HOW ELEMENTARY SCHOOL TEACHERS USE COMPUTERS WITH THEIR STUDENTS IN THE ONE-COMPUTER CLASSROOM

by

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ABSTRACT

The purpose of this study was to discover how the single classroom computer is being used by elementary school teachers with their students in one school district in British Columbia. Questionnaires were completed by 89 respondents, resulting in a response rate of 71%. In-depth interviews were conducted on a sample of 16 of those respondents. Some of the variables investigated included the personal background and data of teachers, the hardware and software details of their single classroom computer, how they integrated the computer into the curriculum, student computer use and factors impacting the use of the computer. The study found that single classroom computers are being used for a variety of purposes. Games and word processing were reported to be used most frequently in the classroom. Teachers also identified a number of factors that affected the use of the computer. Those factors included issues of time, adequate and reliable hardware and software and training needs. The conceptual framework on which the study's findings were examined was Fullan's (1991, 1992) theory of curriculum implementation and change. Fullan's factors of clarity, complexity, quality/practicality and need were considered in interpreting the results of this study. The findings in the present study were consistent with Fullan's contention that change is multidimensional and difficult to implement. The data suggest that the single classroom computer at the elementary school level faces a number of challenges to its implementation. Finding the time and opportunities to learn about their classroom computers, as well as gaining access to upgraded hardware and current software are among the challenges teachers face in their efforts to implement the single classroom computer.

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CHAPTER I

INTRODUCTION

> Over time, it seems likely that the pattern of use of technology in schools will be set as much by people who have not yet embraced computers as by people who are now enthusiastic proponents. If for no other reason than this, there is a need to understand teachers' use of computers in terms of the daily requirements of teaching. How teachers use computers needs to be understood against the backdrop of everyday routines. Classroom routines are not what computers will replace, they are where computers must fit if they are to be useful to teachers. (Olson in Riffel & Levin, 1997, p. 57)

In 1995, a survey was conducted in British Columbia (B.C.) schools to identify trends in educational technology in the province. The report determined that although "there is more hardware and software available now than was the case four years ago . . . the distribution still varies widely across the province" (B.C. Ministry of Education, 1995a, p. 26). Given this finding, and the expenditures involved in equipping computer labs and classrooms with technology, it becomes important to consider how teachers are using the varied, and in some cases, limited resources that are available to them where computer hardware and software is concerned. It is equally important to establish the factors that influence the use of the computer by teachers with their students. The same survey revealed some of the in-service priorities teachers reported as affecting computer usage. They included needs such as learning to use telecommunications, integrating specific software into the curriculum, dealing with educational change

and the role of technology and even learning basic skills to operate a computer. There are, however, a host of other variables that can factor into teachers' decisions regarding the use of computers. The purpose of this study is to examine how teachers with a single computer in their classroom are using that technology with their students in one school district in British Columbia, and what factors serve to facilitate that use as well as hinder it.

Background Information

> The key to successfully implementing Information Technology K to 7 lies not in teaching it as a separate subject, but in using it to enhance student learning in other curricular areas. . . . Teachers should be aware of information technology tools and their effect on their lives, their students' lives, and on society in general. (British Columbia Ministry of Education, Skills and Training, 1996, p. G-3)

As an elementary school teacher with one computer in my classroom, as well as access to a computer lab, I have seen first-hand some of the issues and logistics involved in using a single computer with students. I am aware of the time, effort and training required for one to use a computer with children. The B.C. Ministry of Education's (1995a) technology survey suggests that although computers continue to be placed in classrooms and computer labs, the ability of teachers to use them effectively with their students remains a primary concern for teachers. These concerns, together with a review of the literature on the subject, have led me to this study.

A review of the literature which supports computer use in classrooms and computer laboratories reveals some of the positive effects of computers on students (Butzin, 1992; Dwyer, 1994; Gregoire, Bracewell & Laferriere, 1996; Underwood & Underwood, 1990). Poy (1992a), for example, found that "the most readily observed impact of the computers . . . was the positive effect on children's attitudes towards learning" (p. 12). However, Poy does not define either "attitudes" or "positive". Similarly, Bergin, Ford and Hess (1993) concluded that using a classroom computer with appropriate software was highly motivating to young children. Students' time on task was also very high when classroom computers were used. Mandinach and Cline's (1996) data on the impact of a technology-based curriculum innovation on teaching and learning concluded that positive effects on students' cognitive and motivational processes were found among middle and high school students. Additional studies have indicated that motivation is higher when using technology than in traditional approaches to teaching and learning (Guthrie & Richardson, 1995; U.S. Congress, Office of Technology, 1995).

A large-scale longitudinal study (Project CHILD) conducted in the United States, evaluated the effects of technology in classrooms on student achievement. This study, which spanned a period of over five years, found that "standardized test scores indicated a positive and statistically significant result across all grades, schools and subjects with the largest effects appearing for students who had been in the program for more than one year" (Wellburn, 1996, [on-line]). Another longitudinal study of substantial size was the Apple Classrooms of Tomorrow (ACOT) project that introduced computers into classrooms. Mehlinger (1996) noted that "ACOT classrooms showed more evidence of spontaneous

cooperative learning than did traditional classes" and that "students were taking more responsibility for their own learning" (pp. 404-405). Neither the Project CHILD or the ACOT study's paramount objective was the improvement of test scores, but rather, according to Wellburn (1996) the development of higher order skills was the primary focus. Based on these studies, she concluded that "the most recent research indicates that interactive, self-directed learning and higher order thinking can be fostered by technology and that technology can have the greatest benefit when the environment is conducive to such experiences" (Wellburn, 1996, [on-line]).

Mehlinger (1996) has also described some of the significant findings of the Software Publishers Association (SPA) study which looked at 176 research projects on educational technology from 1990 to 1995. In that study, technology was credited with having made (a) a significant impact on success in all subject areas; (b) positive effects on student attitudes; (c) instruction more student-centred; and (d) promoted cooperative learning. Such observations lend further support for the positive impacts associated with the use of technology with students. And in a documentary review of the literature on new technologies and student learning at the elementary and secondary levels conducted jointly by the Laval and McGill Universities, the following observations were made: "the benefit to students of using new technologies is greatly dependent, at least for the moment, on the technological skill of the teacher and the teacher's attitudes to the presence of technology in teaching;" and "this skill and this attitude in turn are largely dependent on the training the teaching staff have received in this area" (Gregoire, Bracewell & Laferriere, 1996, [on-line]).

This review also detailed a number of studies that have established the positive impacts of technology on students. Among them were Wallis' 1995 study that found that student reasoning skills were enhanced following the use of a particular piece of multimedia software. "The findings were very favourable to the students who had used the software. In fact, they were found to be twice as skilled as the control group at developing and defending an explanation based on data." (in Gregoire, Bracewell & Laferriere, 1996 [on-line]) In addition, a study by Jones in 1994 of grade two students using word processing software to improve writing skills, yielded results that concluded that students wrote longer entries than students in a control group who utilized paper and pencil (in Gregoire, Bracewell & Laferriere, 1996). And a New Zealand study concluded that using computer technology led to greater learning in English, math and science when relying on English, math and science exams. "The participating students performed significantly better on the Certificate examinations than students who had not participated in this project." (McKinnon, Nolan & Sinclair in Gregoire, Bracewell & Laferriere, 1996, [on-line])

The nature of the discussions surrounding the use of computers and its impact on students is perhaps best exemplified by Hadley and Sheingold (1993) when they state that,

> Underlying the incorporation of computer-based technological innovations into education has been the widespread hope that technological innovations will qualitatively improve student achievement—that they will facilitate the kind of learning and thinking that will prepare all students for productive lives. For the most part, the

> "quick fix" beliefs that heralded the incorporation of personal computers into schools more than a decade ago have been appropriately given up, as it has become clear that technology's impact is slow in coming, challenging to access, and a function of, among other factors, how it is interpreted and used. What we need to understand, then, is the complex of circumstances that surround the use and incorporation of technologies over many different examples, and how these are related to a variety of outcomes that are of interest. (p. 263)

While the number of studies that have examined the effects of technology use on students are plentiful, studies on the effects of the single classroom computer on teaching and learning are far fewer in number. Riel (1989) introduced a single computer to four separate classrooms to determine the effect on classroom organization, student/teacher interactions and student learning. An examination of the literature on this specific subject reveals that empirical research is largely absent.

Advocates of the use of technology in education maintain that computers can enhance learning, that mastery of technology is essential to future skills and employment and that productivity is in effect improved when using computers. It is important to keep in mind, however, Ely's (1995) observation that,

> The jury is still out on student achievement because most studies have focused on use of the hardware and have not asked the "right" questions about the software and how it has been used, the type of learner who is using it, and the appropriateness for attaining certain

> curricular objectives. For the most part, teachers are puzzled because: (1) they are unsure how to use technology; (2) they question why they should use it; and (3) they do not know where to place it in the curriculum. (p. 7)

Hence, the study contained in this presentation will assume the positive influences of computer use on education overall as much of the current literature on technology's impact has been positively correlated with student outcomes. As Wellburn (1996), in looking at the review of the literature on the educational effects of technology has commented:

> Although there might not yet be a definitive conclusion since it is becoming apparent that the type of learning that technology best enhances is difficult to quantify. . . . there are many research reports that indicate we now have a deeper understanding of how to maximize the benefit to learners through a variety of technology-rich educational environments. (Wellburn, 1996, [on-line])

The Purpose of the Study

This study was intended to gather data about the variety of ways in which elementary school teachers are using one computer in their classrooms with their students. In addition, this research was intended to determine what factors contribute to the use of the single computer in the classroom. The results of the study will indicate what teachers are currently using a single classroom computer for when working with their students. Riffel and Levin (1997) have characterized attempts to examine computer usage in classrooms as follows:

> It is hard to predict what the outcomes will be. How computers can be used well by teachers is a pressing concern, and this will go beyond simply retraining teachers (a priority for 90 percent of the respondents to our survey). It seems likely that integrating computers into teaching and learning will require many teachers to change. The task is not simply one of putting computers in every classroom and then providing in-service education to teachers, although these are certainly important. The really crucial task seems to be the development and communication of a view of classroom life in which the potential of technology and the most important aspects of teaching complement rather than compete with each other. (p. 57)

In addition to addressing the practical aspects of teaching with a single classroom computer, the theoretical aspect of such an examination is contemplated. The theory of implementation adopted in the present study is that of Michael Fullan. This study's findings will reveal whether or not Fullan's theory is supported by the data collected in this project.

A subset of questions raised included:

1. What factors are preventing or hindering the use of the single computer in the classroom?
2. What are the varieties of uses of the single computer?
3. What do teachers need in order to use the single computer with their students?

4. Is there a gap between what teachers use the single computer for and what it is actually capable of?

5. Is there a difference in usage between primary (Kindergarten to grade three) and intermediate (grades four to seven) classrooms?

6. Are there differences in usage among males and females (both students and teachers)?

7. Does a teacher's familiarity with a home computer affect the use of a computer in the classroom with students?

This study will show how the single computer was being used in the elementary school classroom and it will identify the factors that can be attributed to creating differences in the use of the single computer. A survey research methodology was employed to undertake this task, using questionnaires and semi-structured interviews as a means of collecting data.

Significance of the Study

Findings such as those of the B.C. Ministry of Education's (1995a) survey of technology use seem to indicate that despite the availability of technology, if those educators who have access to it are not both comfortable and adept at using the technology, it may be underutilized. In a similar vein, Chin and Horton (1993) report that,

> Teachers can no longer feel adequately competent merely by knowing how to run a computer, or by knowing how to use different software programs to assist instruction and management. They are expected to integrate its use into the curriculum and have the ability to explore the

> multifaceted applications such as hypermedia, multimedia and telecommunications to support their teaching. Most of all, they are expected to keep themselves updated in knowledge and skill, and be held accountable for preparing their students for the future. They are expected to be more autonomous and independent in the use of instructional technology. (p. 90)

It is important, therefore, to determine how the single computer is being used with students among those teachers who are comfortable with technology, as well as those who are less comfortable with it. Research indicates that teachers put computers to a wide variety of uses (B.C. Ministry of Education, 1995a; Nicol & Butler, 1996; O'Donnell,1996; Sheingold & Hadley, 1993; Ungerleider, 1997). An individual computer within the classroom, therefore, might be used for games, for word processing, for research databases, for internet surfing, as a remedial tool for special needs or ESL (English as a second language) students, as a reward activity for those who complete work in a timely manner or as an enrichment tool for those children who need a challenge. Such uses may be juxtaposed with situations in which the computer remains neglected and/or infrequently used. The reasons behind a computer's use or neglect, and the kinds of uses it is being put to, may reveal some of the inadequacies of current efforts to integrate technology into the classroom, as well as into the curriculum.

Theoretical Significance

Technology is a relatively recent addition to elementary school curricula and like the introduction of any new curriculum, its integration requires considering the

factors that impact on the implementation of that change or innovation. Werner and Taylor (1989) commented that,

> The ultimate goal of curriculum implementation is the improvement of the delivery of instruction and the facilitation of student learning. The focal point is on the student, while the key agents in implementation are the teachers. Teachers determine the extent to which a change actually takes place by what they do or do not do in their classrooms. No two teachers will implement in exactly the same way. They will modify the curriculum in light of their individual subject matter perspectives, beliefs concerning how children learn best, perceptions about particular student needs, and many other classroom-related factors. . . . To be insensitive to the views of teachers about implementation and disrespectful of the complexities of their role is to court disappointment. (p. 8)

A study of the use of technology, therefore, has definite connections to the study of change. Using technology in education, and more specifically in the classroom, represents a significant change in classroom routines and practices of late. As Fullan (1991) contends, real change in schools is difficult to accomplish and requires certain circumstances in order to occur. One might then ask what conditions are required in order for change to take place? As Fullan (1991) has observed, there is often a gap between the innovation and actual practice. In order to influence change, therefore, some understanding of the change process itself and how it affects the innovation needs to be secured.

There are three primary perspectives of change theory and implementation (W. Werner, personal communication, July 8, 1997). The first of these three views of change is that of the multifactor perspective, with which Fullan (1991, 1992) is most readily identified. The multifactor perspective of change looks at the factors that lead to successful or unsuccessful change. It is considered the most optimistic of the three theories. Consideration of the factors involved in change and making meaning of a change are central to this particular notion of change that continually asks how change can happen.

The second perspective of change is that of the workplace or institutional cultures view. This theory examines the norms of the organization or workplace which are frequently seen but unnoticed or not articulated. Therefore, it is the assumptions and beliefs that are shared among those of the workplace or institution which are paramount in explaining why change is so difficult. The third most cited theory of change is that of the phenomenological or interpretive theory of change which focuses on the individual/the user and how change is experienced from the individual point of view.

