expected. It did appear to be a problem that many educators were accepting and that was being addressed by new equipment and better systems.

Compatibility accounted for 33.8% of the elementary discussion with less emphasis on the pace of change and outdated equipment (17.5%). Much of the talk about compatibility at the elementary level revolved around the issue of Macintosh versus IBM hardware and software. Elementary schools were equipped with Macintosh computers, whereas the secondary schools generally used IBM-compatible computers. The secondary panel had more discussion about outdated equipment and the pace of change (30.6%) and less compatibility talk (16.1%). The perpetual change in the world of technology creates difficulties for educators who are trying to keep students informed.

vi. External Issues and Other Priorities: Some discussion related to the wider community (beyond the school) and to other issues not directly related to computers. This theme captured the discussion that did not fit in the preceding categories but could be captured by 3 minor sub-categories.

a. Community Resources and Skills: This category still included reference to computers, but within the community at large. The need for computer skills in the community job market was also mentioned on occasion.

> "With parents, I know that there has been some work, uh, I forget the name of... it's Computers in the Community or something like that...because we have two stations in the school that is for community access..." (Elementary)

> "Well at my husband's work everything is done on the computer. Like, if he is signing up for um, like anything to do with human resources, anything to do with a benefit plan, anything to with anything, they do not use paper and it's all, it's all on computer and I don't know if our kids could, could do it." (Elementary)

b. Corporate Programs: Support from private businesses in terms of

computer resources was referred to less often than the other support categories, so it was included here in the external category. References were made to computers or technical assistance available from corporate programs.

> "A sponsor. Ya, so you could have Company A come into your class and say 'we will put an x amount of computers in your classroom, however, your screensaver has to say Company A right across it.' That would be a way to get more computers in your class and it would also be a way to have um, all the same computers and have the same company fixing them and who knows, maybe they would even supply, you know, for a month or two, something to do in-school training for both teachers and kids..." (Elementary)

> "I guess the other thing, I guess we didn't mention is that there is a program called, ah, Libraries to Schools or something along that, where you can get free computers, old computers from businesses...they get refurbished and then the school board sends them out if you request them and there's no cost but there's no service once you get them." (Secondary)

c. Textbooks: Textbooks were mentioned as another priority beyond computers during some discussion. It appeared to be an "either/or" type of conflict in that teachers were already lacking textbooks and saw computers as competing for limited resources.

> "Do you see it as a priority to get more resources for the computer or are there other things that come priority first?" "Textbooks. I have one, one grade 2 math textbook. And I have nine grade 3 textbooks for 16 so we can pretty much share. But I have one, I left the poor supply teacher with one text book and said...go for it." (Elementary)

> "You won't know until the year starts which textbook your teacher chose." "Exactly, we haven't decided yet." "You won't know in terms of planning so I'm wondering what kind of impact that may have. Are they going to put some things on line? I feel they have to address this issue because really, the money is not there for the textbooks. What's going to happen to these students that can't take home a textbook? Where are they going to get the material from?" (Secondary)

Prevalence of External Issues and Other Priorities Theme. Only 2% of elementary and 2.7% of secondary discussion were included in these categories. The

elementary codings in this category were split amongst the three sub-categories: corporate programs (45%), community resources (35%), and textbooks (20%) whereas the secondary panel spent the majority of discussion (76.5)% in this area on textbooks.

Collaboration between private companies and the schools was discussed in terms of resources (sharing old equipment) and training opportunities. A government sponsored program, Computers in Communities, which uses the school building as a place to house computers available to the community, was also discussed.

Several of the secondary focus groups debated the need for textbooks compared to computers. Most educators thought that money should be not be taken from needed textbook funding to add to computer technology.

Summary of Content Level Themes. Both elementary and secondary educators talked about the same general issues to the same degree (See Table 13). Those issues were varied across five of the major themes, with little discussion fitting into the external issues category. Support issues were responsible for over one-third of the discussion blocks (37.4% for elementary and 35.1% for secondary). An additional third of the blocks were coded as teacher issues (31.1% for elementary and 29.5% for secondary). Context/access issues and student issues each accounted for just over 10 percent of the discussion at both elementary and secondary levels. Computer hardware, software, and system problems were discussed less frequently (7.9% for elementary and 9.7% for secondary).

The educators generally spent a great deal of time discussing the current state of computer implementation within their classrooms and schools, including the material and

human resources they both have and need. The barriers and supports for successful computer implementation were often both apparent in the same category.

Affect Level Themes

The second layer of the coding scheme was the affect level. Four major themes or categories of affect described "how" the educators felt about "what" they were saying: positive, negative, neutral, and complex. These four themes are presented with theme labels, definitions, examples, and a brief summary of the prevalence of each theme in order of frequency from most to least for elementary educators.

The affect component of the coding scheme was necessary to put emphasis on what was currently enhancing computer implementation and what was inhibiting success. For example, some educators saw the computers that were currently available in their school lab to be a positive support, while others saw the computer lab as a barrier to the classroom integration of computers.

i. Complex Affect. Blocks of information that were not clearly negative or positive in affect but contained components of both were coded as complex. That is, many times a block contained an affirmation but was followed by a qualification or a negative aspect. Generally these were the blocks that included statements followed by "but", "if" or "when." The block was coded as complex and the specific statements were coded positive or negative within that category.

> "Just getting all the hardware together, they put in all this fibre optics in the schools, they make this big deal, oh this fibre optics, it'll make everything so wonderful and ours is all done and it's no different than it was before, it's all garbage. (negative) The Internet jams…..I'd love to use the computer lab, go in there and do research, do lessons, you know, you could do so much (positive) *but* you can't until they get this all straightened out." (Elementary)

> "I'm very fortunate in that I have two computers in my classroom because I have a special education room, but even with that I've gone to so many workshops this year, been given great software programs that could really benefit the students in my room, (positive) *yet* I don't have the level of computer I need to run it in my classroom." (negative) (Elementary)

> "I mean, with my French, for example, the web page is something I would love to do (positive) *but* personally I don't know how to do web page myself (negative) *but* if I did, I would like to do that. I would love to teach my kids how to do that *but* I'd have to learn myself *but* I don't know, I have no idea how to do web page." (Secondary)

> "I would also echo that, um, that our computer site teacher that has two periods to look after the labs does an amazing job to keep the computers running you know, does calls to the board when there's servicing required, makes sure software's loaded, all the things,(positive) *and* it's a shame that we're going to lose those people, (negative) those..." (Secondary)

Prevalence of Complex Theme. The complex theme accounted for the greatest portion of the elementary codings (38%) and the second greatest portion of affect codings in the secondary discussions (30.1%). For the most part, this category presented issues that could be very positive, but other issues were interfering or causing difficulties around them. This theme essentially related the barriers to successful implementation. That is, elementary educators found many positive things to say about material resources, training and development, and, human resources in terms of support but related problems in these same areas. They were appreciative of the access to labs but couldn't supervise a primary class of 27 children alone in a lab. They sang the praises of computer-savvy librarians but were angry that they were no longer available to support their computer program. They were willing to take training and development courses but indicated a lack of time and money as barriers. Secondary educators focused more directly on material resources and the frustrations came in the form of not enough resources in some schools.

Both elementary and secondary educators made positive comments surrounding philosophical and pedagogical issues as well as the skills and characteristics of educators (See Table 15). However, these positive remarks were then qualified with problems in the area of support. That is, they supported the idea of computer integration but felt that the support they needed was not available. The problems at the teacher level were identified in the skills and characteristics of educators as well as in curriculum issues (See Table 16). There seemed to be great variability in skills and experience among elementary educators in terms of how comfortable they were with computer integration. Educators often lacked confidence to instruct using the computer or they were greatly enthused and couldn't wait to learn something new.

In the secondary panel, the curriculum was discussed more often as a difficulty than a positive issue. Recent changes in curriculum at the time of the focus groups appeared to be responsible for much of the secondary discussion and sarcasm about the expectations of that curriculum was apparent. Computer hardware and software problems were also seen as detracting from the positive aspects of computer implementation that were discussed at both teaching levels (See Table 16). Context and access issues played a slightly more prominent role as a complex theme for elementary educators (13.7%) than for secondary educators (7.1%). Student issues also entered into discussions surrounding problems (11.1% for elementary and 9.2% for secondary).

ii. Neutral: Blocks that did not demonstrate any obvious negative or positive affect were coded as neutral. These blocks were statements of fact or opinion with little emotion attached one way or the other. There was no obvious or discernable affect accompanying the statement.