Given that Fullan's thesis is (a) central to the multifactor view of change; (b) that the multifactor perspective is the one most commonly used by researchers of change; (c) that this perspective readily lends itself to planning for change; (d) that it considers numerous factors that impinge on change; and (e) because it is an inherently optimistic and positive view of change (W. Werner, personal communication, July 8, 1997), it has been chosen as the theory on which to frame this study. As one author has commented, "Fullan's (1991, 1993) work on

educational change is some of the most comprehensive and useful for those involved in encouraging and facilitating change" (Willis, 1993, p. 31). It is then, factors such as the ones Fullan contemplates, that can be taken into account when examining the implementation of an innovation or change. Fullan himself maintains that "single factor theories of change are doomed to failure" (Fullan, 1992, p. 26).

The Ministry of Education's School District Planning of Curriculum Implementation document acknowledges that there are a number of factors that impact on the degree of success implementation achieves when it states that,

> Throughout British Columbia, one of the best known lists of factors affecting implementation comes from the work of Fullan. . . . This list of very general factors is based upon research literature on curriculum implementation from across North America. . . . Interaction among these factors adds to the complexity of change, so it is important that as many of these factors as possible are judged to be supportive of implementation. (Werner & Taylor, 1989, p. 8)

Although the number of factors that Fullan has described and the labels he has given them have varied slightly over the years, the factors referred to for the purposes of this study are taken from Fullan's (1991) model which include the following nine factors: A. Characteristics of change (1) need, (2) clarity, (3) complexity, (4) quality/practicality; B. Local characteristics (5) district, (6) community, (7) principal, (8) teacher; and C. External factors (9) government and other agencies.

Fullan believes that one of the rationales for focusing on implementation in any attempts to effect a change is to "understand some of the reasons why so many educational innovations and reforms fail" (Fullan, 1992, p. 22). He also maintains that "the implementation perspective, if understood deeply and authentically, can be a powerful resource for accomplishing real improvements in classrooms and schools" (p. 22). It is with this in mind that Fullan's multifactor theory was chosen as the basis on which to examine the change in practice (i.e., using the single classroom computer) that is the subject of this research. An examination of these factors, he claims, is essential if the intended outcome is to be achieved. Particular attention will be given to what Fullan has termed the "characteristics of the innovation" which include need, clarity, complexity and quality/practicality. Although there are nine factors in Fullan's theory, it is the first four that are the most important because one needs to make meaning of these or the change will not be implemented (W. Werner, personal communication, July 8, 1997). The logic is, therefore, that if one or more of the factors are working against the implementation of the innovation, the process and outcome will be less effective. In other words, the more factors supporting implementation, the more change in practice will result (Fullan, 1991).

Fullan himself undertook a case study of the implementation of microcomputers in a Canadian school. His premise was that in trying to implement a change, success will be contingent on how the change affects the practices (new teaching strategies or activities); beliefs (pedagogical assumptions and understandings and theories underlying particular policies or programs); and materials (instructional resources, curriculum materials or technologies) of those involved

(Fullan, 1992). "The tasks of learning about hardware, software, classroom management and integration with the curriculum will present teachers with a severe problem of overload; we can expect that it will take a long time before many teachers are engaged in 'quality use'" (p. 55). Furthermore, "the implementation perspective forces us to confront what is actually happening in practice" (Fullan, 1992, p. 22).

It is the multidimensional quality of change that Fullan believes is often neglected. His premise is that in any attempts to implement a change, an additional three dimensions (beliefs, practices and materials) are also affected because,

> they represent the means of achieving a particular educational goal or set of goals. . . . the change has to occur in practice along the three dimensions in order for it to have a chance of affecting the outcome. . . . It is clear that any individual may implement none, one, two, or all three dimensions. (Fullan, 1991, p. 37)

As Fullan maintains that all three aspects of change need to be considered in any efforts to implement an innovation, many of the questions in both the questionnaire and the interview used in the present study revolved around the elements of beliefs, practices and materials and the use of the single classroom computer.

> Many innovations entail changes in some aspects of educational beliefs, teaching behaviour, use of materials, and more. Whether or not people develop meaning in relation to all three aspects is

> fundamentally the problem. . . . The point is that educational change programs have an objective reality that may be more or less definable in terms of what beliefs, teaching practices, [sic] and resources they encompass. (Fullan, 1991, p. 41)

The thrust of Fullan's premise then is that changes in actual practice in terms of the dimensions of materials, practices and beliefs are crucial to whether or not the intended outcome is achieved. They form a system of variables that interact to determine success or failure.

Werner (1988) conceptualizes Fullan's thesis when he states that,

> Researchers have found that there are many factors that facilitate the teacher's implementation work. Some of these factors are related to the context of the school or the school district, whereas others represent characteristics of the innovation itself. . . . Program developers often forget about the multidimensional nature of change: a change of students [sic] materials may require a teacher to change his or her teaching practices, evaluation strategies and even beliefs about the classroom. (p. 4)

And Werner (1988), like Fullan, believes that "the most important role within program implementation is the teacher's. If the teacher does not use the program, implementation will not occur" (p. 3).

The three dimensions that Fullan refers to are believed to be the most problematic where implementation is concerned as they revolve around what teachers do, as well as what they think. Dealing with innovation, therefore, becomes a matter of altering these three elements. In essence, our knowledge of change theory can help us to understand the phenomenon of implementing computers. It is the multifactors of change, as well as the additional three components of beliefs, practices and materials that have been considered in this research. The components of change have been represented in a diagram adopted from Fullan (1992) and this diagram appears in Appendix A.

Like Fullan (1992) in his case study of the implementation of microcomputers in Ontario, this study aims to use the implementation perspective to analyse what teachers are telling us are the factors involved in their efforts to implement the use of the single computer in their classrooms. Fullan's (1992) study revealed that "current visions of the potential for NET (New Educational Technologies) in education vastly underestimate how difficult it will be for teachers to implement the changes . . . in practices, materials, beliefs and skills" (p. 55). It is the intention of this study then to focus on two aspects of Fullan's implementation perspective on change. Firstly, the materials, practices and beliefs that are affected in attempting to use a single computer in the classroom have been considered in the development of both the questionnaire and the questions that guided the interview. Secondly, the factors that facilitate and hinder the teacher's use of the single classroom computer with students will be categorized based on Fullan's multifactors, with a particular focus on the factors of need, clarity, complexity and quality/practicality.

Practical Significance

"There are no studies that asked a broad spectrum of classroom teachers what their specific needs are for integrating computers into the classroom". (O'Donnell, 1996, p. 16) By undertaking this project, it is my intention to shed light on what is occurring in the single computer classroom in terms of usage and factors impacting that use, as well as to discover some practical classroom suggestions that are helpful to teachers in using the single classroom computer. It seems crucial, therefore, to build upon what is already working well (and determine why), if educators are to provide instructional uses for the single classroom computer. This study has implications then for educational practice, as teachers search for ways to integrate the computer into the day-to-day curriculum in a variety of subject areas.

O'Donnell (1996) has criticized studies dealing with the integration of computers into the classroom for neglecting the role of the teacher. She comments that:

> Until now, the research base has reflected primarily two kinds of evidence. The first consists of small-scale case studies in a number of schools and classrooms where technology has been introduced. . . . Other small-scale case studies have tracked practices and impacts that result from classroom environments that are richly endowed with computer-based technologies. Typically these cases have involved unusual amounts of both technological and human resources . . . In sum, although these case studies provide detailed and encouraging examples of the process and outcomes of technological innovation in a few unusual circumstances, they do not tell us much about schools and

> classrooms that have neither been the subject of such attention or had access to such resources. (p. 263)

It is important, therefore, to consider in what areas teachers require further training and what can be attributed to their varying levels of expertise and interest.

In an examination of the literature, it is apparent that the issue of teacher training and technology is a recurring theme for discussion. One of the needs identified by B.C.'s Ministry of Education (1995a) report of technology in schools was to provide teachers with the training needed to help them in incorporating technology into daily learning. Similarly, the Ministry's Report and Action Plan on technology (1995b) concluded that "many teachers have little or no background or training in the use of information/education technology. Teachers require a specialized skill set that allows them to integrate technology into everyday classroom learning activities" (p. 11). Hadley and Sheingold's (1990) study revealed that it took an average of five to six years for teachers to achieve an adequate comfort and confidence level with using computers in their classrooms. Underwood and Underwood (1990) maintained that "it is increasingly apparent that new in-service training goals need to be set. Teachers need to develop not only competence but they also need guidance on how to integrate the computer into the curriculum" (p. 16). And Zammit (1992) concluded that,

> in the history of computers in schools it has been easier to approve expenditure to purchase equipment than to pay for time to enable teachers to develop their knowledge and expertise. . . . It is inappropriate to expect teachers to undertake such fundamental and

> critical professional development completely in their own time while, at the same time, it is crucial that teachers should be able to base their decision as to whether to use computers in their teaching on knowledge rather than allowing ignorance to colour their thinking. (p. 65)

Given the number of studies citing the litany of factors that hinder as well as facilitate the use of technology, it becomes important to find the commonalities among such research in terms of factors that effect use, in the hopes of discovering recurring themes in the implementation of computers in education. The Ministry of Education is requiring teachers to "have an awareness of the technological capabilities available in the school" and tells us that "the rapid rate of change in information technology makes it especially important for teachers to keep updating their skills in this area" (B.C. Ministry of Education, Skills and Training, 1996, p. G-4). The newly prescribed information technology curriculum makes it apparent that it has become the responsibility of teachers to use technology to further both computer skills and education skills among their students. What is not apparent, or widely known, is what teachers are using the single computer in the classroom for and what factors are impacting that use.

Current dialogue

Clouse (1991) has characterized the changing configurations of computer placements in schools as having come "full circle." He describes computers as having first been placed in individual classrooms. As more computers were acquired in schools, computer labs came to dominate placements. The trend now, he maintains, is to bring computers back into classrooms. In recent years there

has been much debate as to whether placing computers in computer laboratories or in classrooms will yield the greatest benefits to students. Maddux, Johnson and Willis (1997) found that "computer labs are still a popular approach to placing computers in schools, but we believe the long-term success of computers in education depends on widespread use of computers as teaching and learning tools in individual classrooms" (p. 101). Others have come to similar conclusions (Fraundorf, 1997; Johnson, 1997; Murphy & Thuente, 1995). Poy (1992a) concluded that "most teachers held the view that in Primary, it was very important to have the computers in the class to support the integration of the computer with class activities and to give more flexibility in meeting the needs of the individual student" (p. 32). Similarly, Johnson (1997) has noted that,

> It becomes obvious to all computer users that a few minutes or even a few hours per week at a computer in a computer lab or resource center will bring little integration of computers to the curriculum. . . . The full potential of the computer as a teaching and learning tool will not be realized unless the computer is in the classroom and is an integral part of the teaching and learning process. (p. 3)

O'Donnell (1996) has observed that "so much time is consumed in moving the class to the lab that there is not enough instructional time left to conduct quality instruction" (p. xii). Given the debate on the subject and current trends cited, it becomes essential to consider how the computer is being used in the classroom.

Assumptions, Delimitations and Limitations of the Study

> As it should be clear . . . it is not possible to design and conduct the "perfect" research study in education. . . . Therefore, it is incumbent on the researcher to recognize and discuss the limitations of a study. (Mertens, 1998, p. 345)

As the population to be studied in this research represents but one of many school districts in the province of British Columbia, results will be reflective of only that particular population. Secondly, the study will reflect only the circumstances of those who complete the questionnaire, not those who don't. It is conceivable, therefore, that only interested teachers may have completed the questionnaire or agreed to be interviewed. Thirdly, with respect to the pilot study, because questionnaires were, in many cases, electronically mailed to volunteer participants, a certain amount of technological literacy may be presumed given these teachers' access to and use of this form of telecommunications. Fourthly, the data collected is based on self-reports and as such, its accuracy is difficult to establish. There is, however, no reason to believe that respondents weren't able and willing to give truthful answers to the questions asked of them. Fifthly, as the data were analyzed I discovered that adequate or consistent definitions for such terms as novice, intermediate and expert computer users may not have been provided. Consequently, some respondents may have classified themselves inaccurately. And finally, an assumption made of this study is that computers are by and large positive influences on education and students in general and that overall they represent favourable influences on schooling.

Definition of Terms

Throughout this research, a number of terms may be used that require definitions for ease of understanding. The following definitions (with the exception of "implementation" and "innovation") are those used by Geisert and Futrell (1995). The two exceptions are definitions borrowed from Fullan (1992).

Database: "A logically connected collection of information usually in a form that can be manipulated by a computer. It is commonly designed and organized in a consistent manner so as to be of value to a wide variety of users." (p. 313)

Desktop publishing: "Using microcomputer software and a printer to lay out and produce pages of text and graphics." (p. 313)

Drill and practice program: "A type of computer assisted instruction software in which the computer engages a learner in a sequence of exercises characterized by response elicitation and evaluation." (p. 314)

Graphics: "Visual material such as pictorial images, designs, or graphs displayed on a screen or as hard copy." (p. 314)

Implementation: "Implementation focuses on what happens in practice. It is concerned with the nature and extent of actual change, as well as the factors and processes that influence how and what changes are achieved." (Fullan, 1992, p. 21)

Innovation: "a new or revised curriculum, a policy, a structure an idea—is something that is new to the people encountering it for the first time" (Fullan, 1992, p. 22).

Multimedia: "Term connoting the capability of producing text, color pictures, sound, and motion video, perhaps in combination." (p. 317)

Peripheral: "A device connected to a computer, typically located outside the computer's housing and attached by a cable." (p. 318)

Scanner: "A device that uses light to scan images (text, graphics, marks, bars, or characters) and send the information to a computer in a form it can use in a program." (p. 318)

Simulation: "In software, using the computer to feign a real-world situation in which variables are changed. The computer program mathematically models a process or represents the behaviour of a system as the user varies selected conditions." (p. 319)

Spreadsheet program: A type of application program used for number processing and designed primarily for displaying numerical data.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Research on the subject of computer usage and its impact on students has yielded a variety of results. How computers are being used has been examined from the classroom perspective, but more frequently from the standpoint of a computer lab situation. Issues of time, software and hardware reliability or adequacy together with concerns about training, support and teacher interest and knowledge have recently been discussed in the literature. Current debates have focused on the advantages and disadvantages of computer labs versus computers in classrooms. Together these studies have provided evidence of the multidimensional nature of change which is the focus of the present study. The following is a review of the literature regarding the use of the computer among teachers as well as a review of the literature on implementing an innovation or change.

Research on Using Computers in Elementary Schools

Schofield (1995) has pointed out that "computers often do not live up to their promise because no one shows teachers how to integrate their new technology into their instruction or, sadly, into their students' learning processes" (Schofield in Caverly, Peterson & Mandeville, 1997, p. 56). Maddux, Johnson and Willis (1997) cite the American Office of Technology Assessment's 1988 and 1995 reports that found that a lack of training remains a key factor in the use of technology by teachers. Numerous other studies have drawn conclusions as to the factors that

influence the use of technology with children (Evans-Andris, 1994; Hadley & Sheingold, 1993; Mandinach & Cline, 1996; O'Donnell, 1996).

In 1992, Zammit looked at factors that teachers perceive as hindering or facilitating their beginning computer use in labs in schools in Australia. Factors that encouraged them to begin to use computers included access to computers, software availability and self-motivation to keep up to date. Factors that inhibited use were identified as, computer room access, not enough computers for individual student use, not enough time to review software and software quality. In the case of Project CHILD (one of only a handful of large-scale longitudinal studies) the effects of computers in classrooms were examined. This five year study of kindergarten to grade 5 classrooms found that "lack of sufficient quantity of classroom equipment, lack of training for teachers and the inherent difficulty of retrofitting technology to the existing structures of education combine to keep computers confined to the back of most classrooms, expensive distractions at best" (Butzin, 1992, p. 51).

Time

That time was a major barrier to computer use was a recurring theme in much of the literature reviewed for this project. (Becker, 1994; Chiero, 1997; Poy, 1992a; Sheingold & Hadley, 1993). Poy (1992a), for example, discovered that teachers "grappled with trying to balance the time demands of integrating computers in Primary with their already heavy time commitments in teaching" (p. 40). Means and Olson (1995) also determined that lack of time was the most frequently cited hindrance to technology use. Nicol and Butler (1996) drew a similar conclusion when they stated that,

> As with other demands placed on teachers, time is a controlling factor. Teachers do not have the time to explore a program fully in order to thoroughly master it. As a result, few teachers appear to make full use of the software ordered by the school and many programs simply gather dust on the shelf. (p. 26)

Strudler's (1996) study of technology coordinators' opinions as to barriers for teachers implementing technology included time, the difficulty for teachers to partake in staff development, and the scarcity of equipment, both hardware and software. Sheingold and Hadley (1993) concluded that "there is not enough time for teachers to prepare computer-based lessons, nor enough time in the school schedule for computer-based instruction, and there are problems scheduling enough computer time for different classes" (p. 282).

Chiero (1997), in seeking insights into teachers' perspectives on the use of technology and the factors that facilitate and hinder their use, found that the obstacles to non-instructional uses of computers included a lack of time to learn to use the software, lack of training, the absence of technical support and outdated equipment. Training in fact is another frequently reported barrier to use.

> Teachers listed lack of training, limited access to hardware, lack of interest by teachers, fear of failure, lack of knowledge about integrating technology into the curriculum, teachers already burdened with many things to do, and fear of the innovation as barriers to acceptance and

use. Each of the barriers identified by teachers posed a threat to successful implementation. (Hope, 1995, p. 162)

Technical Issues

Teacher confidence is another factor that has arisen from surveys of computer usage (O'Donnell, 1996). Technical assistance and on-site coaching were key factors requested by teachers in Poy's (1992b) evaluation of elementary schools and technology. She also found that "on-going support in inservice and hardware needs were recognized as two critical areas" (Poy, 1992b, p. 43). Ham (1997) came to similar conclusions in his New Zealand study on a professional development program in the use of information technologies that attempted to gain an understanding of the practical issues surrounding the integration of technology. He found that "most problems the teachers faced were technical or systemic" (p. 67).

Cost

Zammit (1992) is quick to point out that the obstacles to computer use are often affected by financial constraints.

> Adequate funding can give teachers both the opportunity and the time to practice, learn and assess options offered by a fast-changing technology. However, in the history of computers in schools it has been easier to approve expenditure to purchase equipment than to pay for time to enable teachers to develop their knowledge and expertise. This situation continues despite the obvious and well-known fact that acquisition of the best equipment is not a guarantee that it would be

> used, let alone used to best advantage, unless the personnel has the training to use it effectively. (p. 65)

Sheingold and Hadley (1993) also cited financial support as a major administrative barrier to computer use.

Uses of the Computer

That there is a changing landscape in the use of technology in education has been acknowledged by Willis (1993) who states that,

> Hardware choices, general software compatibility, and computer literacy training are minor rather than major points on the topography of the field today. The major educational information technology issues today are related to instructional strategy issues, software appropriateness, the stages of the training and support process, and conditions needed to create self-sustaining communities of technology-using educators. (p. 31)

In addition to studies that have examined the factors influencing the use of computers, research has documented the variety of uses for computers in both classrooms and computer labs. Among the accomplished computer-using teachers in Hadley and Sheingold's (1990) study, word processing was reported to be used the most frequently with students; drill and practice type software ranked second in use; and tutorial applications placed third in order of use. As well, they found that a number of barriers existed regarding the use of computers. In this case, two of the significant factors that led to the success of the teachers

involved was their motivation and commitment and the support and colleagiality they experienced. Such results, however, can only be applied to those teachers who already possess a relatively high level of computer literacy.

Classroom Computers Versus Computer Labs

A frequently debated point that has arisen from various studies on the use of computers in education is the question as to whether classrooms or computer labs are the most appropriate environments for housing computers. Murphy and Thuente (1995) claim that:

> For technology to become part of an active learning centre for students, hardware should be placed in the classroom rather than a computer lab so that students do not have to leave the classroom for computer time. They will then be more likely to view the computer as a learning tool rather than as a special object they visit occasionally. (p. 8)

Those who advocate placing computers in labs cite a number of advantages for doing so. Among them are cost effectiveness, the ability for a whole class to engage in use simultaneously and access by all students (Fraundorf, 1997). Fraundorf comments that "in spite of the advantages (of computer labs) . . . recent studies advocate dismantling labs and distributing all computers into individual classrooms" (p. 51). The disadvantages of labs have included issues of scheduling and separation from classroom routines (Geisert & Futrell, 1995). Some of the advantages Fraundorf cites are the ease of integration into the curriculum and increased access. Those who support the use of computers in individual classrooms contend that stability and flexibility of use prevails (Geisert

& Futrell, 1995) and students come to see the computer as a learning tool that is part of their daily activities (Murphy & Thuente, 1995). Individual classroom distribution, however, has been associated with some disadvantages as well. These include concerns over isolation from other computer-using teachers and lack of computing power to achieve certain tasks (Geisert & Futrell, 1995). The debate is likely to continue, but if those who have predicted a trend towards distributed models of computer placement are correct, the need to examine computer use in classrooms becomes even more imperative.

Surveys of Current Practice

The positive impacts of technology on primary children have been documented by Poy (1992a). In this study conducted in 12 B.C. schools, technology was found to have a positive effect on attitudes towards learning and sense of accomplishment; it also resulted in fewer discipline problems, increased the exchange of information between students leading to learning from each other, contributed to ease of writing and editing and built confidence levels. Despite these findings, the Ministry of Education's (1995a) survey of technology usage in British Columbia schools found that "in general, computers are not highly integrated into day-to-day learning activities" (p. 3) at the elementary school level. What this survey did not reveal is why this was the case. O'Donnell (1996) came to similar conclusions when she said that, "many studies on computer use by teachers indicate that, although computers are widespread in schools, their use by classroom teachers is not widespread" (p. 17).

A number of studies has been done in British Columbia regarding the use of computers in schools. Poy (1992a, 1992b), for example, looked at how primary

teachers implemented and used computers in both computer labs and individual classrooms. More recently, the B.C. Ministry of Education (1995a) conducted a survey of technology in education in an effort to identify current trends in usage and practice. In addition, Ungerleider (1997) surveyed K-12 teachers as to their teaching practices, use of resources and confidence in teaching with technology. He found that "regardless of the grade levels at which they teach . . . teachers use a variety of teaching practices and resources" (p. 33). Moreover, he determined that technology was used most frequently for the preparation of student worksheets and for writing. He also concluded that,

> Among the obstacles to more frequent use is the absence of adequate technology, equipment which does not support current software, hardware and software which does not function properly, lack of familiarity with hardware and software, inadequate preparation for the use of hardware and software, and too little time to practice, apply, and assess the effectiveness of hardware and software. (p. 33)

The Ministry of Education (1995b) concluded that,

> B.C. elementary schools report that writing, publishing and word processing (WPWP) is the highest use computer application in the classroom today—other applications receive low use, and in general, computers are not integrated very much in day-to-day activities. (p. 5)

Nicol and Butler (1996), in an examination of the use of computers in B.C. elementary schools, concluded that,

> It would be easy to blame the teachers for failing to make use of whatever technology is available to their students. . . . for many teachers the promise of the technological evolution is little more than an overwhelming pressure in what they see as an already overloaded curriculum. . . . the potential of computers in education, as envisioned by computer literate educators, is far beyond the understanding and expertise of many classroom teachers. To expect these teachers to make full use of computer technology is rather like assuming a child can run a marathon because he or she has learned to take those first faltering steps. (p. 26)

This same study found that "computer use by students is often limited to drills or producing 'good' copy of a previously handwritten and corrected story" (p. 27).

A report by Sheingold and Hadley (1990), summarized the results of a nationwide survey of American teachers who were accomplished at incorporating computers into their teaching. "One of the most striking results of this study is the number of different uses, or practices, teachers report" (p. 7). This study, however, only looked at what accomplished teachers were experiencing and not what teachers of varying levels of computer literacy were undergoing. In the United States, Becker (1991) conducted a survey of over 1,400 schools to uncover school and teacher practices using computers in both classrooms and in computer labs. He found that, in general, computers were being underutilized. When computers were being used, word processing was used most frequently. However, greater proportions of time were being used to learn the software itself rather than in

using the application for a particular instructional assignment or product. O'Donnell's (1996) survey of computer usage among teachers found that the subject areas in which computers were being utilized most often were in math, writing and reading and that using the computer to supplement instruction was the second most popular use of the computer by teachers with their students.

While numerous other studies have looked at computer usage in both labs and classrooms (Butzin, 1992; Mathinos & Woodward, 1988; Nicol & Butler, 1996) others have focused exclusively on computers in lab settings (Zammit, 1992). Far fewer in number are those researchers who have examined computer usage in classrooms alone (Mandinach & Cline, 1996; O'Donnell, 1996; Sheingold & Hadley, 1993). A review of the literature clearly illustrates the need to look not only at the use of computers in classrooms but more specifically, at the use of the single computer in the classroom.

Wellburn (1996) has commented that "studies of technology in the classroom have tended to focus rather narrowly on very specific learning outcomes. Also, such studies rather frequently forget. . . to take into account the need for ongoing support to the teachers." Underwood and Underwood (1990) reported that "while teachers may value the computer *per se*, when faced with it in the classroom they simply don't know what to do with it" (p. 16). Findings such as these lend further support for the study of the single classroom computer.

Implementing a Change or Innovation

"The implementation perspective warns us that we need to think through the change process and address the key factors known to impact on the likelihood of

success" (Fullan, 1992, p. 57). Consistent with Fullan's notions of change is O'Donnell's (1996) computer usage survey findings that determined that, "change is necessarily a slow process because, before altering teaching practices, and beliefs must be altered" (p. 28). She further contended that,

> The degree of integration achieved and the time required for teachers to learn how to fully utilize computers in the classroom is dependent upon the perceived beliefs of the teacher concerning computers and their use in instruction. . . . Beliefs are not changed quickly. However, the perceived beliefs of the teacher will guide and drive the teacher toward the goal of computer integration. (O'Donnell, 1996, p. 52)

Riffel and Levin (1997) also concluded that "it takes time for technology to be accommodated to existing practices, and even longer for existing practice to change so as to take advantage of the new potential of the technology" (p. 51). Their examination of the results of four case studies of school districts in a Canadian province attempted to explain the varying degrees of implementation in the use of technology when they stated that,

> Over the last ten years school districts have invested a lot of time, energy, and money in computer technology and the in-service education of teachers, and the number of classrooms and curricular areas in which computers are used is growing. Still, it seems that information technology is at best adjunct to education, not yet integrated into people's thinking about teaching and learning. (Riffel & Levin, 1997, p. 51)

Henry Becker's (1994) study of how exemplary computer-using teachers use technology concluded that five particular categories of implementation need to be considered in implementing technology. They include time for teachers to plan and develop applications for use, the presence of on-site assistance, access to appropriate hardware and software, attention to curriculum and instruction issues and teacher training. Mandinach and Cline (1996) identified participation in and commitment to an innovation as the additional issues of concern to teachers. O'Donnell (1996) established that,

> the majority of teachers who are utilizing computers in their instruction have not fully integrated them into the curriculum but have only incorporated the computer with little change in actual curriculum and classroom strategies. . . . Effective and innovative computer use in classrooms can be found, but it is rare. (p. 3)

Mandinach and Cline (1996) also discovered that teachers who are implementing the innovation require computers dedicated to their personal use. In order to become better versed and acquire a higher degree of comfort with the computer, teachers were found to need greater access to the hardware. They further determined that the availability of a technical support person to maintain equipment, provide advice and troubleshoot and support the software was also required. Poy's (1992a) study concluded that "teachers found it important to have time to play with and explore the various capabilities of the computer in order to gain ease and comfort with it" (p. 41). Poy's study also ascertained that lack of adequate access to hardware was a limiting factor to the use of computers.

Hope (1995) has summarized the literature on the implementation of computer technology as falling into five main categories that need to be looked at in any effort to support the likelihood of teachers' adopting the use of technology. Those five factors include ease of implementation (complexity), access to technology, collaboration, training and time. Willis (1993) summarized the literature on barriers to technology use among teachers including issues of complexity, isolation, time for exploration, ownership, administrative support and technical support. The factors that Nicol and Butler (1996) concluded would facilitate the use of technology with elementary children were hardware in good working order, collaboration among teachers and the creation of outlines of assignments and examples of student work detailing the software used and how it was used. Evans-Andris (1995) has concluded that studies on the use of computers with children fail to examine the subtleties of how teachers negotiate technical change. She observed that studies "show that teachers demonstrate varying behaviours associated with computer technology, ranging from overt resistance to aggressive embracement" (p. 16).

The descriptions of computer use and the factors impacting that use in the studies discussed illustrates the difficulty of effecting significant educational change where technology is concerned. Williams and Williams (1994) concluded that, "schools adopting and implementing curriculum changes have too little time to spend gaining an appreciation of the factors that determine successful change . . . therefore such innovations in the past have proven to be unsuccessful" (p. 201). Current findings have documented many barriers to full-scale, sustained integration of technology into the curriculum. Lack of time for teachers, lack of

adequate staff development and on-site support, and lack of access to current hardware and software were all cited as major impediments to technology integration.