> "Our school's kind of divided up into... I only know because I have my kids going into integration for the computer component of the grade 1/2 class and uh, one of the teachers in our school runs, is responsible for, the lab but she also does all of the primary computers so she does Almena with them." (Elementary)

> "I teach grade 4 and 5 French Immersion. I tend to use computers, not quite as often as my colleague here, we tend to use them in a lab setting. So I have one period a week with each of my classes. Ummm, so it depends on what we're doing. Recently I was using it...website to help with research." (Elementary)

> "You partner up students, like finding out, okay who's friends with who and so can you go over to their house and finish an assignment up on their computer." (Secondary)

> "It's a tool. I mean if you, if you gave them a book and you said find info in the book, they have to know how to use it and read the contents or the index and if you give them a computer, you say find info on the Internet or write something or whatever too. It's a tool..." (Secondary)

Prevalence of Neutral Theme. Approximately one-third of the discussion blocks were coded as neutral (31.2% of elementary and 34.0% of secondary). The neutral discussion was also spread across a variety of content themes. The elementary panel's neutral discussions involved material resources, human resources, philosophical and pedagogical issues, skills and characteristics of teachers, and, curriculum (See Table 17). The secondary panel also spoke about philosophical and pedagogical issues, material resources, and, human resources with a neutral tone. Secondary educators also presented student motivation, skills and characteristics a great deal in the neutral category with less emphasis on characteristics of teachers (See Table 17). The neutral discussion was generally statement of fact, giving a picture of computers in education at the present with reference to material and human resources available and the beliefs of educators regarding technology.

iii. Negative Affect: Negative affect was evident in blocks of the transcripts where participants degraded or dismissed concepts or technologies with a negative tone. These comments were separate from the negative qualifiers in the complex theme. The affect was clearly negative with no redeeming additions or qualifications.

> "And it's very hard to keep those 29 or 30 kids focused on that demonstration. Ideally it should be 6 or 8 max. But you've got 30 people to entertain with this screen. You probably got the attention, if you're lucky, of half, and the other half are doing their own thing." (Elementary)

> "It doesn't suit. None of it. All three of us, we feel by the sounds of it that it doesn't match what we need at all. Not by a long shot." (Elementary)

> "But doesn't it kill you that they only usually train one person. That's frustrating. Like, we'll, we'll train one person for a staff of 38." (Elementary)

> "I have probably just as many problems with systems not working in a given period than I do with students that may just not know what they're doing. It's just always a computer problem, always, ah, even today I ran a practical test and went down, checked the lab facilities last night, everything was in working condition. Practical tests...they needed to print it out for me and there was a computer problem with the printer and the system so I have about 10 tests that I never got printouts for and printers just not working. It's ah, you know, just the patience that you have to have some days. It's just incredible and it mentally wears you down, um, it's just um, you sometimes wonder...how much longer will I last at this job?" (Secondary)

> "But it's I mean, as I said, it's been years and years, and you fight and you fight, and it's just so discouraging to have something that I've built up for 10 or 12 years and now next year it's gone." (Secondary)

Prevalence of Negative Theme. Support issues (33% of elementary and 34.6% of secondary) and teacher issues (28.9% of elementary and 19.6% of secondary) accounted for more than half of the negative codings. Interestingly, discussions of computer hardware and software problems accounted for less than 20 percent of the negative codings (13.1% of elementary and 17.0% of secondary). Context and access issues included a negative overtone slightly more often in elementary discussions (14.9%) than

secondary (11.1%), while student issues were a topic of negative conversation more often in the secondary panel (13.1%) than the elementary (8.6%). The negative comments often portrayed frustration with equipment and lack of support. They generally took the form of complaints with inadequacy in terms of materials, people or time. Elementary educators expressed more negative emotion in regard to access than the secondary panel did. Although, as stated earlier, the general tone of the discussion groups was supportive of technology, the negative affect was displayed by educators who saw the barriers as insurmountable or had experienced enough difficulties to build a disdain for technology. They were "fed-up" with constant change and afraid to plan computer integration only to be let down again.

iv. Positive Affect: Blocks that included any affirmative statements, endorsements, or emotional comments indicating positive support for technology were coded as positive. Once again these statements were clearly positive and did not include any qualifications or negative factors that might temper the positive affect.

> "So it's a great tool, right." (Elementary)
>
> "When a new program comes out and you look at the advantages of a new program, you want to immediately start using it." (Elementary)
>
> "I, we just don't have those problems and I think it's because our computer, our teacher, he only is given one period a week but he has devoted himself to that, and he's crazy, but he's always fixing everything, I don't know of a time when our labs have crashed." (Elementary)
>
> "Actually it's handy because our classroom is right across the hall from the CATC lab and it takes three or four weeks sometimes to get a booking. So what I'll shuttle kids back and forth and they like that." (Secondary)
>
> "So I like using the computer for research because it opens up access, you know, to so much more information that you wouldn't have just using library books." (Secondary)

Prevalence of Positive Theme. Although the overall pattern of affect was similar between the two teaching levels, the allocation of positive affect differed somewhat. Forty-five percent of positive elementary codings were categorized as teacher issues, specifically, philosophical and pedagogical issues. The positive comments in this sub-category at both levels were generally endorsements of computers as an effective instructional tool.

The secondary teachers discussed support issues in a positive light more often (See Table 19) than elementary educators. The positive discussion regarding support from secondary educators was generally directed at material resources (69.7%) and, to a lesser degree, human resources (21.2%). They generally made positive comments about the hardware and software available to them.

The elementary educators directed their positive comments about support issues at material resources (45.2%), human resources (32.3%), and training and development (22.6%). They were expressing the benefits of support at levels other than the hardware and software. Their positive endorsements were directed at sufficient computer equipment, qualified colleagues, and, professional development experiences.

The positive comments regarding student issues, for both panels, revolved around the motivation, skills and characteristics of students (See Table 19).

Summary of Affect Level Themes. Affect was clearly a component of the focus group discussions and a definite part of the message educators wished to impart. Implementation of technology is obviously an emotional issue for these educators. Approximately two-thirds of the coded blocks contained an identifiable affective

component. Although the affect was divided, the discussion was more often negative than positive. The complex theme gave a clear indication that not all is negative, but educators do feel that the possibilities of computer technology are being hampered by a variety of factors. The positive affect that was present offers a picture that includes some supports and possibilities for successful implementation of computer technology.

Interpretation of the Thematic Analysis

In order to gain a clear understanding of what the educators were saying about technology in the focus groups, it is important to integrate the two components of the coding scheme identified above (i.e., content and affect levels). Overall, the discussion covered an array of issues with emotional content varying across the issues. For example, discussion centering on the availability of computers and the ways in which they are being used would be captured as neutral. Positive affect was apparent when educators told success stories of using computers to explore databases, create legible reports, do simulations, support peer tutors, and research current information. They were enthusiastic about sharing accomplishments and acknowledging the assistance of their colleagues and students. Similarly, when resources were adequate and available, educators saw computers as a functioning part of their environment. When hardware, software, and personnel to manage computers were missing, educators were frustrated and searching for help. In these portions of the discussion, participants indicated resentment about support that had been taken away, including technical personnel, release time for teacher experts, and librarians.

The complex category in the affect level spoke to the barriers in the process. Educators were excited about using computers and stated that they are a useful tool of

benefit to students and educators but the lack of money and time for training, equipment breakdowns, and lack of time to develop lessons and incorporate computers in the curriculum were all included in the discussion as barriers. Secondary educators were upset about access difficulties, such as the inability to book labs, and resources that did not have the capabilities to run current software. Their negative comments were often directed at a mismatch between content-heavy curriculum requirements and the knowledge construction that is possible using technology.

Elementary educators were quite positive about human resources and teacher characteristics but there were definite individual differences. Some of the educators were struggling with being a "perpetual novice", noting their own weaknesses and the lack of time to become an "expert" in the fast-changing world of technology. Others embraced the knowledge and skills of students, and the resources available to them.

A more detailed presentation of the "educator's voice" is included in the discussion where we attempt to bring together the quantitative and qualitative results to provide a picture of the state of computer implementation within these schools.

Discussion

The results of this study, both quantitative and qualitative, indicate that both elementary and secondary educators are computer users who support the integration of technology in theory but recognize that there are problems or barriers to be overcome and that supports are required to integrate technology successfully within the curriculum. Analysis of their surveys and focus group discussions presents a complex, multi-faceted framework for examining the successful implementation of technology within the school system.

First of all, it is important to look at the educators as users of technology in order to understand the foundation from which their responses were provided. The educators in this sample were familiar with technology in that the vast majority (over 91%) indicated that they had a computer at home that they used both for personal and school-related tasks. In addition, all of the secondary and the majority of elementary school educators (over 86%) had access to a computer at school that they used primarily for school-related tasks. Interestingly, the greatest reported use of computers was at home.

As in most other studies looking at computer use (such as, Anderson, 1996; Brosnan, 1998; Rosen & Weil, 1994) the impact of gender was an important consideration, especially with respect to the amount of time spent with computers and level of comfort with technology. There was a trend for female elementary educators to spend less time on computers than all males and female secondary educators. It seems likely that the difference may be linked to different expectations in training and use of technology among educators at the different levels and choices of how time is spent outside school. There were no differences in comfort level, however. Overall, it is difficult to make conclusions about the presence or absence of gender differences in the present study due to the very small sample of males in the elementary sample. Although the small number of male elementary educators was representative of the population of elementary educators, there really are too few to confidently interpret whether gender was or was not important in these data.