That change is not an easy task is perhaps best illustrated by Hope (1995) who claims that,

> Change is an important feature of the restructuring efforts that are taking place at the school level in the attempt to improve education. The process involves the diffusion of a specific innovation in schools, the acceptance of the innovation by teachers, and the delineation of appropriate strategies and techniques for implementing and integrating the innovation into education practice. (p. 3)

As the change process accompanies any attempt to implement an innovation, in this case the single classroom computer, it is intended that this study will provide some insights into the multidimensional nature of the implementation of the single classroom computer. Research has shown that there is a myriad of factors that hinder as well as facilitate teachers using technology in the classroom. Providing teachers with the time, tools, training, resources and providing them with the strategies to integrate technology into instruction is no mean feat. This study intends to shed light on the factors that make the implementation of the single classroom computer more likely and what factors contribute to impeding that implementation.

The Speculative Aspect of the Literature on the One-Computer Classroom

In the 1980s, some authors speculated on the benefits of having only one computer in the classroom. Wainwright and Gennaro (1984) for example, contend that "a single microcomputer can mean higher student motivation, greater classroom flexibility and more time for you to spend teaching in the ways you do best" (p. 63); while Watson (1988) claims that, "having the computer in the classroom instead of the lab gives a direct connection between the regular curriculum and the data used on the computer. . . . using one computer for the whole class can foster a spirit of teamwork and cooperation" (p. 21). In the 1990s, the emphasis in the literature has shifted from discussions on the benefits of the single computer to how to use one computer in the classroom (Dockterman, 1995; Kahn, 1996; Robinette, 1996). Despite these anecdotal accounts as to what the single computer is capable of, there is little empirical research about what teachers of varied computer skill levels are actually doing with the single computer in their classroom. Much of the existing literature on the subject of the single computer in the classroom amounts to testimonials by computer-using educators.

A Gap in the Literature

An exploration of the literature on the subject of the one-computer classroom has included a search of the ERIC computerized database and books, as well as a survey of scholarly journals including (but not limited to): the Journal of Research on Computing in Education, Educational Research, the Journal of Curriculum Studies, the Journal of Educational Technology Systems, the Journal of Educational Computing Research, the Journal of Technology Education and

Educational Technology Research and Development. Upon examining journals of a more non-empirical nature such as Learning and Leading with Technology, Educational Leadership, Learning and Instructor, it is apparent that although there is an abundance of journal articles on the subject of the use of computers in the elementary school in these publications, much of it can be categorized as anecdotal and not empirical in nature. Much of what currently exists reflects the opinions of teachers, software producers and other educators who provide a narrow slice of classroom life based on personal experiences. Such an absence of scholarly writing on the subject furthers the need to bridge the gap between what is being written on the topic of the single computer classroom.

Concluding comments

> We have learned that benefits do not happen in some miraculous way simply because the technology has been provided. Research indicates that to accomplish the profound changes associated with the integration of technology in the overall learning environment, there is a real need for training and support at all levels (Wellburn, 1996).

The B.C. Ministry of Education, Skills and Training (1996) has recognized the need for students to gain some level of computer literacy by prescribing curriculum on the subject of technology. Such an acknowledgement has come in the form of the Information Technology K to 7 Integrated Resource Package. Given this mandate, British Columbia teachers are now expected to integrate technology into their classrooms, be it a computer lab or the classroom itself, as well as into the curriculum. Despite this addition to the curriculum, the conditions and resources required to teach and implement that curriculum effectively are by

no means universal in their existence, but in fact vary widely among schools and school districts in B.C. (Ministry of Education, 1995a). Such unequal distribution can make instruction problematic. Even where computer labs are available, limited access may be the reality (Zammit, 1992). Such circumstances can be coupled with issues of non-use. The training of teachers who have access to computers is equally problematic (B.C. Ministry of Education, 1995a). Underwood and Underwood (1990), citing their own survey of teachers' attitudes to computers in schools, suggest that there is evidence that computers often go unused in classrooms. "There is a paradox here—on the one hand it can be argued that there are too few machines in the classroom and on the other hand research points to an under-utilization of the resource". (p. 16)

In 1988, Mathinos and Woodward observed that although national surveys (largely in the United States) were revealing the availability and teacher support of computers in schools, how computers were being used and integrated into the classroom and the curriculum was mostly a neglected area of study. Such an observation can, to a great extent, still be applied to today's studies on computers in classrooms. Marcinkiewicz (1994) concluded that "to understand how to achieve integration, we need to study teachers and what makes them use computers, and we need to study computers and what makes teachers want to—or need to—use them" (p. 188). This study is intended to add a piece to the puzzle of how computers are being used by teachers with their students and what factors influence that use, by investigating the one-computer classroom.

CHAPTER III

METHODOLOGY

Overview–Survey Research

This study is aimed at discovering and describing how elementary school teachers in one school district in the Lower Mainland are using the single computer in their classrooms with their students. In addition, the purpose of this study is to establish the factors that facilitate and hinder their using those same computers with the children in their classrooms. These factors are examined based on the theoretical framework provided by Fullan (1992) multifactor theory of curriculum implementation.

The Ethical Review Procedures required by the University of British Columbia were adhered to in devising this study. Upon approval by the ethical review committee, a certificate of approval was issued. This certificate can be found in Appendix B to this paper.

The method of inquiry chosen for this particular study is that of survey research. Survey research has been described in a variety of ways. Goodwin (1995) for example has defined it as "a structured set of questions or statements given to a group of people in order to measure their attitudes, beliefs, values or tendencies to act" (p. 343). Bordens and Abbott (1996) consider survey research to be "used to evaluate behaviour (past, present, future) and attitudes of participants" (p. 213). Dyer (1995) categorizes descriptive surveys as intending to "establish the features of a particular group to provide a description of the group in relation to some specific characteristics which it possesses" (p. 90). The definition

of survey research chosen to describe the methodology used in this research is that of McMillan and Schumacher (1993) who define it as follows:

> In survey research the investigator selects a sample of respondents and administers a questionnaire or conducts interviews to collect information on variables of interest. The data that are gathered are used to describe characteristics of a certain population. Surveys are used to learn about people's attitudes, beliefs, values, demographics, behaviour, opinions, habits, desires, ideas, and other types of information. (p. 279)

These authors go further to say that "in addition to being descriptive, surveys can also be used to explore relationships between variables, or in an explanatory way" (McMillan & Schumacher, 1993, p. 279). The focus of this survey research is largely descriptive in nature as it is deals with the present and the status of things as they currently exist (McMillan & Schumacher, 1993).

One researcher has deemed that,

> the hallmark of surveys is that the researcher presents specific questions or items (the survey instrument) to which people (the respondents) provide answers or reactions (the responses). Thus, surveys involve an exchange of information between researcher and respondent; the researcher identifies topics of interest, and the respondent provides knowledge or opinions about those topics. Depending upon the length and content of the survey as well as the

> facilities available, this exchange can be accomplished via written questionnaire, in-person interviews, or telephone conversations. (Dane in Colman,1995, p. 79)

The study that is the focus of the research contained in this project has employed the written survey as well as the face-to-face interview.

Several authors have included cautions when using survey research. Goodwin (1995) for example warns that careful consideration needs to be given to sampling procedures in survey-related research when attempting to make statements about a larger group of people based on information gleaned from a smaller number of participants. The sampling procedures in the present study will be described later in this chapter. In order to improve the validity of a study Goodwin (1995) insists that the sample possess qualities similar to the larger population from which they derive in order that they be representative of that larger demographic.

Further cautions on the use of survey research have included the fact that surveys are correlational and not causal; context may be neglected; complex answers may be placed into simple categories; the process by which people came to possess a certain behaviour or attitude may be neglected; and external forces rather than human consciousness may be given primacy (de Vaus, 1991; May, 1997). Social science researchers have, however, attempted to counter these arguments by advising us to pay careful attention to the design and measurement of any study and to conduct pilot work as a matter of course (May, 1997).

Questionnaire Development

In an effort to determine how the single computer is being used by teachers, with their students, in the elementary school classroom, I chose to gather information using a combination of interactive techniques including, questionnaires and interviews. Data collection on the subject population began in March of 1998, beginning with the questionnaire. Once questionnaires were completed and returned, interviews were conducted during the months of April and May. All data was gathered by the completion of the 1997-98 school year.

The questionnaire was developed based on Mertens' (1998) suggestions for questionnaire creation. Initially, a review of the literature was conducted in order to determine if an appropriate questionnaire for the purposes of this study had already been developed. No such questionnaire was deemed suitable for this research. The questionnaire was designed and refined largely using questions of my own creation, with the exception of four questions that originated from two other studies. One study was conducted by Mathinos and Woodward (1988). Questions B (5), D (2) and D (3) (Appendix C) of the present study were adapted from four of the questions asked in that 1988 project. Question A (10) was adapted from Sheingold and Hadley's (1990) study on computer-using educators.

At the outset, a variety of topics was considered for inclusion in the questionnaire. Among these topics were the categories of personal background, student computer use, hardware and software details, curriculum integration and factors influencing computer use. Subsequently, 32 questions were devised that revolved around these topics and these questions were later increased to the 36

that appear in the final questionnaire (Appendix C). Just as O'Donnell's (1996) survey of computer usage attempted to do: "each item on the questionnaire was directly associated with the specific area in which we wished to acquire information concerning the computer usage skills" (p. 74). Additional evidence of content validity can be found in the administration of the survey. Pilot respondents did not indicate any problems concerning understanding questions on the survey and the questionnaire responses from the actual study were anonymous so there was no reason to believe that the teachers were not completely honest in answering the questions on the survey (O'Donnell, 1996).

The appropriate degree of structure of the questions was also considered. Given the substantial number of questions arrived at, a decision was made to use a combination of both closed or structured and open format questions, with a weighting in favour of more closed format questions. It was my intention that by doing so, both breadth and depth to the investigation would be maintained. This decision was also made in order both to ease and to encourage completion of the survey. The intention was to allow as many questions to be asked without making completion unduly lengthy (Palys, 1997). Such a method of data collection is "particularly useful when one wants to cover a lot of ground . . . since one can ask many more structured than open questions in a given period of time" (p. 166).

Perhaps the best argument for incorporating some open-ended questions into a study comes from Palys (1997) when he contends that "when interwoven within a structured questionnaire, open-ended items can be a rich source of illustrative vignettes that . . . can provide material that helps the researcher interpret responses" (p. 165). Bordens and Abbott (1996) have also supported the use of

open-ended questions because of what they deem to be their potential to uncover a "richness of information." What was kept in mind, however, was the number of questions of this type that were used, as respondents may have become reluctant to complete questions that required great detail and data could have become unmanageable as so much information accumulated (Palys, 1997). Palys also considers open-ended questions to be advantageous because "respondents enjoy being offered at least a few chances to express matters in their own words" (p. 165). Bordens and Abbott (1996) also advocate the use of partially open-ended questions (i.e., responses that are defined but allow for the participant's own response category).The intent in the design of this instrument was to provide room for respondents to provide greater detail and express their own thoughts on particular subject matter. Questions of the closed variety were also chosen because responses can entail a standard form "making comparability among respondents easier" (Palys, 1997, p. 165).

Consideration was given to Mertens' (1998) cautions to avoid psychologically threatening questions, to strive for clarity, to avoid negatively worded questions as well as jargon and biased or leading questions and every attempt was made to not include items that asked about more than one idea. With respect to the format of this instrument, considerations of questionnaire attractiveness, an organizational style that made questions easy to answer, clear and succinct instructions, and laying out the questions in a logical sequence were all made.

According to several researchers (Bordens & Abbott, 1996; Goodwin, 1995; Palys, 1997; Whitley, 1996) the positive features of questionnaires are varied and

numerous. They include the qualities of efficiency, lesser expense, the ability to reach large numbers of respondents, respondent anonymity, access to widely dispersed samples, time for respondents to give thoughtful answers, the elimination of interviewer bias and less time needed for data collection. In this particular case, the questionnaire also provided a starting place for developing appropriate interview questions.

Researchers suggest that perhaps the least positive characteristic of the questionnaire is its potential for low return rates (Bordens & Abbott, 1996; Goodwin, 1995; Mertens, 1998; Whitley, 1996). Wherever possible, steps were taken to ensure a high response rate in order to make the sample more representative of elementary teachers as a whole. Bordens and Abbott's (1996) suggestions were followed of making personal contact with potential participants (questionnaires were personally distributed at staff meetings attended by me); ensuring participants of their anonymity (this point was stressed during my verbal presentation at staff meetings as well as in the cover letter that was included with the questionnaire); and providing a deadline for the return of questionnaires. The questionnaires were hand delivered for the study itself, in order to improve response rates and an inter-school mail system was used to return completed questionnaires to me. Providing a nonmonetary incentive in the form of a candy bar to those who volunteered to complete a questionnaire was an additional attempt to garner a higher return rate.

Given that the respondents were teachers, the element of timing around a school calendar was also contemplated. Questionnaire distribution was planned around many of the schools' second report card periods so as to avoid loading teachers

with an additional task to complete at a very busy reporting time. A large number of the questionnaires was also distributed well in advance of the week-long spring break so that teachers could either complete the questionnaires before the break or take them home with them for completion during the break. And finally, every effort was made to make the return of completed questionnaires as easy as possible. To this end, the questionnaires were distributed in an envelope that was addressed to me and could be returned through the inter-school mailing system provided by the school district. These last three efforts to improve response rates (nonmonetary incentives, timing and ease of return), were all strategies adopted on the recommendations of Mertens (1998). Mertens (1998) has maintained that a response rate of approximately 70% is acceptable. A response rate of 71% was achieved in the present study.

Goodwin (1995) remarks that among the less positive features of the questionnaire are its potential for ambiguity which results when a researcher is not present to clarify respondents' queries. The pilot study was intended to eliminate questions of ambiguity. Additional concerns of literacy and questionnaire vocabulary (Palys, 1997) were minimized by the presence of a pilot study as well. Palys (1997) has also warned that questionnaires limit data to what is on paper. Such a disadvantage was ameliorated through the use of interviews.

In-depth Interviews

"Many of the disadvantages of questionnaires are handled admirably by the interview" (Palys, 1997, p. 154). It is with this in mind that I chose the interview as a second method of data collection. A number of writers have cited the advantages of the interview which include its ability to reveal both verbal as well

as non-verbal behaviour; providing the interviewer with some ability to motivate the respondent; uncovering otherwise concealed attitudes, discovering personal details, attitudes and beliefs that might go undetected in a written survey; and rendering a higher response rate than written surveys (Dyer, 1995; Leong, 1996; Mertens, 1998; McMillan & Schumacher 1993; Whitley, 1996). Many of these authors recognize the major disadvantages to this means of data collection including the possibility of response and/or interviewer bias, the greater expense involved and the higher cost of time required to conduct interviews, as compared to some other forms of data gathering.

And while others have acknowledged that interviews can involve much expense and lead to interviewer bias, interviews are nonetheless credited with being more comprehensive and yielding greater detail than other forms of data collection (Bordens & Abbott, 1996; Goodwin, 1995; Mertens, 1998; Whitley, 1996). As well, interviews have the potential to allow for the clarification of any questions that are unclear. Bordens and Abbott (1996) contend that when respondents are getting the same questions and are allowed the chance to respond individually and in their own words, more complete and comprehensive data may result.

In order not to defeat the purpose of having a face-to-face interview, the interview questions were not structured around closed format types of questions (Mertens, 1998). Rather, open-ended questions were created that were considered for the questionnaire but were rendered inappropriate to a survey because of the potential depth of response that was required. Such in-depth responses would likely have escaped discovery as respondents would have been unlikely to provide such detailed answers in a written format and in fact may have been

discouraged from completing the questionnaires entirely. Given the in-depth nature of the questions, the interview afforded the opportunity to probe for greater detail than would have been gleaned from a written questionnaire, as Mertens suggests.

The interview questions used in this study can best be described as containing semi-structured questions as they did not entail having specific choices from which the interviewee could select a response. McMillan and Schumacher (1993) have defined the semi-structured interview question as being "an open-ended question but is fairly specific in its intent" (p. 251). Given that the interview questions included a number of predetermined open-ended questions and offered much room for individual responses, it could be said to be semi-structured in nature.

Interviews ranged from 25 to 90 minutes in duration. The data from the interviews were collected over a seven-week period. All of the interviews took place in the schools of the teachers involved and all were conducted in the participating teachers' classrooms with the exception of one interview which took place in a staff lounge. At times, interviews were briefly interrupted by other staff members, students, custodial staff or school broadcasting announcements. All data collected were transcribed by me into written records.

The Pilot Study

> The most important admonition is that you should always do a brief pilot study or trial run before going out and administering your research instrument "for real." There are always things you take for

> granted without recognizing and there are always surprises you never even considered when constructing the questionnaire. (Palys, 1997, p. 176)

The reliability, or the ability of this study to produce similar results if it were to be repeated (Bordens & Abbott, 1996), was given attention. In order to increase the reliability of this study, both the questionnaire and the interview questions were piloted. The pilot study was undertaken during the months of January and February, 1998. The pilot study of the questionnaire was undertaken, once again, using Mertens' (1998) recommendations. It was my intention to employ a global approach in the pilot study to sampling teachers who fit the profile of the one-computer classroom in order to sample a wider range of people and therefore, uncover a greater diversity of perspectives. The subjects for the pilot study were sought out by several means including e-mail networking, listserv postings on the internet and through my contacts in the educational community. The pilot sample included respondents similar to the population of the school district from which the final questionnaire would eventually be administered. The criteria for the inclusion of subjects in the pilot study were that they be teachers outside of the school district involved in the study itself, who teach in an elementary school one-computer classroom and who were willing to engage in a questionnaire via electronic mail, facsimile transmission or by means of traditional mail procedures. Subjects were drawn from school districts within Canada and the United States. With the exception of four teachers who taught at the high school level, all other participants were elementary school teachers. Approximately 34 questionnaires were distributed. Of those distributed, 24 completed questionnaires were returned by similar means. These questionnaires were then examined in an effort to

determine whether or not respondents clearly understood questions, if additional categories of responses were suggested and what respondents' general comments were regarding the survey. As Mertens (1998) has suggested, pilot respondents were instructed that there was an interest in their reactions to the questions and an effort was made to "encourage them to note any ambiguities or response options that are (were) not included" (p. 117).

Based on the results of this study, questions on the questionnaire were refined. To question B (2) was added the category of 0 minutes; Question B (7) was amended to include the words "on average"; and Question D (1) was revised to omit the category of art as it was believed that the category of fine arts incorporated art as well. Both the pilot questionnaire (Appendix D) and the final revised questionnaire (Appendix C) are included in this presentation.

Given that the pilot study was not a dry run of the study itself, but rather served as a data gathering means in order to refine questions for the proposed study, a different set of criteria were set to conduct the pilot study. The limits of this pilot study need to be acknowledged. They are as follows: (1) the method of gathering data was, in some cases, through electronic mail; (2) the population selected was not representative of those in the school district from which the sample of the actual study was drawn.

Interview questions were devised and refined by myself, based in part on the results of the questionnaire responses. Appendix E is a copy of the interview questions which were not revised from their original pilot version. Pilot interviews were conducted on approximately six respondents either in person or by

telephone. In four cases, the entire set of interview questions was used on these respondents while in other cases, only some of the questions were administered. Once again, Bordens and Abbott's (1996) suggestions were heeded in order to increase reliability where the questionnaires were concerned. The substantial number of items on the questionnaire, the standardization of administration procedures and the appropriateness to the sample involved were considered in order to establish reliability.

Data Collection

Initially, school principals were approached in the form of a letter (Appendix F) personally issued to them through the school district's electronic inter-school mailing system. Approval to approach staff members was given either in writing in the form of a reply to the electronic mail or during follow-up telephone calls. Staff meeting dates were provided and appointments were scheduled for me to attend the various schools. Teachers were then approached at after school staff meetings to participate in the research. At that time, interested teachers were asked to indicate their willingness to participate in completing a questionnaire and/or an interview. Once these individuals were identified, a questionnaire (Appendix C) was distributed, ensuring the anonymity of the volunteer. A total of 126 questionnaires were distributed. A total of 89 questionnaires were returned to me through the district's inter-school mail system. Those teachers who wished to take part in an interview by virtue of having completed an interview reply form attached to their questionnaires were subsequently contacted. A total of 54 response forms regarding interviews were returned indicating a willingness to participate in a audiotaped interview. A stratified random sample, based on grade level taught was used to select the 16 participants to be interviewed. The forms

completed by teachers which indicated a willingness to partake in an interview were divided into grade levels (kindergarten through to grade seven) and from these a random sample from each stratum or grade level was selected (i.e., approximately two interviewees from each grade level were chosen from among the strata). This subset of volunteers engaged in an audiotaped interview ranging from 25 to 90 minutes in duration. Pseudonyms, of the participants' own choosing, were created to ensure confidentiality.

With respect to the questionnaires, the elementary schools attended had at least one staff member who fit the profile of the single computer classroom teacher. Only five of the elementary schools were not included in the study because they did not have any staff members who qualified for the study (i.e., had a single classroom computer). Seven of the 89 completed questionnaires were subsequently discarded as respondents indicated that they had more than one computer in their classrooms on their questionnaires.

Criteria for Inclusion of Subjects

Subjects included in this study had to fulfill the following criteria:

(1) an elementary (Kindergarten to grade 7) school classroom teacher in a moderately sized school district (10,000 to 25,000 students) in British Columbia
(2) student access to a single working computer in their classroom with at least one piece of compatible, working software
(3) willing and able to complete a questionnaire designed for the purposes of this study

(4) a sample of volunteer teachers will be willing to consent to a taped interview with me.

One of the foundations for subject selection in this study came from the advice of Marshall and Rossman (1995) who have developed a set of criteria for the ideal site of a study. They include (1) entry is possible; (2) a high probability of a rich mix of processes, people, programs, interactions and structures of interest; (3) the ability of the researcher to build trusting relations with the participants; and (4) data quality and credibility are reasonably assured. This particular school district was chosen because it is a district in which I am known, and as such, makes the fulfillment of Marshall and Rossman's first and third criteria very likely. In addition, the district is one that includes a combination of schools including those with a computer in every classroom, schools in which only a handful of classrooms fit this profile, and schools in which only one classroom has a computer in it. Within the one-computer classrooms that exist within the district, there is a wide variety of hardware and software being used. Such qualities render the likelihood of satisfying Marshall and Rossman's second and fourth criteria highly probable as well.

Recruitment of Subjects

In order to recruit subjects for this study, I approached all school principals in the school district for permission to attend staff meetings to present the details of this study and to solicit volunteer teachers at that time who might be interested in and willing to participate in the research. This initial contact was made by means of a letter sent through the inter-school electronic mail system unique to the district (Appendix F). Of the principals whose staffs consisted of at least one member who

fit the profile of the single computer classroom teacher, two principals referred me to another staff member to discuss the project. Subsequently, these two teachers distributed the questionnaires to their staff members who qualified to participate, on my behalf. A sample size of not fewer than 20 teachers was sought for questionnaire completion. Once these teachers were identified, the questionnaire was issued to those who expressed a desire to participate.

Characteristics of Subject Population

The sample was drawn from a school district in B.C. which serves between 10,000 and 15,000 students registered in approximately 30 schools—80% of which are elementary schools. The school district involved serves both rural and suburban communities in the area. Different geographical areas of the district were represented, as well as schools with varied levels of technology implementation, varied levels of interest in the role of technology in learning and varying levels of involvement with computers. The subjects included could have come from a school in which every teacher on staff had access to a computer in the classroom or from a school in which only two or three classrooms were equipped with a computer. The subject population included those teachers who have additional access to computers through computer labs, as well as those who have limited or no access to labs.

Data Analysis Procedures

> Data analysis is the process of bringing order, structure, and meaning to the mass of collected data. It is a messy, ambiguous, time-consuming, creative, and fascinating process. It does not proceed in a linear fashion; it is not neat. (Marshall & Rossman, 1995, p. 111)

The first stage of data analysis involved reporting the response of each individual question in terms of the percentages attributed to each response category. For example, the percentage of females and males who participated in the questionnaire is displayed. This analysis was chosen based on the survey research of O'Donnell (1996). The second stage of analysis involved determining the characteristics of teachers who implement the use of the single classroom computer regularly (more than 30 minutes per day in class time) and those who use it less frequently (less than 30 minutes per day). This analysis was performed with the aide of computer analysis using a spreadsheet. A subset of questions from the written survey was examined in this analysis (specifically, questions A 1, 2, 3, 4, 5, 6, 12, B 1, 6, C 3). These variables were selected based on the results of the pilot study and a review of the literature. The third stage of analysis entailed establishing the factors that hinder and facilitate the use of the single classroom computer and then categorizing these factors based on Fullan's multifactors of change. The factors of need, complexity, quality/practicality and clarity were focused on.

The process of analysis adopted at this stage closely follows Bogdan and Biklen's (1992) suggestions for analyzing data. Initially, the data were organized sequentially by numbering all questionnaires and interview transcriptions. In order to discover any regularities or patterns in the data, as well as topics or themes, this data were then read through in an attempt to establish possible coding categories as well as to look for common answers among the open-ended questions posited. Subsequently, notes were made regarding ideas, words or phrases that represented the topics or patterns found. It was on the basis of these notes and the conceptual framework adopted, that a coding scheme was devised.

Once this coding scheme was in place, the data were examined once again, marking units of data that fell under the particular topic represented by the coding category. It should be noted that a list was also kept of information that illustrated findings contrary to the theoretical framework relied on in this research (Creswell, 1994).

Concluding Comments

It was my intention to discover the factors that hinder as well as facilitate the use of the single computer in the classroom. The intent of this study, as well, was to consider how elementary school teachers use the single computer with their students. It was intended that my data would demonstrate the nature of the multidimensional aspects of change that Fullan (1991, 1992) refers to, at work. The purpose of this study, therefore, was not only to illuminate what teachers are doing with their students where the single classroom computer is concerned and what is affecting that use, but whether or not the factors that impact that use are reflected in the perspective of the multifactor theory of change as described by Fullan (1992). The findings of this study will also reveal the characteristics of teachers who engage students in the use of the single classroom computer, as well as the characteristics of those who implement their use less often.

CHAPTER IV

RESULTS

The purpose of this study was to provide insights as to how the single computer in the class room is being used in one B.C. school district and the factors that impact on that use in order to examine the implications for the implementation of a change. Fullan's (1991, 1992) implementation perspective was used as the basis for examining those factors that facilitate and hinder the computer's use. The basis of Fullan's premise is that change is a multidimensional process. He has identified a number of factors of change and this study focuses on four of those–clarity, complexity, quality/practicality and need. These dimensions were used to categorize the factors revealed in the present study.

In addition to looking at the change process that accompanies the implementation of technology in classrooms, an analysis of the data revealed the characteristics associated with teachers who implement the use of the single computer on a regular basis. Teachers were identified as either regular users (their classroom computer was used on a moderate or frequent basis) or infrequent users. Several variables were considered in this portion of the analysis including years of teaching, comfort level with computers, model of computer being used and teacher gender.

At both the primary and intermediate grade levels, teachers were found to use the single classroom computer for a variety of uses with their students. Games and word processing dominated use in the classroom. The study also found that

teachers implement the computer's use based on a number of factors including time, training, and the adequacies and reliability of hardware and software.

Results of the study have been organized to address each of the questions in the questionnaire systematically. Tables and figures have been used to display the data graphically. The data displayed are accompanied by a description and an interpretation of the findings for each individual question.

A. Personal Data and Background

Questions 1-3: Grade level taught, years of teaching experience, gender

As Figure 1 shows, all of the 82 subjects were elementary school teachers; 57% of them were primary teachers and 43% were intermediate teachers. Figure 2 demonstrates that of the individuals who completed the questionnaire, 76% were female and 24% were male.

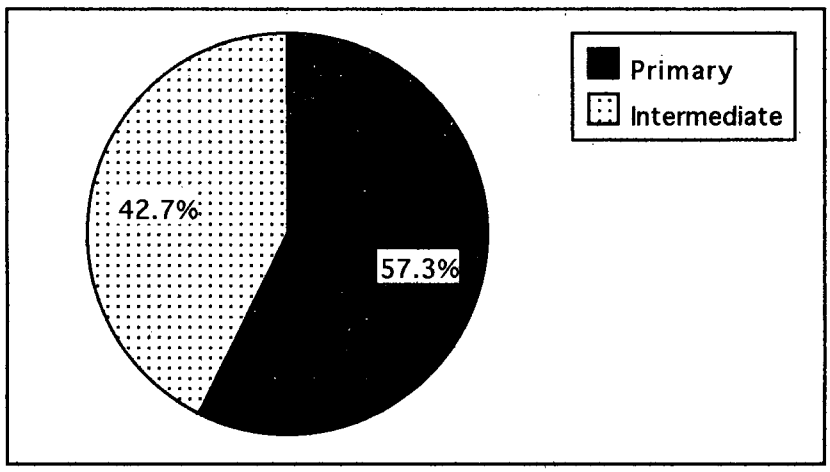


Figure 1: Primary and intermediate teachers: Percentages of primary and intermediate teachers who participated in completing the questionnaire.