The study also examined differences between elementary and secondary educators. Although secondary school educators were more enthusiastic in their support of technology than elementary school teachers, both groups identified contexts where

computer technology would add to their instruction. Secondary school educators saw technology as a tool and used it as such to facilitate instruction in many domains. Similarly, elementary school educators indicated that technology could be a useful tool, but a small proportion, especially those in the early primary grades, indicated that computer technology was not consistent with their pedagogical beliefs and may not be appropriate for the special needs of young learners. In the majority of cases, educators supported the integration of technology but recognized that they were not maximizing its potential. The complex theme in the coding scheme, developed from the focus group transcripts, gave voice to the qualifications educators often added to their statements of support for computer technology.

The overall positive endorsement of computers came with the caveat that the current environment did not necessarily support the integration of technology. The large number of themes in the open-ended survey responses and focus group coding scheme suggests that there are indeed a wide variety of supports and barriers to be considered in computer implementation.

The barriers and supports that limit and facilitate the integration of technology were found at two levels: the individual educator and the environment in which the educator taught. Although commonalities existed in terms of general support for technology and concern with material resources, these individual and environmental concerns differed in emphasis, and sometimes in content, between the elementary educators and the secondary educators.

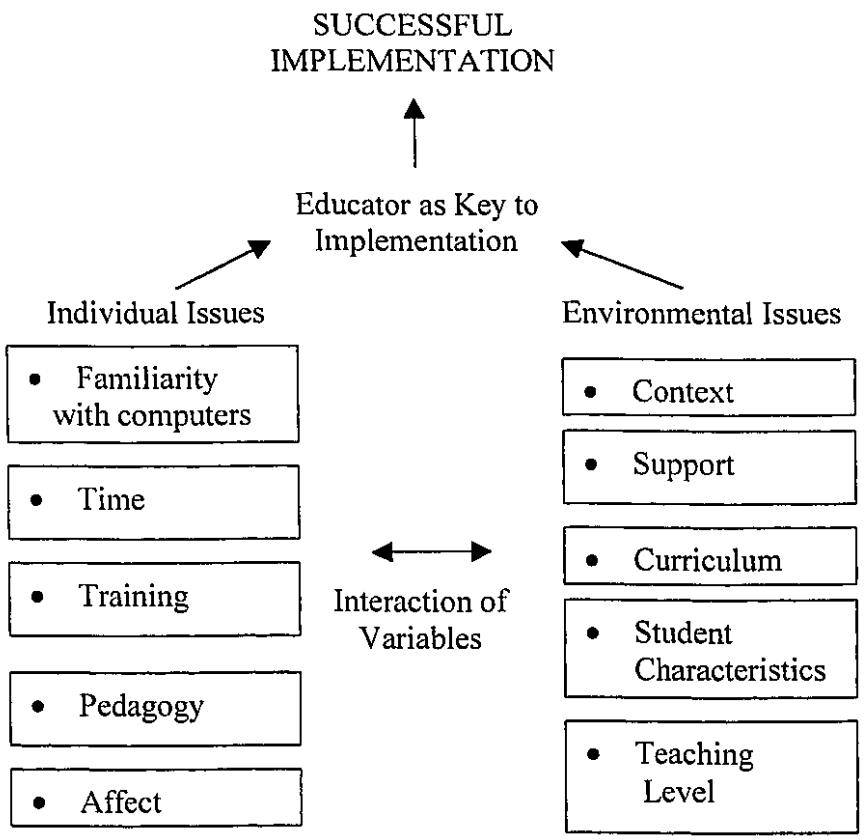

Figure 2. Framework for Examining the Implementation of Computer Technology

Figure 2 provides an outline that will be used to frame further discussion of the influencing factors identified in this exploration of computer implementation. In this framework, the educator is key to our understanding of what is currently happening within the schools in terms of computer implementation. The educators in this sample provided insight into the individual and environmental factors that affect this implementation. Future investigations need to consider how these variables might interact.

Individual Barriers and Supports

Individual issues emerged as a prominent topic in the thematic analysis of the focus groups and were evident within the survey responses. Many of the factors affecting

computer implementation were very personal to the educators and were presented with a great deal of affect attached. The most salient of these issues concerned familiarity with technology, time, training opportunities, pedagogical beliefs and emotional responses related to technology.

Familiarity with Technology. Existing research demonstrates that individuals with greater experience and practice using technology experience less computer anxiety (Anderson, 1996) and are more likely to use technology (Clements, 1995; Pelgrum, 1992). These findings were also demonstrated in a recent investigation among early childhood educators (Wood, Willoughby, Stern-Cavalcante & Specht, 2002). Although early childhood educators supported the use of computers with young children, in many cases, they did not feel comfortable implementing that technology in their classrooms. In addition, individuals who report more comfort with computers have greater experience and knowledge about computers (Kirkpatrick & Cuban, 1998; U.S. Department of Education, 2000). In the present study, teachers reported that they used technology with much of this use taking place at home. Clearly, the skills needed to use technology in the school environment were a concern for educators.

Educators who are uncomfortable using a tool or teaching a concept in which they are not "expert" could have difficulty mastering computers to a degree that would allow them to integrate that technology in their instruction. This appeared many times in the discussions. For example,

> "So unless you've taken those courses and spent the hours learning it yourself and trying to implement it in your own mind before you go into a class of 26 and look like an idiot..."

> "But you need to know something about a computer, cause some student's going to ask a question." "Oh, for sure." "And the person supervising is going to have to do something."

Educators recognized the effects of not being "expert" with computer technology and frequently requested training in this domain, especially at the elementary level. Educators voiced the need for more experience and training specifically directed at the integration of technology within their classrooms. They indicated this through requests for workshops, in-service training, and access to "somebody (who can) sit down and tell (them) what they need to know and how to go about it."

Consistent with these responses, the multiple regression analyses conducted on the survey data indicated that the use of technology predicted comfort, and greater comfort with technology predicted greater integration of technology. It is important to note that the secondary educators reported greater comfort and ease with computers and, interestingly, more of them reported using computers in their instruction. It is also important to note that neither level indicated the degree of anxiety surrounding computers that would prevent any integration. The "technophobia" and the belief that computers are not an effective tool for instruction that Schofield (1995) identified as barriers to computer use in secondary schools, were not a major barrier in our sample.

Time. Time, most notably the lack of time, appeared as an important point in both the focus groups and the open-ended survey questions regarding barriers to computer implementation.

The pace of change was also seen as a hindrance to the integration of technology, leaving many educators as "perpetual novices" in the domain of computers. Hardware

and software change at a rapid pace with little time for learning before systems are altered or updated. This is captured by one participant's response:

> "I get frustrated with the computers in terms of being outdated and old and because the technology's changing so fast and so rapidly that just how on earth could the school board try and keep up with that."

Training. Most of the educators in our sample had participated in some workshop training in the use of computer technology (on average, 2 workshops). Although there were these formal opportunities for training, most training occurred informally through interactions with colleagues. In fact, the dependence on in-school support through colleagues (librarians, technicians and other staff) was a prevalent theme in the focus group discussions. The role of these individuals varied markedly, including providing notes, trouble-shooting advice, as well as hands-on experience for students in classes other than their own.

In particular, educators indicated a need for training in the management of hardware issues (e.g., what to do to "fix" computers).

> "...well, if all of us are supposed to know how to troubleshoot computers that break down, give us 3 workshops that show us how to fix them. Don't just expect us to get it through osmosis because, it's not happening."

The need for information about managing computer failure was tied to support. Educators identified the need for ready access to an "expert" or technician who could manage equipment breakdowns and system failures as well as provide information about system changes (e.g., move away from independent desktop units to networked systems). The current school environments did not provide easy access to an expert and participants indicated that they often relied on an experienced computer user who was also teaching at the school. This system was not ideal as the "experienced " person was not always

available when they were needed, and the dependence on these individuals was seen as placing an onerous burden on their already heavy workload.

It is important to note that the need for hardware/system support was perceived as a critical prerequisite, so much so that it overshadowed discussion of how to integrate technology within the curriculum.

Training and professional development needs were more prevalent at the elementary than the secondary level. Secondary educators appeared to be more confident in terms of their knowledge and computer expertise and were more concerned with access to the equipment. The presence of "site managers" at the secondary level seemed to ensure that an "expert" was available, although many of these positions were disappearing.

Pedagogy. The secondary educators were unanimous in stating that computer technology fit within their instructional approach. Elementary educators were also supportive in 81% of the cases. In spite of this endorsement, educators at both levels indicated that although they supported integration in theory, actual implementation was often conditional on the characteristics of the lesson or task to be performed and the availability of equipment. Some elementary educators went so far as to say that computer technology did not fit with their philosophy due to lack of training, equipment problems or a lack of human interaction.

Survey results indicated that educators see computers as an integrated activity to a much greater degree than a stand-alone activity. The focus groups indicated that educators use computer technology, for the most part, as a "tool to complement instruction". Educators were clear that the characteristics of the task and students were

considered when planning whether or not to use computer technology in a lesson. Computers were seen as a way to add "variety" to instruction, with few references to any major changes in pedagogy as a result of technology implementation.