Statistics provided by the B.C. Teachers Federation for the 1996-97 school year indicate that across all grade levels, females represent 63% of the population of teachers and males make up 37%. The number of years of teaching experience in the present study ranged from two to 25 years. The average number of years of teaching experience was 13 years. According to the British Columbia Teachers' Federation the average number of years of teaching experience for females is 11.4 years and for males the average is 14.6 years. In the present study, four per cent of respondents had less than two years of experience; 10% had three to five years of experience; 16% had been teaching for six to nine years; and 70% of the teachers surveyed had ten years or more of experience. As Figures 2 and 3 show, the sample population is similar to what one would expect to find in elementary schools in B.C. While these are samples of a different population, the profiles in the present study are generally similar to the rest of B.C.

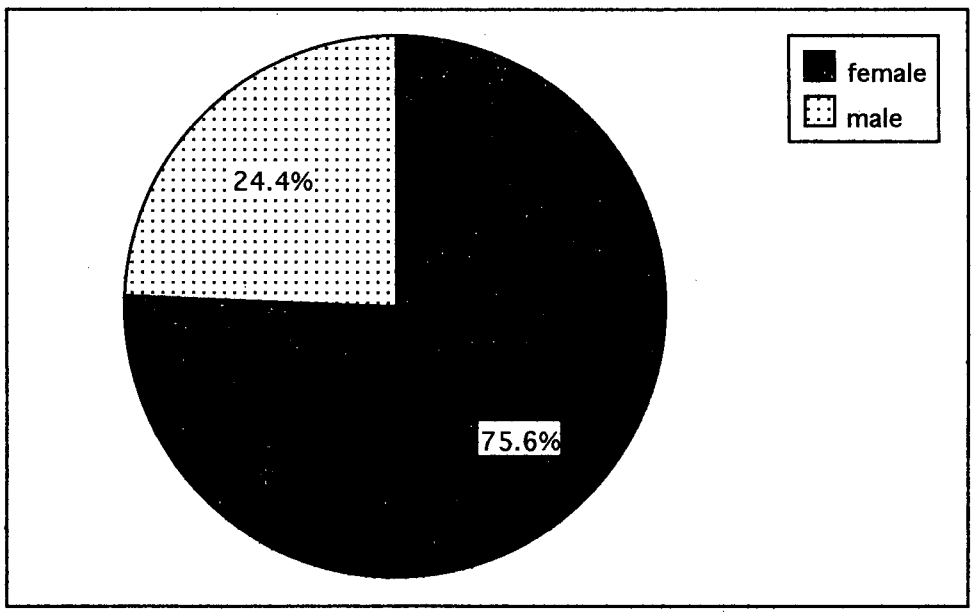


Figure 2: Male and female teachers: Number of female and male questionnaire participants.

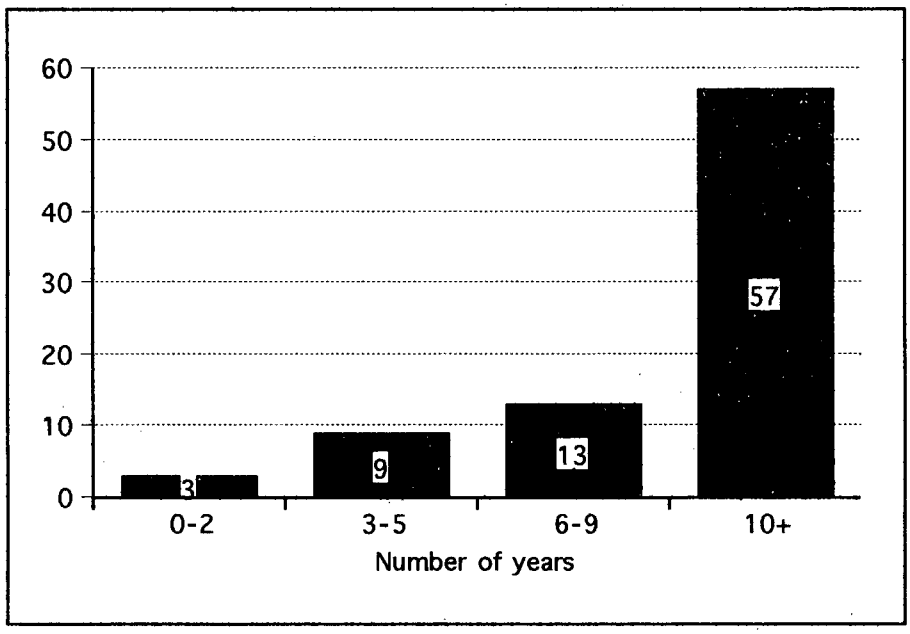


Figure 3: Teaching experience: Number of years of teaching experience.

Questions 4-5: Computer user abilities, years of working with computers

Respondents rated their computer using abilities as either experts, intermediate users or novices. Figure 4 shows that the majority of teachers rate themselves as intermediate computer users, while only a small percentage of teachers considered themselves to be experts. Six per cent considered themselves to be experts; 68% were categorized as intermediate users; and 26% were novices. That such a high percentage of teachers rated themselves as intermediate users may be explained by a tendency to underestimate their own abilities rather than to rank themselves as experts. Similarly, a number of teachers may be experts in using various computer applications but consider an expert to be someone with knowledge beyond software use (i.e., computer programmer, troubleshooter) and

as a result, do not categorize themselves as expert computer users. Similarly, given that teachers rated themselves in this question, some teachers may have rated themselves as intermediate users when they might have been novices.

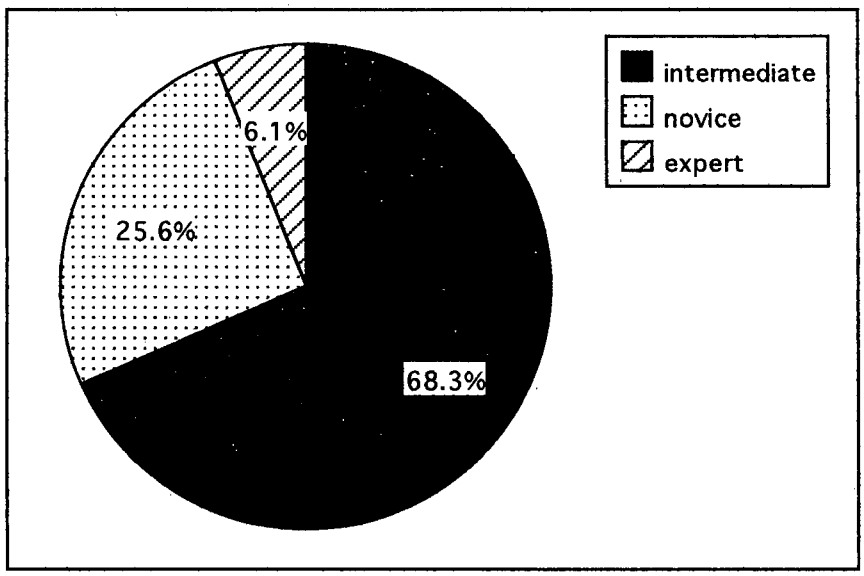


Figure 4: Teachers' computer abilities: Self-ratings of level of computer expertise.

Figure 5 represents the average number of years that respondents had been working with computers. Eight and one half years was the average. No teachers had fewer than two years experience in working with computers; 24% had been working with computers for three to five years; 38% for six to nine years; and 38% had worked with them for ten years or more. It would appear that experience with computers levels off around the nine year mark, which may be indicative of the time at which computers were first routinely being used in schools.

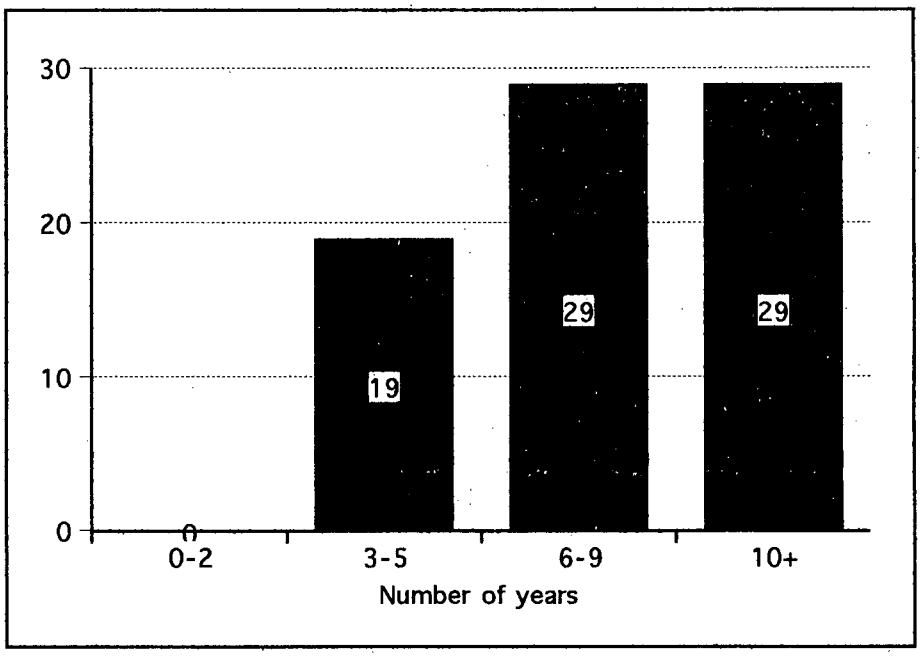


Figure 5: Years of computer experience: Number of years teachers had been working with computers.

Questions 6-7: Comfort level with computers

Comfort level in using computers was described as high, moderate or low. Figure 6 shows that 22% of teachers had a high comfort level when using computers; 65% possessed a moderate comfort level; and 15% of teachers had a low level of comfort. The numbers reported in teachers' self-ratings of their comfort level are similar to the self-ratings of their computer user abilities in Figure 4. The study was unable to determine, however, whether the people who responded in each category of these two questions were the same people or different ones. Figure 7 illustrates the explanations of what teachers attributed their comfort level to with respect to their classroom computer. Assistance from a colleague and self-help were ranked highest indicating that less formal resources are providing teachers with the most assistance where computer use is concerned.

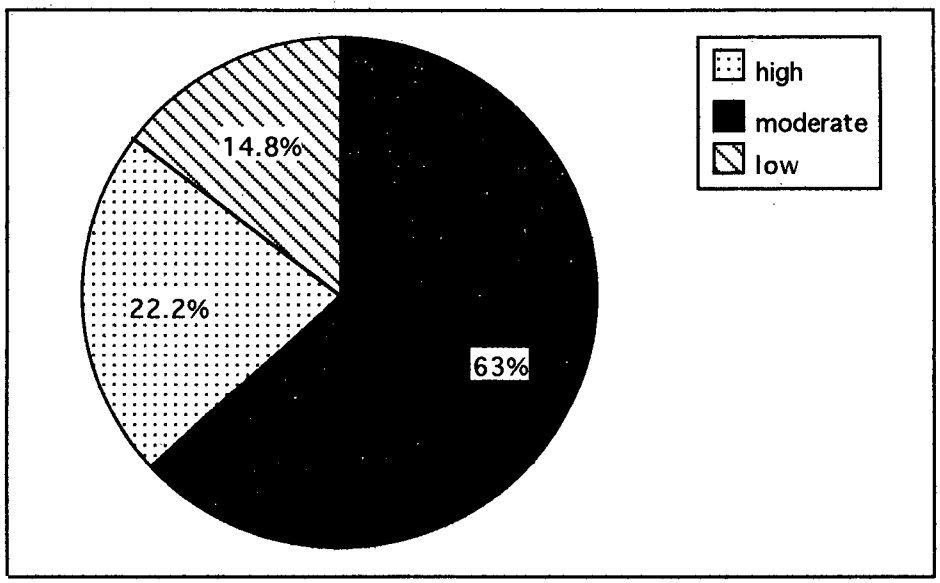


Figure 6: Teacher comfort level: Percentages of comfort levels when working with computers.

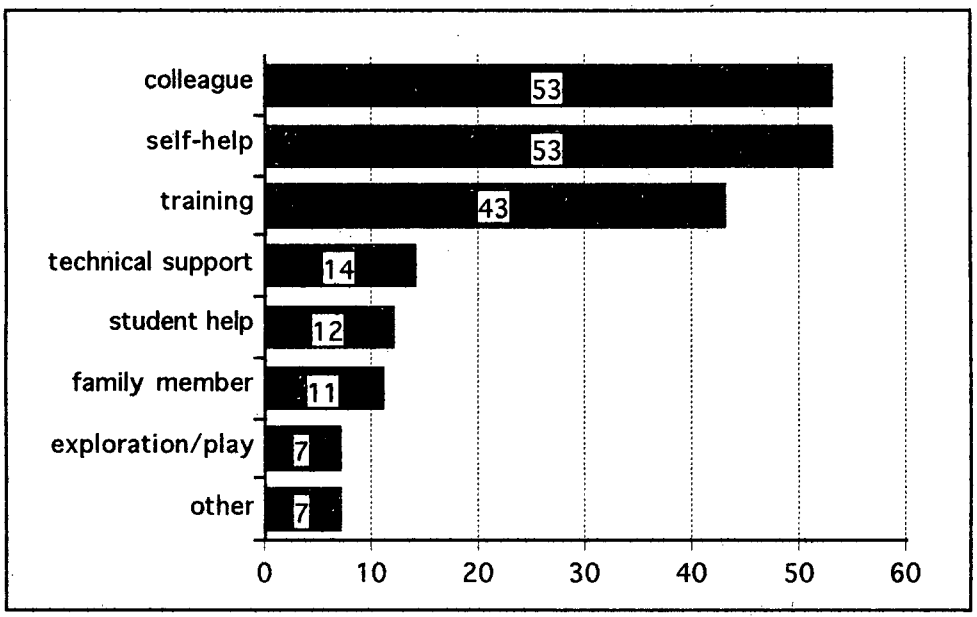


Figure 7: Reasons for comfort level: What teachers attributed their comfort level to when working with computers.

Questions 8-9: Teaching styles

Teachers were asked to name the teaching style that best described their instruction in the classroom. As Figure 8 shows, the most frequently cited style was that of facilitator. The second most common style was direct instruction and the coaching style was indicated in 14 cases. It should be noted that in several instances, teachers indicated that more than one style of teaching characterized their instruction at any given time. That teachers implement different teaching styles at different times in the classroom is not surprising given the variety of subjects taught at the elementary school level. No single style of teaching dominated, indicating that the computer was used by teachers who practiced any one of these teaching styles.