Differences in pedagogy were most apparent between the two levels, elementary and secondary. Secondary educators work with a curriculum that is much more compartmentalized than elementary educators. In addition, secondary educators specialize to a much greater degree and computers seem to be attached to specific subject areas, whereas elementary educators are attempting to integrate the use of technology across the curriculum. The secondary educators use the technology more specifically for information gathering and research.

Differences were also identified in terms of the general teaching philosophy of the educator and their beliefs concerning appropriate and effective instruction, and how computers fit within that philosophy. How technology is used may be determined by the resulting classroom structure as well as preferred instructional methods. For example, compare the following two views on learning.

> "I have a unit which I do and the kids, it's an independent study unit and the kids, the kids almost always enjoy it, is um, just a research essay on, based on a particular novel that we've chosen together and the stuff, you punch in the name of a novel or the name of an author and you just get this plethora that comes and you can choose what you want and what you don't want to use. So for me I like it. I like it very much and um, ever if it's something that's product oriented and I think I put this on my sheet, if you're product oriented as a teacher, ah, it's much, much easier for me to read a paper like this than jamming up and sat there for 17 hours and see you know, product, if you're product oriented, it, good if you're product oriented it can be good but you have to spend some time teaching the process so for me it works because I like it and I want it to work. For others it just may not be their...the method of choice."

> "And that's why I'm traditional enough I guess that um, at least initially you have to be, I have to be process oriented rather than product oriented cause once you've

> got the product process you can produce the product anyway or another, stone tablets or laser printers."

With respect to structural differences, elementary educators supported in-class computer access with a desire for small group work, while secondary educators often indicated a need for individual access in a lab setting.

Aside from the instructional level, be it elementary or secondary, individual differences in pedagogical beliefs may account for varying degrees of technology implementation.

> "Um, so I see my colleagues using them at various stages. Some people are not as comfortable with it and some people use it all the time. I find myself somewhere in the middle trying to balance it with traditional methods and other things that are going on."

Although the great majority of elementary educators indicated using a variety of teaching methods, not all supported the use of computers.

> "I find that some of the programs don't really lend themselves to student learning. And I worry about, I see the direction the Ministry is headed, is to involve more computing in the classroom and more learning with computers and I don't think that just because you put a program in front of a kid and that it has information on it about a subject, you know, noun, verb, adjective, that the student's going to do it because with computing, a lot of it is click and there's no risk, there's no risk. I can get it wrong and then 2 seconds later I can have it right."

Affect. Perhaps one of the most salient features in this study was the identification of affect as a critical component in interpreting educators' experiences with technology. Two-thirds of the discussion in the focus groups was laden with identifiable affect. When asked to discuss computer technology within the focus groups, these educators did not merely "present the facts" but discussed the issue with a good deal of emotion. Successful integration of technology appears to include attention to the frustrations and anxiety of educators in a variety of areas and not merely the introduction of equipment.

Positive affect and negative affect were both spread across a variety of themes with few issues being strictly positive or strictly negative. The complex theme was the most prevalent category (38% of elementary and 30.1% of secondary discussion blocks) of affect codings in the thematic analysis of the focus group transcripts. Elementary and secondary educators identified many positive components in the implementation of technology but these endorsements were frequently qualified by a negative component or barrier to be overcome. A great deal of frustration with the lack of support available in terms of training, technical assistance, and access to quality resources (both material and human) was evident in the discussion.

The fully positive portion of the discussion was smaller (9% of elementary and 11.9% of secondary) but also varied in terms of content. Both resources and supports are available to some degree. A portion of both elementary and secondary educators used positive affect when discussing the use of computers in education and the amount of material resources available. Differences across schools in terms of personnel and equipment may account for some of the discrepancy in the level of support available to educators.

The amount of negative affect was similar at both levels of instruction (21.9% of elementary and 24% of secondary), but was focused in somewhat different directions. Elementary educators were more concerned with a lack of support in terms of material resources, human resources and training, as well as teacher characteristics and pedagogical issues, while secondary educators concentrated their negativity in discussion of material resources and curriculum concerns.

Although the educator plays a key role in successful implementation of computer technology, and their opinions, beliefs and emotions contribute or distract from that implementation, the environment that educators find themselves in certainly affects the decisions that they make. The environmental factors that these educators presented are discussed below.

Environmental Barriers and Supports

Although we see the educator as a key component in the successful integration of computer technology, that educator does not work in isolation from the many variables that make up their teaching environment. The context in which computers are found, the support (material and human resources) that is available or lacking, the characteristics of the students, and the curriculum that dictates the content of the instruction, were all identified as environmental variables through the thematic analysis. The context of computers and support measures were also investigated through the survey questions.

The teaching level of the educators (elementary or secondary) was an environmental factor that was accounted for in the design of the study and did appear as a significant variable related to computer experience and integration. The emphasis on issues also differed between the two teaching levels in the thematic analysis of the focus groups. Although the teaching level of an educator may also be related to their individual characteristics, it is discussed here as an environmental factor since the student characteristics and teaching environment differ according to level.

Context of Computers. The frequency data indicated that within the school environment, the most likely place to find computers for student use is in a library/resource centre or a computer lab. About half of the educators reported access to

a computer in their classrooms. Interestingly, as indicated in Figure 1, the report of student use of the library and lab computers was lower than the availability, whereas use of classroom computers was equal to availability. It seems then, that when computers are readily available, they are more likely to be used. That availability was specified as either in the classroom or as a lab with a large number of computers. When computers were available in small numbers but not within the classroom, as in a pod or work area, they were not used as frequently.

The location of computers was particularly salient for the elementary school educators. Although both secondary and elementary educators indicated that greater access to computers in the classroom would be an important feature in an "ideal world" and that incorporating technology within the classroom should be an area of concern for future planning initiatives, it was the elementary teachers that stressed location in the classroom more frequently. Educators at the secondary level were asking for more access to computers generally rather than in classrooms in particular. Differences likely relate to developmental level of students and classroom structure. For example, elementary educators discussed supervision difficulties in labs and practical issues regarding travel to and from a computer lab.

> "This year, at the end of last year, we made the decision to dismantle the lab and the computers have now come back to the classroom. I have 2 computers which I use a whole lot more than I did the lab just because it was a major thing to take your whole class up there to use the lab, but in the classroom, I can always send 2 kids over to use the 2 computers, or 4, like I can buddy them up."

> "Like, I would like to have about 5 computers in every single classroom, all with internet drops, you don't have to, and one printer, you don't have to worry about uh, sending kids off to a lab or with a volunteer because you can watch them right there and just have small groups going rather than having a group of 30 where three quarters of them will get distracted if you leave them alone for too long so

> you just have the rest of them doing their independent work and take a group of 5 out at a time and work with them individually but that's not going to happen."

In addition, integration of technology would be more challenging when learning units are shorter and smaller, as is the case with the curriculum for young children relative to the full class sessions that would be used with secondary school students. Computers are used less formally in primary grades as a learning tool, often in pairs or small groups where individual access, such as found in most secondary labs, is not necessary (Pelgrum, 1992). Elementary educators in this study repeatedly made requests for computers in their classrooms in response to survey questions regarding the "ideal world" and "what could happen to make things better" as well as in the open discussion of the focus groups.

> "And access, you're always being forced to book out the lab, to book out the library, to me it's everything is inconvenient. It would be much better if I had 6 computers in my room with kids assigned to them every day. But we know that's not going to happen..."

> "And I'm not sure that it's a reasonable expectation of a classroom teacher to be up at the forefront of this technology as well, especially when it's in a lab removed from your day to day classroom."

In cases where technology is actively incorporated, the opportunity to move quickly and easily between technology and other demonstrations is available. That is, fluent transitions with technology are best met when technology is readily accessible. Becker (1999) identified classroom connectivity as one of eight independent variables affecting teacher's Internet use with students. That is, educators who had a high level of access were more likely to use the technology available. The educators in this survey indicated that the computers that were available in classrooms were indeed used by

students on a regular basis. When educators are forced to take the students out of the classroom, not using the technology becomes an option.

> "It becomes to a point where I choose not to go to the lab rather than go through the headache, because the kids are 6 and 7 years old, and that's really difficult..."

Some of Becker's more recent research (2000), based on a national survey in the United States, supports the results of the current analysis. Becker's results indicated that students with 5 to 8 computers in their own classroom were more than twice as likely to use computers regularly during class than those who had computers available in labs, even though there were more computers available in the labs in terms of number.

Support. Much of the discussion within the focus groups surrounded not just the context of the computers but the support required to integrate the resources that were there. Not surprisingly, material resources (i.e., hardware, software, network systems) and financial resources are a major concern with respect to computer implementation. Although educators indicated the presence of computers in every school, they were frustrated by machines and systems that were unreliable, outdated or incompatible, and in some cases insufficient in numbers. A lack of working, up-to-date, accessible computers was consistently cited as a major, although not the sole, inhibiting factor to computer integration.

Overall, material resources were discussed as a limitation when they "didn't measure up," and were infrequently listed as an enhancing factor or current support. When considering an "ideal world" or suggesting action that could improve the current situation, however, access to material resources (the computers) was a wish for both elementary and secondary educators.

The unequal distribution of resources across schools became an issue in the focus group discussions. It became apparent that the working environments and material resources available were not the same in each school. Some educators were satisfied with the quantity and quality of the resources that were available to them, while others were reporting major difficulties with systems and equipment shortages. For example, compare

> "And as far as my classes are concerned too, I don't expect homework to do, done outside of class only because I know a lot of students don't have the software at home or may not have the facilities, or they may not even do the work if you send it home with them. Our lab facilities are available to them every noon hour."

versus:

> "That's if you have enough units to do that. We're limited because if we use our lab I can only go in for 3 consecutive periods and then I have to opt out. We have a maximum number of consecutive periods I can use it for then you've gotta free it up for somebody else cause we're so limited with how many computers we have. We don't have the luxury of having an open lab during lunch hours, we would like to, we request that, we're just outta space."

Elementary educators reported less concern with material resource difficulties than secondary educators. Human resources was seen as the prominent enhancing factor at the present for elementary educators and was often discussed as a support during the focus groups. In particular, elementary educators expressed a need for personnel to supervise students, to manage the actual technology, to provide training and in some cases, instruct the children. As mentioned earlier in the discussion on training, elementary educators relied heavily on "human resources" within the school in the form of colleagues, librarians and volunteers. A "key person" in the school was often responsible for activating a school plan and implementing technology.

Curriculum. The curriculum that dictates the content that educators will teach is an important part of the educators' working environment. Although some of the

elementary discussion included positive examples of ways in which computers had been integrated into curriculum, curriculum issues were reported with a clearly negative tone in secondary panel focus groups. Elementary discussion about curriculum was more often negative, as well, in reference to computer technology adding to an already "crowded" curriculum.

Issues surrounding curriculum made it clear that many of these educators were overwhelmed by additions to the curriculum, and computer technology was often seen as another one of those additions. As mentioned earlier in the section on training, educators are already struggling to keep up with the rapid pace of change in technology, leaving them as "perpetual novices" in that arena. New curriculum compounds the difficulties of integrating a new "tool" with the integration of new "content".

Secondary educators had recently been presented with new curriculum documents at the time of the focus groups and that issue was apparently a "hot topic" at many schools. It is important that we recognize the strong influence of a myriad of such factors in the complex teaching environment when we investigate the implementation of technology.

Students. Surprisingly, the students themselves, and how technology might affect their learning environment, were a limited topic of discussion. A small portion of conversation was devoted to student impact or influence. Educators appear to still be struggling with the implementation of computer technology and are not at a stage where they consider the learner in relation to computer technology (Borich, 2000). When students were mentioned, however, educators at both levels identified students as an enhancing factor in computer implementation. Students were described as knowledgeable

and patient and seemed to be coping despite the many barriers and limitations to computer implementation that educators discussed in much more depth.

> "And the kids are absolutely…no problem. They love it. Oh ya, get outta my way, I don't need you to show me."

The knowledge and experience of students was, in many cases, reported to be superior to that of the educators.

> "Well, now I'm comfortable with the basics but then I'll get into a computer lab with a grade 8 class, like I took a grade 8 immersion class in last year and I had kids that were almost hackers. They knew way more than I do and they were trying to break down firewalls that the board had set up…..So I thought I knew enough and they you get in there with these grade 8's and they know way more than I do."

There was also reference to a "digital divide" that exists between students who have computers at home and those who do not. This is an equity issue that did not appear as a problem at the elementary level where the divide may not yet be so obvious.

The reason for limited discussion of student issues may be related to a developmental process in computer implementation. Educators are still struggling with the physical implementation of equipment and resource shortages, both material and human. Their concerns were directed more at the support that is required to actually implement the technology and less at how they integrate the technology into their classroom instruction and lesson planning. Many educators were concerned about becoming "expert" with technology and were not yet at a point in their development of computer knowledge and skill to consider the learner impact. The majority of educators supported computer technology at a philosophical level and were focused on the personal impact of computer implementation and the barriers that exist in their working environment.

Teaching Level: Elementary and Secondary Differences. Although common features of implementation carried across elementary and secondary teaching environments, several patterns of differences between the teaching levels became apparent. Some of these differences have been identified above, but are highlighted here in more depth. The picture of current computer implementation, integration within the classroom, current barriers and suggested action, is different for an elementary educator than it is for a secondary educator.

The implementation issues of elementary and secondary educators would certainly be influenced to some degree by the developmental differences of the students that they teach. It may be important then to define what "successful implementation" means for particular developmental stages. The amount and type of computer use may differ greatly for young children who need concrete, active experiences and teens who are developing abstract thought. The secondary panel is dealing with students who are capable of independent work and construction of knowledge. The lab with networked computers and Internet connections may be a productive learning environment for secondary students but not for elementary children who require more direction, supervision and assistance.

Both elementary and secondary educators reported hardware limitations as a current barrier to the integration of computer technology. However, elementary educators also focused on a lack of time and knowledge as reasons for limited use. Secondary educators saw barriers from a much more material outlook, adding limited financial resources and an insufficient number of computers as current inhibiting factors.

The same pattern of differences—an elementary focus on teacher characteristics and knowledge and a secondary focus on material resources—was obvious when educators were asked to describe their "ideal world" and suggest "what could be done to make the current situation better." Elementary educators asked for access to computers in their classrooms while secondary educators requested more general accessibility to use the computer as an instructional tool. While secondary educators again suggest that equipment, software and financial resources would assist them in the implementation of technology, elementary educators are asking for education and training to go with equipment and software available in their classrooms. The information that elementary educators are looking for is not as available as the training secondary educators might utilize, such as software-specific courses often offered in the community. Elementary educators are looking for professional development aimed at integrating computer use into the current curriculum. They need concrete, practical applications that have been shown to be successful in other classrooms.

The differences between the teaching levels were also apparent in terms of actual integration. Secondary educators were more likely to incorporate the use of technology in their lesson plans. As indicated in the earlier discussion of the quantitative analysis, the variable that predicted integration was comfort with technology. The limited use of computers by elementary educators is not surprising, then, considering that the elementary educators reported less ease and enthusiasm for computers than their secondary counterparts. The use and comfort cycle becomes apparent when we consider the fact that comfort with technology was predicted by use. The secondary educators

who had a greater degree of comfort were also using computers more and that use may be adding to their comfort.

The philosophy of the two groups of educators may also come into play. Most elementary educators indicated that technology "fit within their instructional approach", as did all of the secondary educators. However, when elementary educators said that technology did not fit within their approach, this was because they didn't feel trained, felt the equipment was unreliable, or believed computers should not replace human interaction. The earlier discussion on pedagogy pointed to the differences in structure and curriculum between the two levels that may result in differing approaches to computer implementation as well.

Differences between the two teaching levels may be attributed to contrasting work environments, including student characteristics, as well as individual teacher characteristics that accompany the choice of teaching level. It is clear that elementary and secondary educators differ in their approach to computer implementation and that teaching level must be considered as a factor in any future research.

Summary: Answers to the Initial Research Questions

1. What is the current state of computer use and access in Ontario elementary and secondary schools?

A good number of computers were available in these schools, mostly in labs and library resource centres. Many of them are networked and connected to the Internet. There are computers in about half of the classrooms and those computers are used by students. Although educators in many schools reported adequate material resources, some educators reported a need for more and up-to-date hardware and software.

Elementary educators are asking for more computers in the classroom while secondary educators see access to labs as a greater need. Many of the schools are lacking necessary technical support and personnel to manage the computer systems.

There is a general endorsement of and support for computers from administration and educators. Computers are seen by many educators as an additional instructional tool that adds variety and provides motivation. Although there is some debate as to the appropriateness of computers for younger children, they are being used from kindergarten to senior secondary school for a variety of purposes: playing games, whole class lessons in labs, individual and group research, word-processing, school websites, and scientific simulations, are just some of the applications. The type of use is dependent on the developmental level of the students, the resources available and the beliefs of the educator.

Elementary educators are "sometimes" including computers in their planning, while secondary educators incorporate them "often." The educator's comfort with computers is important in predicting integration. It seems that educators who are more comfortable with this teaching tool are integrating computers into their classroom.

2. What are the barriers and supports surrounding computer implementation in elementary and secondary schools?

Barriers and supports were identified in the survey responses and focus group discussions. Current supports include a favourable attitude toward computers, accessibility to computers, human resources (teacher experts, librarians, technicians), patience and skills of students, and individual teacher characteristics (comfort with technology). A teacher or administration within the school who was enthusiastic and

knowledgeable in the area of computers was often cited as an invaluable resource and often quoted as responsible for getting computer programs started. Secondary educators put more of an emphasis on the hardware and software available when describing current supports while elementary educators included human resources as a major support more often.