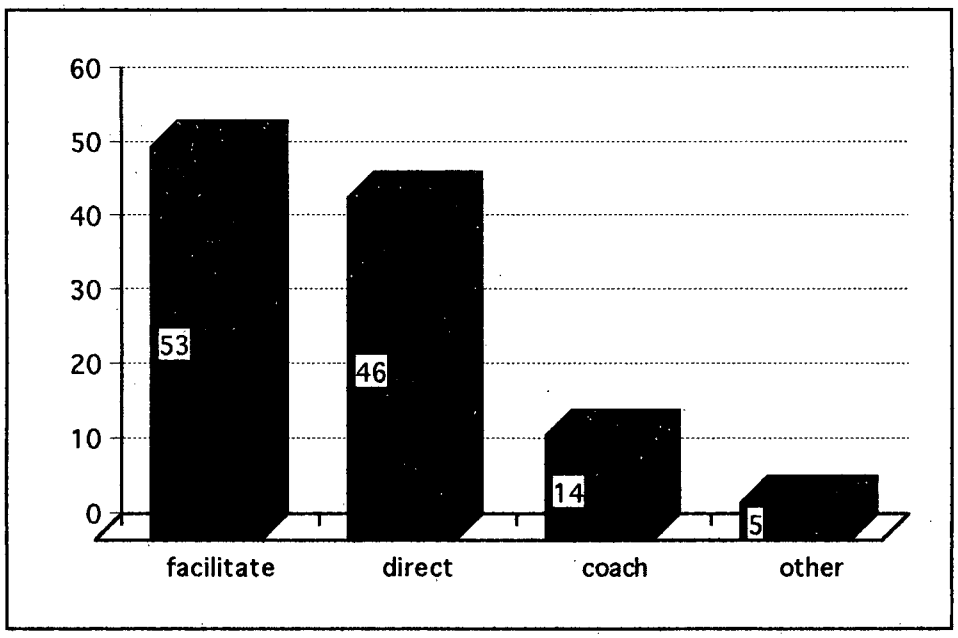


Figure 8: Teaching styles: Teachers identified their style as either facilitators, direct instructors, coaches or some other style.

When asked whether or not teaching with technology had changed their teaching style(s), 76% of the respondents indicated that it had not. Figure 9 illustrates this

data. Of the 24% who believed that it had changed their teaching style, they named some of the following explanations for that change:

- more variety permitted
- easier to prepare materials
- children can learn from each other
- able to rely on technology for preparation of materials
- speed/organization skills improved
- more individualization of instruction
- able to undertake research projects more often
- can utilize drill and practice functions
- have higher expectations for student work
- the children can be more independent
- able to integrate curriculum more
- communication with parents increased.

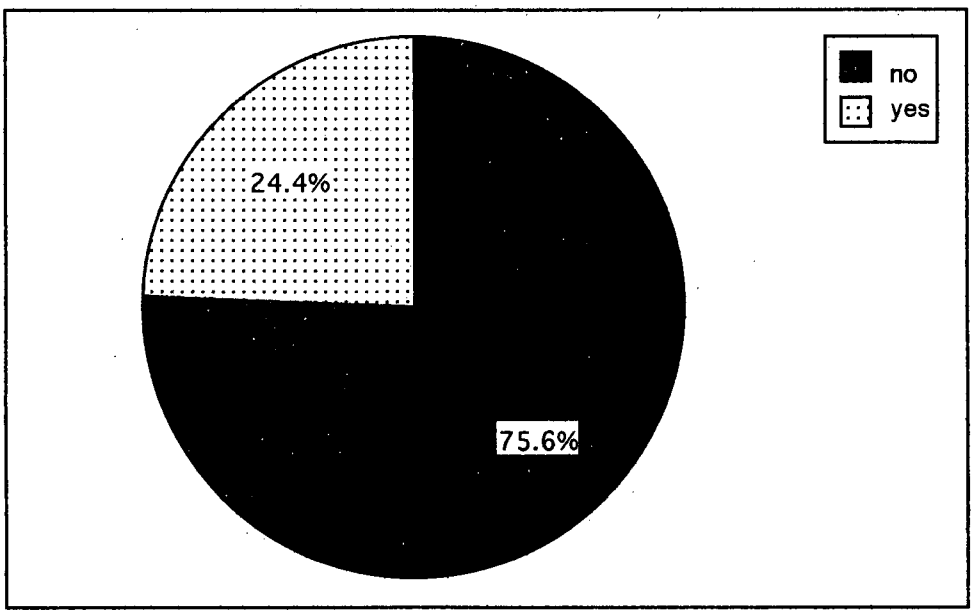


Figure 9: Have computers changed teaching styles: Percentage of teachers who indicated whether or not teaching with computers changed their teaching style.

Question 10: Changes in teaching

As Figure 10 reveals, in response to the question of how the single classroom computer has changed respondents' teaching, the most frequent response was that teachers are more comfortable with students working independently. The data suggest that tailoring instruction to students' needs and allowing them more independence is more easily achieved when using the computer. The "other" category was chosen in 21 cases. Among the answers specified were: use of the computer for a centre, enrichment, better presentations and the children can help each other. Twenty-five respondents said that the computer had not affected their teaching.

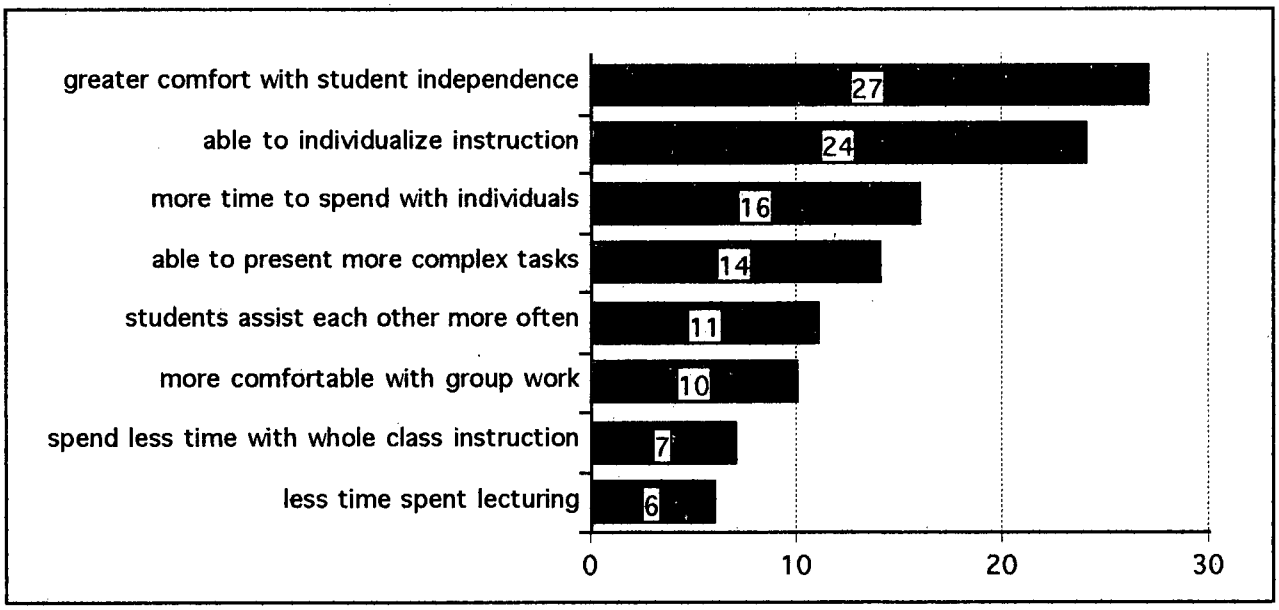


Figure 10: How the classroom computer has changed teaching: How the computer has changed instruction.

Question 11: Professional tasks on classroom computer

As Figure 11 shows, 55 of the 82 respondents engaged the classroom computer for the purpose of report card preparation. Although the school district does not mandate that elementary teachers complete report cards using a computer, their availability within schools and the expediency of preparing report cards using computers has contributed to a trend within the district to utilize them for this purpose. That so many teachers are using the classroom computer for the creation of class newsletters as well as lesson plans could be attributed to the ease of access to a computer in the classroom both during class time as well as outside of it. Among the 13 tasks indicated in the "other" category were enrichment, printing products, coursework, making certificates, teaching log, daybook, reading materials and feedback to children on their computer discs; three of the respondents did not use the computer for professional tasks.

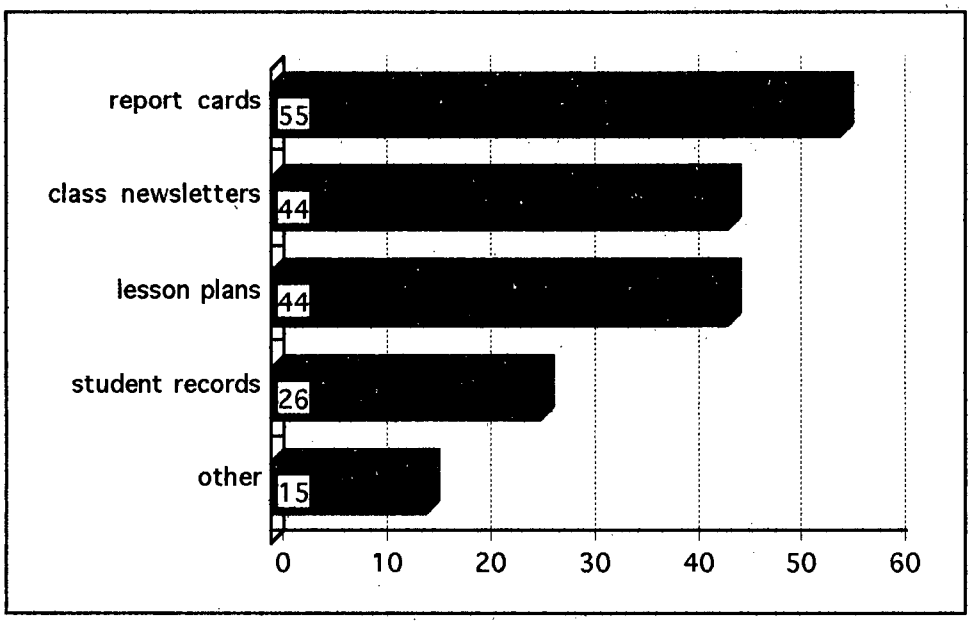


Figure 11: Professional uses of the classroom computer: How teachers use the computer for their own professional tasks.

Of the 82 respondents who completed a questionnaire, Figure 12 illustrates that only 10% of teachers did not have access to a computer outside of school.

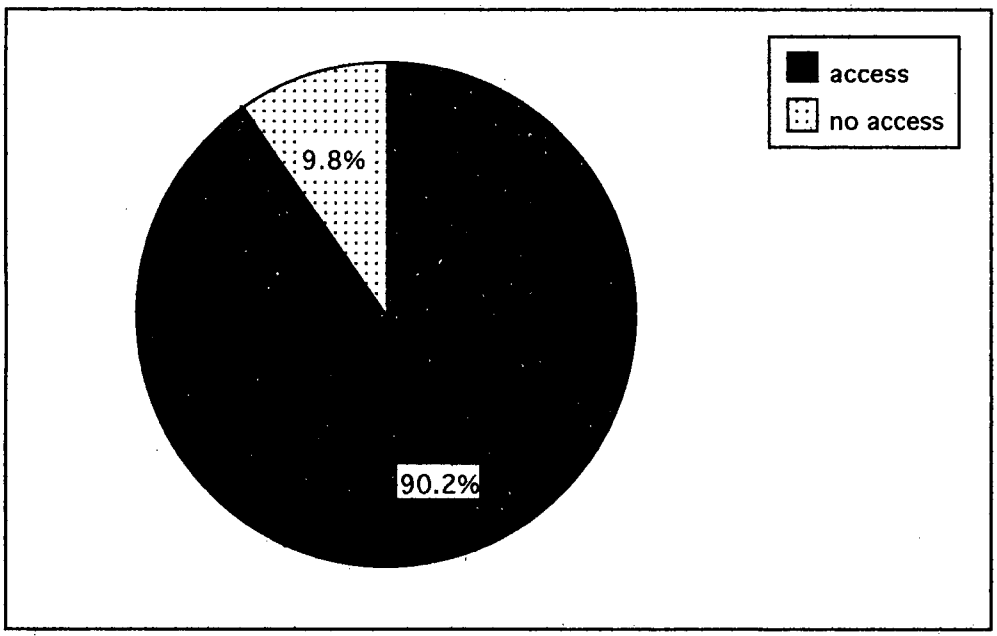


Figure 12: Access to a home computer: Percentage of teachers with a computer at home.

Figure 13 demonstrates that among those who did use a computer outside of school, the preparation of report cards was the most common use of the computer. It would appear from the data that teachers are using their home computers for substantially professional purposes. Those responses specified in the "other" category included record keeping, banking/finances, test/worksheet preparation, letters/newsletters, research, university coursework and web page authoring.

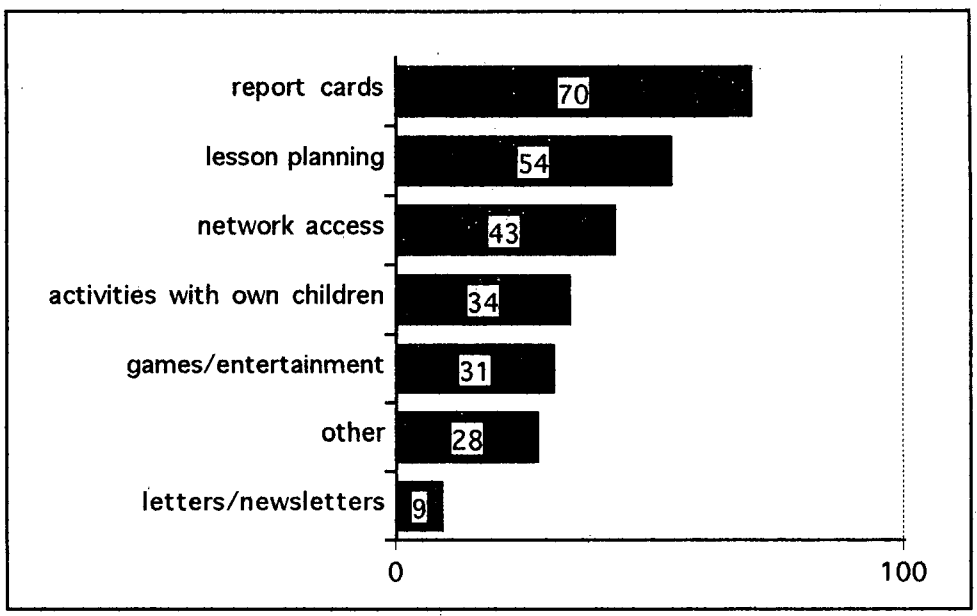


Figure 13: Home computer tasks: The variety of uses of home computers represented by the number of teachers who indicated each type of use.