The current barriers to implementation for elementary and secondary educators differed somewhat more than the supports. The elementary educators identified barriers as hardware and software limitations (the malfunction or inadequate number of computers or appropriate programs), lack of time, lack of knowledge and comfort with computers, lack of computers in the classroom, and shortages of human resources (supervision and technical assistance). The secondary educators were for the most part comfortable with technology and saw material resources as the major barrier. Secondary educators seemed to be limited more by breakdowns in equipment, insufficient machines, and out-dated equipment, than any other factor. Lack of time for computer work within the curriculum was another barrier brought forward by the secondary educators. Secondary educators also noted inequities between students who had computers available at home and those who did not.

3. What do Ontario elementary and secondary educators see as the relevant issues surrounding implementation of technology?

One outstanding characteristic common across the results of all three measures used in this study was the wide variety of themes or range of response. The issues involved in the implementation of computer technology are varied and complex, and mixed with a great deal of emotion. There is no single factor or theme that stands out as

the primary consideration in computer integration. Issues identified in the focus groups as important to educators echoed many of the responses on the survey but added emphasis and focus. The thematic coding of the transcripts and the calculation of frequencies allows us to summarize the content in terms of emphasis.

Educators still see material resources and their maintenance as a major issue, along with the support from human resources, particularly at the elementary level. The inequity between schools was an issue that was highlighted by the focus groups. Training and the successful use of computers is still an important issue that was related to comfort and integration. These concrete needs of hardware, software and technical support seem to be of priority before issues such as how to actually use the computers in your instruction can be addressed.

Educators see the need for time to share information amongst colleagues and become comfortable with the technology before they are able to integrate it. Another issue related to time was the amount of curriculum that is required. Computers were brought up as an addition to an overcrowded plate.

Educators indicated a general support for computer integration and acknowledged the supports that exist from administration, colleagues and students.

Contributions of this Research

This study was successful in identifying the issues and concerns surrounding computer implementation with a sample of educators across a school board for both elementary and secondary levels. The individual survey information provided an initial glimpse of who is implementing computer technology. The open-ended survey questions and the focus groups provided a wealth of data indicating the barriers and supports that

educators currently deal with and provided suggested actions for the future. The rich set of qualitative data provides the emphasis and affect that is just not available from a forced-choice, pre-determined set of questions.

The focus groups provided a forum for the educators themselves to hear about computer implementation in other schools, both success and failures. It was an opportunity for them to contribute their own recommendations and requests to the larger picture across the school board. There were several instances of individuals receiving advice from and being offered solutions for computer problems by fellow participants during the discussions.

The investigation was, admittedly, an initial exploration of what appears to be a complex, multi-faceted process. However, analysis of the results led to the framework outlined in Figure 2 that details the individual and environmental factors that need to be considered in the successful implementation of computers in education. From this framework, policymakers and administrators can begin to develop recommendations for successful integration of computers within their schools. Future research will use the framework to begin to identify the variables, both personal and environmental, that contribute to positive computer implementation and how those variables might interact in the context of classrooms.

The information obtained through this research is directly applicable to the "real context" of education and is a beginning step in the dissemination of practitioner knowledge using a scientific base. The framework for more detailed future investigation is founded in the working environment of educators rather than an artificial intervention project removed from the day-to-day influencing factors that educators face.

Limitations and Future Research

Although this sample of educators included both male and female elementary and secondary educators from a cross-section of grades, subjects, and schools, the randomness of the sample may have been hindered by difficulties in contacting and obtaining consent from secondary educators. It is possible that the secondary educators who were contacted and agreed to participate are more representative of those who are comfortable with computer technology than the general population of secondary educators. Although participants were told that the focus groups were intended to capture all views regarding computer technology, and experience with or support for computers was not required, it is not guaranteed that those educators not comfortable with technology were equally inclined to participate. The elementary panel was much easier to contact and did include participants who were admittedly not "computer experts".

The quantitative portion of this study was limited in the scope of measures in that a small number of questions were used to measure some complex concepts, such as integration. In several cases, aggregated measures were used to compensate for single question measures. Future research would expand on measures, for example, to identify exactly how and how much computers are integrated within the classroom.

This research was intended to develop a foundation for continuing investigations into specific barriers to and supports of computer implementation. The importance of individual characteristics and comfort with technology identified here suggests that research examining individual educators who have successfully overcome barriers may be a next step. Although several environmental barriers were identified, this study does not allow for the interpretation of the likely interaction between individual characteristics

and environmental factors. A larger scale survey addressing the issues emphasized by these educators would allow comparison of the characteristics and environments of educators who are successfully integrating technology.

The issues and emphasis identified through these discussions with educators may not be specific to the implementation of technology. It would be informative to investigate how educators approach other educational changes. In this case, there was no comparison to the implementation of another school reform. If technology is considered simply another reformation in education, school change research may need to be considered together with the factors specific to computer implementation.

In another direction, support for more specific, applied interventions could be gained from the results of this study. Training programs for educators directed at increasing comfort with technology and improving technical support should be implemented and evaluated for their effects on computer integration. Policy work should focus on overcoming environmental barriers and building supports that work together with individual factors to build a successful implementation appropriate for all students.

In conclusion, the cooperation and honesty of the educators involved in this research were essential for providing an understanding of the barriers they face when given the challenge of integrating computer technology within the curriculum. The acquired knowledge and experience of these practicing educators can serve as an important database for future educational research and for future policy considerations. Finally, this study highlights how including the educator's voice substantially enriches our knowledge of the front-line issues involved in the integration of computer technology in the classroom.

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Table 1

Affirmative Responses to "Yes/No" Questions Regarding Computer Use, Access and Integration

Question	Elementary	Secondary	Total
Computer Use Section			
1. Do you have a computer at home?	94.6	94.1	94.4
2. Do you, yourself, use the computer at home? If yes, do you use it for:	91.9	94.1	92.6
a) personal use	91.9	94.1	92.6
b) school-related tasks	94.6	94.1	94.4
3. Do you have computers in:			
a) your classroom	45.9	58.8	50.0
b) a lab at your school	83.8	94.1	87.0
c) the library resource centre	91.9	100.0	94.4
d) pod work areas	24.3	58.8	35.2
4. Do your students use a computer(s) in:			
a) your classroom	40.5	64.7	48.1
b) a lab at your school	78.4	82.4	79.6
c) the library resource centre	67.6	88.2	74.1
d) pod work areas	5.4	17.6	9.3
5. Do you, yourself, use computers at school? If yes, do you use them for:	86.5	100.0	90.7
a) personal use?	32.4	52.9	38.9
b) school related tasks?	86.5	100.0	90.7

Table 1 continued

Affirmative Responses to "Yes/No" Questions Regarding Computer Use, Access and Integration

Question	Elementary	Secondary	Total
6. Do you have access to computers outside of those at home and/or at school?	27.0	35.3	29.6
8. Have you participated in professional development workshops on any topic in the past three years?	97.3	94.1	96.3
12. Are you aware of a school computer plan?	18.9	5.9	14.8
Your Views Section			
2. Do you believe in the integration of computer technology for children in your division?	97.3	100.0	98.1
3. Does the school support the integration of computer technology for:			
a) yourself as an educator	89.2	94.1	90.7
b) students	86.5	94.1	88.9
6. Do you implement computer technology in the classroom?	70.3	100.0	79.6
7. Do you see computers as:			
a) an integrated part of the curriculum?	81.1	94.1	85.2
b) stand alone activity?	48.6	35.3	44.4

Table 2

Variables Included in Aggregated Measures Used In Regression Analyses

Aggregated Measure	Survey Questions Included
Aggregated integration	Your Views: questions 2, 7, 11
Aggregated access	Computer Use: questions 1, 3, 6
Aggregated use	Computer Use: questions 2, 5
Aggregated comfort	Computer Use: questions 10, 11
Aggregated support	Computer Use: question 12 Your Views: question 3

Table 5

Frequency of Responses to "In what other forms of professional development do you engage?"

	Elementary		Secondary	
Category	Frequency	%	Frequency	%
Discussion with Colleagues	26	24.6	11	31.4
Conferences	25	21.2	11	31.4
External Sources	20	16.9	6	17.1
In-school Workshops	18	15.3	0	0.0
Courses	10	8.5	2	5.7
General Workshops	8	6.8	3	8.6
Board Workshops	8	6.8	2	5.7
Others	3	2.5	0	0.0
TOTAL	118			

Table 6

Frequency of Responses for Explanation of "Does your school support the integration of computer technology for yourself as an educator and for students?"

	Elementary		Secondary	
Category	Frequency	%	Frequency	%
School Supports Integration				
Supportive/Favourable Attitude	10	17.5	3	21.4
Accessibility for Students	8	14.0	5	35.7
In-service at School	8	14.0	0	0.0
Equipment and Resources	5	8.8	3	21.4
Knowledgeable Colleagues and Students	5	8.8	1	7.1
Organized Computer Committee	2	3.5	1	7.1
Other	2	3.5	0	0.0
School Does Not Support Integration				
Lack of equipment/problems	8	14.0	1	7.1
Lack of expertise	5	8.8	0	0.0
Rapid change	2	3.5	0	0.0
Limited time	2	3.5	0	0.0
TOTAL	57		14	
No Response	6		4	

Table 7

Frequency of Responses to "Does the integration of computer technology fit within your personal instructional approach(es)/orientation(s)? (Explain)"

	Elementary		**Secondary**	
Category	Frequency	%	Frequency	%
Yes	18	48.6	12	70.6
Tool to complement teaching	12	48.0	8	50.0
Provides variety, learning styles	6	24.0	1	6.3
Attitude/Motivation	4	16.0	1	6.3
Allows for independent work	3	12.0	1	6.3
Up to Date information/research	0	0.0	5	31.3
Conditional	12	32.4	4	29.4
Need resources/equipment...	5	50.0	2	50.0
Depends on task, children...	3	30.0	2	50.0
For play	1	10.0	0	0.0
Low priority	1	10.0	0	0.0
No	7	18.9	0	0.0
Teacher doesn't feel trained	4	28.6	0	0.0
Can't replace human interaction	4	28.6	0	0.0
Insufficient equipment, unreliable...	4	28.6	0	0.0
Too much support required	2	14.3	0	0.0

Table 8

Frequency of Responses to "Given an ideal world, please outline how you envision computer technology within your classroom/educational program (feel free to indicate whether or not computer technology would be part of that ideal world)."

	Elementary		Secondary	
Category	Frequency	%	Frequency	%
Accessibility—Classroom	23	25.3	5	16.1
Human Resources/Support for instruction...	14	15.4	1	3.2
Use a computer as a tool/enhance instruction	13	14.3	7	22.6
Equipment and Supplies/Computers...	10	11.0	4	12.9
Accessibility—Pod/Lab	8	8.8	3	9.7
Integration across curriculum	7	7.7	1	3.2
Accessibility—General	5	5.5	7	22.6
Information Resources	4	4.4	2	6.5
Time to share/Plan	4	4.4	0	0.0
Individualized learning/special education	3	3.3	1	3.2
TOTAL	91		31	

Table 9

Frequency of Responses to "What currently enhances your implementation of computer technology in your classroom?"

	Elementary		Secondary	
Category	Frequency	%	Frequency	%
Human Resources	23	24.5	6	16.2
Access—Lab	17	18.1	6	16.2
Student Characteristics	9	9.6	4	10.8
Software	9	9.6	2	5.4
Teacher Characteristics	7	7.4	0	0.0
Not Enhancing	7	7.4	0	0.0
Teacher Education	6	6.4	3	8.1
Access—General	3	3.2	3	8.1
Access—Classroom	3	3.2	4	10.8
Internet Access	3	3.2	4	10.8
Technical Support	3	3.2	2	5.4
Access—Library	2	2.1	2	5.4
Hardware	2	2.1	0	0.0
Financial Resources	0	0.0	1	2.7
TOTAL	94		37	

Table 10

Frequency of Responses to "What currently inhibits your implementation of computer technology in the classroom?"

	Elementary		Secondary	
Category	Frequency	%	Frequency	%
Hardware Limitations	20	17.4	9	20.5
Lack of Time	18	15.7	4	9.1
Lack of Knowledge	14	12.2	0	0.0
Insufficient Number of Computers	10	8.7	5	11.4
Access—in the classroom	8	7.0	0	0.0
Access—in the lab	8	7.0	4	9.1
Curriculum Expectations	8	7.0	1	2.3
Human Resources	7	6.1	3	6.8
Software	6	5.2	2	4.5
Financial Resources	5	4.3	7	15.9
Lack of Resources	4	3.5	1	2.3
Physical Environment	3	2.6	0	0.0
Internet/Network Access	3	2.6	4	9.1
Student Characteristics	1	1.0	4	9.1
TOTAL	115		44	

Table 11

Frequency of Responses to "What could happen to make your current situation closer to your ideal?"

	Elementary		Secondary	
Category	Frequency	%	Frequency	%
Education and training	23	25.6	4	10.5
Equipment and software	22	24.4	11	28.9
Computers in the classroom	12	13.3	3	7.9
Time for planning, sharing ideas	8	8.9	1	2.6
Technicians	5	5.6	1	2.6
Funding	5	5.6	10	26.3
Reduced Expectations	5	5.6	1	2.6
Attitude, direction	4	4.4	4	10.5
Computers in the lab	3	3.3	2	5.3
Special education	2	2.2	0	0.0
Documents	1	1.1	0	0.0
Applied Use	0	0.0	1	2.6
TOTAL	90		38	

Table 12

Frequency of Responses to "When you are planning a lesson/unit, what factors make you decide to integrate the use of the computer?"

Category	Elementary Frequency	%	Secondary Frequency	%
Characteristics of the Lessons/Process	22	24.7	14	43.8
Access to and Availability of Computers	20	21.5	7	21.9
Time	13	14.0	4	12.5
Software	13	14.0	1	3.1
Human Resources	9	9.7	0	0.0
Curriculum Expectations	6	6.5	4	12.5
Teacher Characteristics	5	5.4	2	6.3
Student Characteristics	4	4.3	0	0.0
Doesn't consider computer integration	1	1.1	0	0.0
TOTAL	93		32	

Table 13

Frequency of Themes at Content Level

Themes and Sub-Categories	Percentage of Coded Blocks Elementary	Secondary
Support Issues	37.4	35.1
Material Resources	48.0	69.6
Human Resources	28.5	19.6
Training and Professional Development	18.7	5.8
Administrative and Parental Support	4.7	4.9
Teacher Level Issues	31.1	29.5
Philosophy/Pedagogy	46.5	56.9
Skills and Characteristics	30.9	21.3
Curriculum	18.8	19.7
Digital Divide	3.8	2.1
Context and Access Issues	11.5	10.2
Access	55.2	76.9
Context	44.8	23.1
Student Level Issues	10.1	12.9
Motivation, Skills and Characteristics	65.7	84.1
Digital Divide	24.5	7.3
Sabotage	9.8	8.5
Computer Hardware, Software Problems	7.9	9.7
Malfunctions and Problems	48.8	53.2
Compatibility	33.8	16.1
Pace of Change and Outdated Equipment	17.5	30.6
External Issues and Other Priorities	2.0	2.7
Corporate Programs	45.0	23.5
Community Resources/Skills	35.0	0.0
Textbooks	20.0	76.5

Table 14

Frequency of Themes at Affect Level

	Percentage of Total Number of Coded Blocks	
Theme	Elementary	Secondary
Complex	38.0	30.1
Complex: Positive	19.2	14.7
Complex: Negative	18.8	15.4
Neutral	31.2	34.0
Negative	21.9	24.0
Positive	9.0	11.9

Note: Percentages listed for Complex: Positive and Complex: Negative combine to create the total for Complex theme.

Table 15

Frequency of Content Themes In Complex: Positive Affect Theme

Content Theme	Elementary	Secondary
Support	**43.8**	**42.6**
Material Resources	51.8	80.0
Training and Professional Development	23.5	7.5
Human Resources	22.4	10.0
Administrative and Parental Support	2.4	2.5
Teacher Level Issues	**40.2**	**44.7**
Philosophical and Pedagogical Issues	67.9	64.3
Skills and Characteristics	23.1	26.2
Curriculum Issues	7.7	9.5
Digital Divide	1.1	0.0
Student Level Issues	**6.7**	**7.4**
Motivation, Skills and Characteristics	100.0	100.0
Context and Access Issues	**6.1**	**4.3**
Access	58.3	50.0
Context	41.7	50.0
External Issues and Other Priorities	**3.1**	**1.1**
Corporate Programs	50.0	0.0
Community Resources/Skills	33.3	0.0
Textbooks	16.7	100.0

Table 16

Frequency of Content Themes In Complex: Negative Affect Theme

Content Theme	Elementary	Secondary
Support	**38.9**	**38.8**
Material Resources	39.2	60.5
Human Resources	32.4	21.1
Training and Professional Development	18.9	13.2
Administrative and Parental Support	9.5	5.3
Teacher Level Issues	**21.6**	**25.5**
Skills and Characteristics	46.3	32.0
Curriculum Issues	26.8	36.0
Philosophical and Pedagogical Issues	22.0	32.0
Digital Divide	4.9	0.0
Computer Hardware, Software Problems	**13.7**	**19.4**
Malfunctions and Problems	46.2	42.1
Compatibility	34.6	31.6
Pace of Change and Outdated Equipment	19.2	26.3
Context and Access Issues	**13.7**	**7.1**
Access	53.8	57.1
Context	46.2	42.9
Student Level Issues	**11.1**	**9.2**
Motivation, Skills and Characteristics	61.9	66.7
Sabotage	23.8	11.1
Digital Divide	14.3	22.2
External Issues and Other Priorities	**1.1**	**0.0**
Corporate Programs	100.0	0.0

Table 17

Frequency of Content Themes In Neutral Affect Theme

Content Theme	Elementary	Secondary
Support	**36.8**	**27.6**
Material Resources	54.3	63.3
Human Resources	29.3	28.3
Training and Professional Development	12.9	0.0
Administrative and Parental Support	3.4	8.3
Teacher Level Issues	**28.6**	**31.3**
Philosophical and Pedagogical Issues	40.0	69.1
Skills and Characteristics	28.9	13.2
Curriculum	21.1	13.2
Digital Divide	6.7	4.4
Context and Access Issues	**13.0**	**13.8**
Access	51.2	86.7
Context	48.8	13.3
Student Level Issues	**10.8**	**16.1**
Motivation, Skills, and Characteristics	47.1	85.7
Digital Divide	47.1	8.6
Sabotage	5.9	5.7
Computer Hardware, Software Problems	**7.9**	**7.8**
Malfunctions and Problems	44.0	35.3
Compatibility	44.0	11.8
Pace of Change and Outdated Equipment	12.0	52.9
External Issues and Other Priorities	**2.9**	**3.2**
Community Resources/Skills	44.4	0.0
Corporate Programs	55.6	28.6
Textbooks	0.0	71.4

Table 18

Frequency of Content Themes In Negative Affect Theme

Content Theme	Elementary	Secondary
Support	**33.0**	**34.6**
Material Resources	43.8	75.5
Human Resources	28.8	15.1
Training and Professional Development	20.5	3.8
Administrative, Board, Parental Support	6.8	5.7
Teacher Level Issues	**28.9**	**19.6**
Skills and Characteristics	35.9	16.7
Curriculum	29.7	60.0
Philosophical and Pedagogical Issues	29.7	23.3
Digital Divide	4.7	0.0
Context and Access Issues	**14.9**	**11.1**
Access	57.6	76.5
Context	42.4	23.5
Computer Hardware, Software Problems	**13.1**	**17.0**
Malfunctions	55.2	73.0
Compatibility	24.1	7.7
Pace of Change and Outdated Equipment	20.7	19.2
Student Level Issues	**8.6**	**13.1**
Motivation, Skills, and Characteristics	68.4	75.0
Sabotage	15.8	10.0
Digital Divide	15.8	15.0
External Issues and Other Priorities	**1.4**	**4.6**
Textbooks	66.7	100.0
Community Resources	33.3	0.0

Table 19

Frequency of Content Themes In Positive Affect Theme

Content Theme	Elementary	Secondary
Teacher Issues	**45.1**	**30.3**
Philosophical and Pedagogical Issues	70.7	78.3
Skills and Characteristics	19.5	17.4
Curriculum	9.8	0.0
Digital Divide	0.0	4.3
Support	**34.1**	**43.4**
Material Resources	45.2	69.7
Human Resources	32.3	21.2
Training and Professional Development	22.6	9.1
Student Level Issues	**16.5**	**14.5**
Motivation, Skills, and Characteristics	80.0	100.0
Digital Divide	20.0	0.0
Context and Access Issues	**4.4**	**9.2**
Access	75.0	71.4
Context	25.0	28.6
External Issues and Other Priorities	**0.0**	**2.6**
Corporate Programs	0.0	100.0

Appendix A

Individual Survey

Descriptive Information:

Age: _____ Sex: male female

Total number of years teaching: _____

Number of years teaching: _____ primary
(Circle current division) _____ junior
_____ Intermediate
_____ senior

Highest level of education: _____ Secondary
_____ Secondary plus teacher's college
_____ Secondary plus some Post-Secondary
_____ College Diploma
_____ Undergraduate Degree
_____ Master's Degree
_____ Doctorate Degree

Computer Use:

1. Do you **have** a computer(s) at home? Yes No

2. Do you, yourself, use the computer at home? Yes No
   If yes, do you use it for a) personal use? Yes No
   b)school related tasks? Yes No

3. Do you have a computer(s) in
   a) your classroom Yes No
   b) a lab at your school Yes No
   c) the library-resource centre Yes No
   d) pod work areas Yes No

4. Do your students use a computer(s) in
   a) your classroom Yes No
   b) a lab at your school Yes No
   c) the library-resource centre Yes No
   d) pod work areas Yes No

5. Do you, yourself, use the computers at school? Yes No
   If yes, do you use it/them for a) personal use? Yes No
   b) school related tasks? Yes No

6. Do you have access to computers outside of those at home and/or at school? Yes No

7. On average, how much time do you spend working on a computer per week? (please estimate number of minutes or hours and indicate with min. or h.)

   At School_____ At Home_____ Other_____

8. Have you participated in professional development workshops on any topic in the past three years? Yes No
   If yes, how many of these workshops were related to computer use? (estimate) ____

9. In what other forms of professional development do you engage? (Please list, for example-- conferences, online training, talking with colleagues, videos/journals etc.).

10. In general, how at ease do you feel using computers (Circle one number)?

1	2	3	4	5
Very At Ease		Neutral	Very	Ill At Ease

11. In general, how enthusiastic do you feel using computers (Circle one number)?

1	2	3	4	5
Very Enthusiastic		Neutral	Not	At All Enthusiastic

12. Are you aware of a school computer plan? Yes No Don't Know

    If yes, was your school plan devised
    a) collaboratively with teachers and the administration
    b) independently by some teachers
    c) independently by the administration
    d) Other_____

Your Views:

1. Please identify the approach(es) that you take to instruction?

1. a) If you identified an approach or a combination of approaches in question one--- could you please describe one activity/learning environment and use that to demonstrate how this approach (these approaches) translates into practice.

2. Do you believe in the integration of computer technology for children in your division? Yes No

3. Does your school support the integration of computer technology for

   a) yourself, as an educator Yes No
   b) students Yes No
   Explain briefly:

4. Does the integration of computer technology fit within your personal instructional approach(es)/orientations?

5. Given an ideal world, please outline how you envision computer technology within your classroom/educational program (feel free to indicate whether or not computer technology would be part of that ideal world).

6. Do you implement computer technology in the classroom? Yes No

7. Do you see computers as
   -- an integrated part of the curriculum? Yes No
   -- a stand-alone activity? Yes No

8. What currently enhances your implementation of computer technology in the classroom?

9. What currently inhibits your implementation of computer technology in the classroom?

10. What could happen to make your current situation closer to your ideal?

11. When you are planning a unit, do you assume that computer use by students will be part of your instructional plan?

1	2	3	4	5
Never		Sometimes		Always

12 When you are planning a lesson/unit, what **factors** make you decide to integrate the use of the computer?

13. Identify one practical day-to-day example to demonstrate a challenge that you had using computer technology in your classroom?

14. Identify one practical day-to-day example to demonstrate a positive experience that you had using computer technology in your classroom?

Appendix B

Telephone Consent Script

Hello, My name is _____. I am a Research Assistant with the Psychology Department at Wilfrid Laurier University. I am calling you today as one of 60 other teachers who were randomly selected to participate in focus groups discussing computer technology in the classroom. Do you have a few moments for me to tell you some details?

Approval for this project has been obtained from Laurier, the Board of Education Research Committee, and your principal. This study is a collaborative effort including researchers at Laurier, Western, Brock, and the CATC group at the Board.

We want to know what you and other teachers think about computers in the classroom. We are asking you to join with about five other teachers to come and talk to us about your impression of computer technology. We would like to understand when, where, and why computers do or do not fit within the classroom. We have noted that very few studies have actually asked teachers whether they use computers in the classroom, how they use them if they do, and what they think about the role of computers in education. If you participate, you would be helping us to understand the perspective of teachers on this important topic.

Your participation is completely anonymous. The focus group and survey data will be handled only by researchers at the university and no one at the board will have access to your responses. We should mention that the focus groups will be audio and videotaped. This is to allow the researcher to listen to the discussion rather than immediately writing down everything that you are saying. That means that you can talk a comfortable pace and we will not lose any of your important contributions. Just so you know, once the tapes are transcribed, they will be destroyed.

We can give you more information about the study, but first we would like to know if you would be willing to participate. A replacement teacher will be provided for you for half of a day to allow you to come to the Education Centre to complete a short survey and participate in the focus group.

Thank you (if yes, time was scheduled) or thank you very much for your time (if no).

(Confirmation number for replacement was given)

Appendix C

Example of Written Confirmation Letter

Dear

We would like to thank you for agreeing to participate in the focus groups being conducted as a joint venture between the Board of Education (CATC group) and Eileen Wood (Wilfrid Laurier University), Teena Willoughby (Brock University) and Jacqueline Specht (Huron University College). The topic of discussion for the focus groups will be computer technology. The discussion will take about forty-five minutes of your time preceded by a short survey. I look forward to seeing you there. If you need any further information, please do not hesitate to contact me at (519) 884-0710 extension 3738 or Julie Mueller at extension 2950.

Eileen Wood, Ph.D.

Date: Tuesday, May 22
Time: 1:00 p.m.
Place: Education Centre, Ardelt Dr., Kitchener
Room: Elmira Room (adjacent to the board room)
Reference Number for Replacement: S359