B. Student Computer Use

Question 1: Allocation of time

Figure 14 shows the data on how teachers allocate student time on the classroom computer. Random use was the most common means of designating time, followed closely by posted schedules and students determining use. In some cases, teachers are using more than one method for allocating time on the computer. Given the number of teachers using the classroom computer on a random basis, it is possible that teachers are unsure as to how best to allocate computer time. Other means of allocating time on the computer included lunch designations, free time, student need, educational assistant decisions, the use of a timer, as a reward, specific children designated, challenge requirements and centre time.

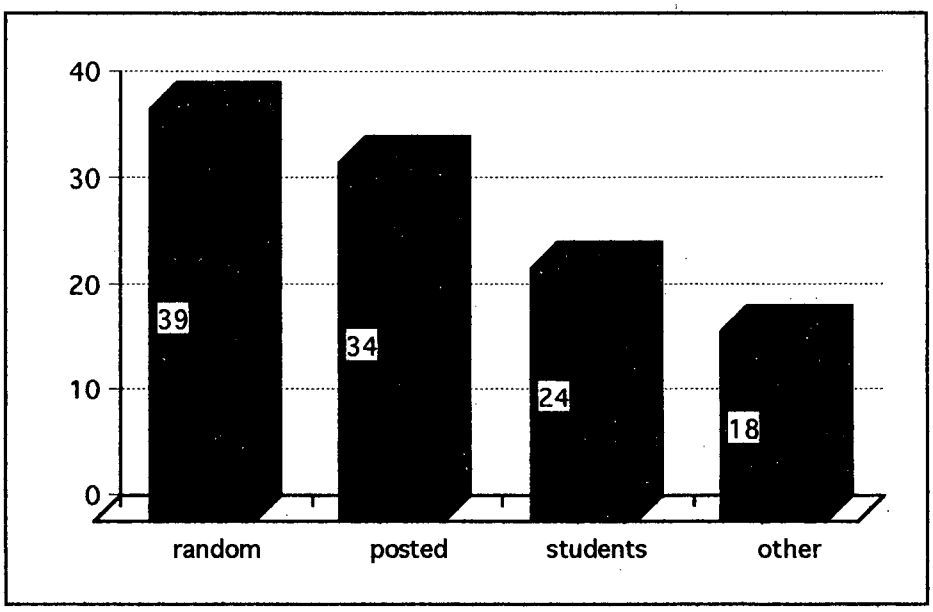


Figure 14: Allocation of time: How student time is allocated on the classroom computer.

Question 2-3: Minutes per day of use, frequency of use

Figure 15 reveals that the majority of teachers appear to be using the classroom computer most often during class time. The most typical durations of time per day for use during class time appears to be in the range of 1-30 minutes and 31-60 minutes. During lunch and after school the range of 1-30 minutes was most frequently reported. The other times during which the classroom computer is being used, although far less frequently, is before school, during "inside" days and at recess. The ability to supervise computer use during non-class hours and the length of lunch periods could be partly responsible for this data. Despite the fact that school days consist of approximately five hours of class time, it would seem that many teachers are utilizing the classroom computer at some time during the day, but use beyond 60 minutes per day in class is not very frequent. The data indicate that the computer is being underutilized.

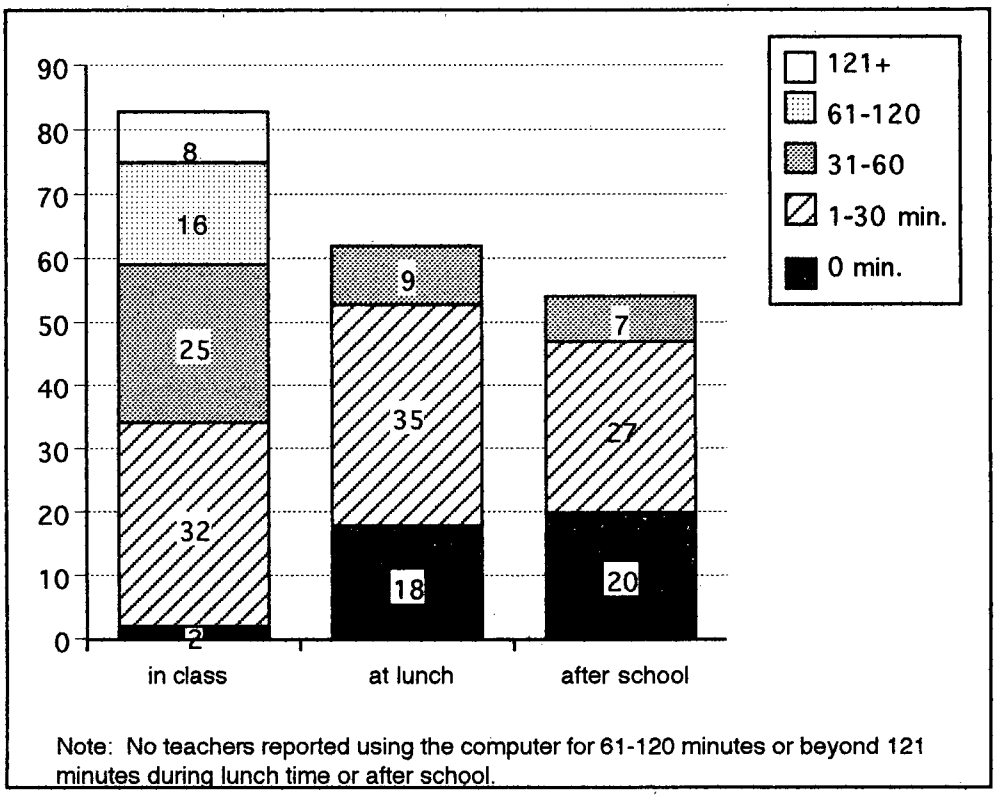


Figure 15: Time on the classroom computer: Minutes per day that the classroom computer is in use during class time, lunch time and after school. Numbers within bars indicate how many teachers responded in each particular time category.

Figure 16 shows that when asked to divide their classes into frequent users, moderate users and least frequent users of the computer, teachers indicated that the average number of combined minutes per week during which the frequent users were at the computer was 65 minutes. The middle third of the class used the computer, on average, for a combined total of 38 minutes per week and the least frequent users spent 10 minutes per week with the classroom computer. Once again, the data reveal that the classroom computer is being underutilized given that there are approximately 1500 minutes of class time each week and the most frequent users are using the computer for a combined total of just over an hour each week.

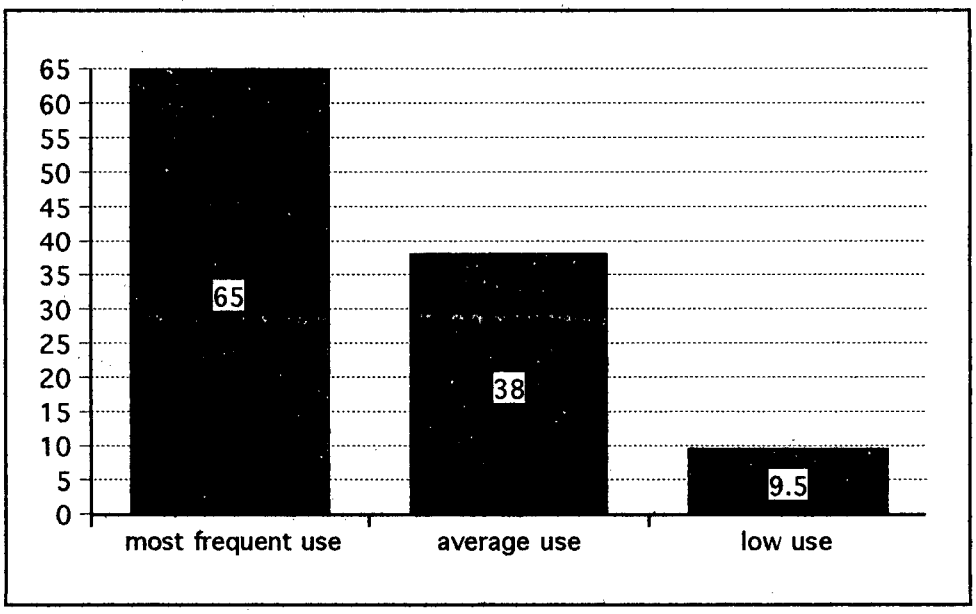
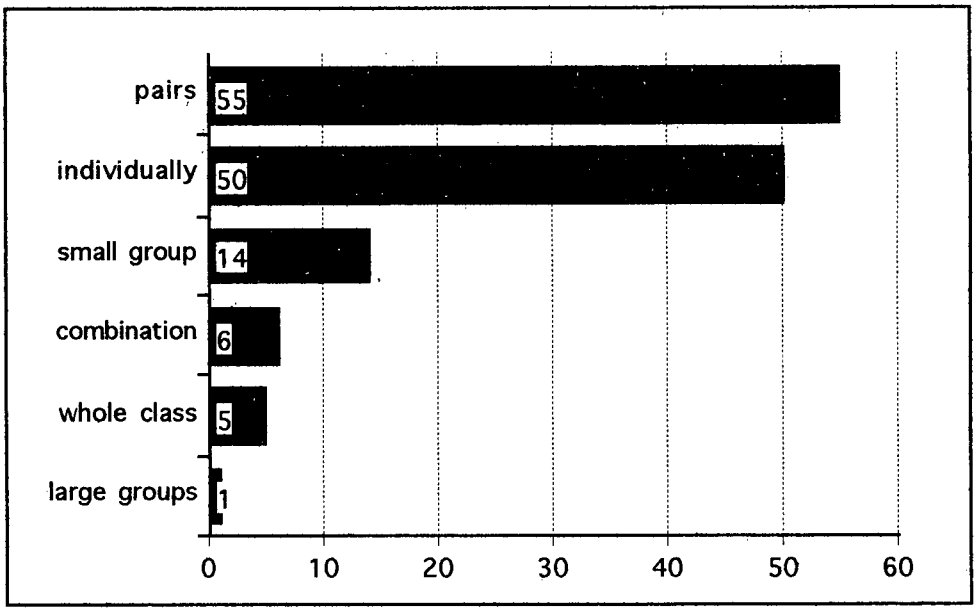


Figure 16: Average time spent using the computer: Average combined minutes per day spent on the computer among frequent student users, average student users, and low use student users.

Question 4-5: Student groupings, decisions on computer use

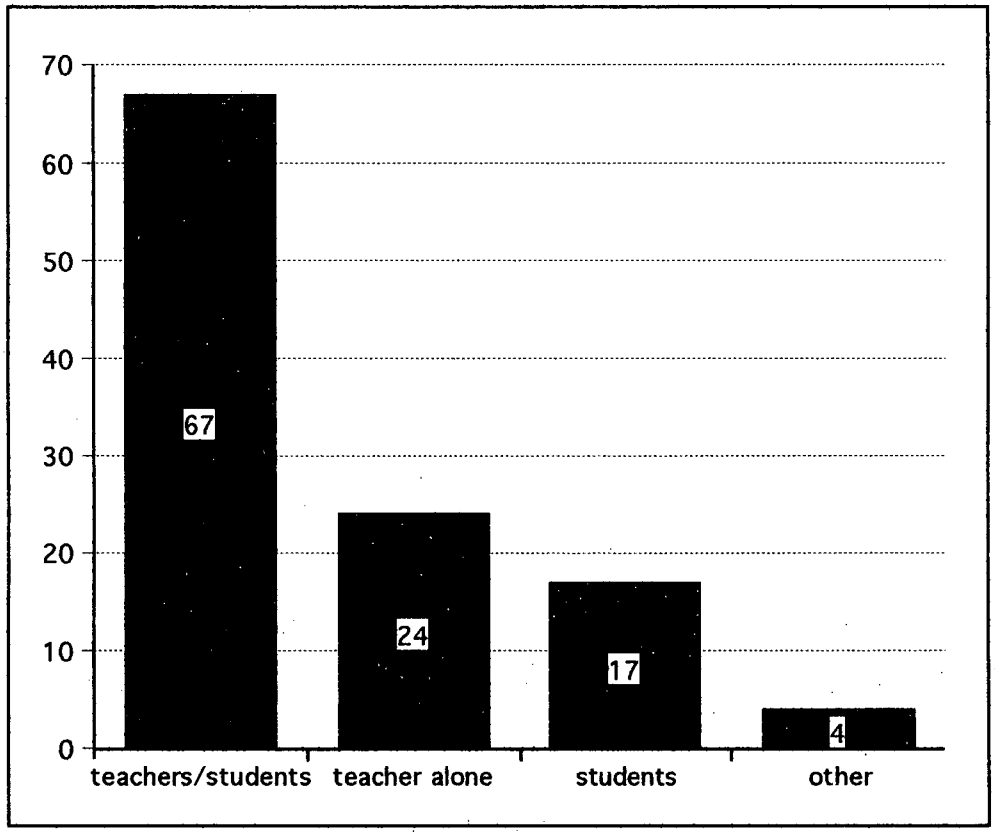
As Figure 17 demonstrates, the most frequently reported configuration of students working at the classroom computer was working in pairs, followed closely by individual use. It should be noted that in several cases, teachers were using a combination of groupings. Given that students are working at one computer, individual and paired use are possibly the most practical configurations when using one keyboard and one computer screen.



Note: In some cases, teachers responded in more than one category.

Figure 17: Student groupings: How students are grouped at the classroom computer.

Figure 18 reveals that when students work at the computer, the majority of teachers make the decisions as to what is to be done there in conjunction with their students' input. The teacher alone and the students themselves made those decisions in the remainder of cases. The "other" options cited as determining use was an aide or teaching assistant (2) or that the software dictated what was done on the computer (2). That so many teachers are including their students in determining the computer's use is consistent with the data that indicated that many teachers employ a facilitator style in their teaching.



Note: In some cases, teachers responded in more than one category.

Figure 18: Computer use decisions: Who makes decisions as to what is done at the computer.

Question 6-7: Lab access, time spent in lab

With respect to access to a computer lab, Figure 19 points out that 88% of the classrooms surveyed reported that they had access to a lab and 12% did not have lab access. Where access to a computer lab existed, the average amount of time per week spent in the lab was 54 minutes. Such a figure should be expected given that where computer labs are available in a school, usually only one exists and must accommodate a number of classes in the school.

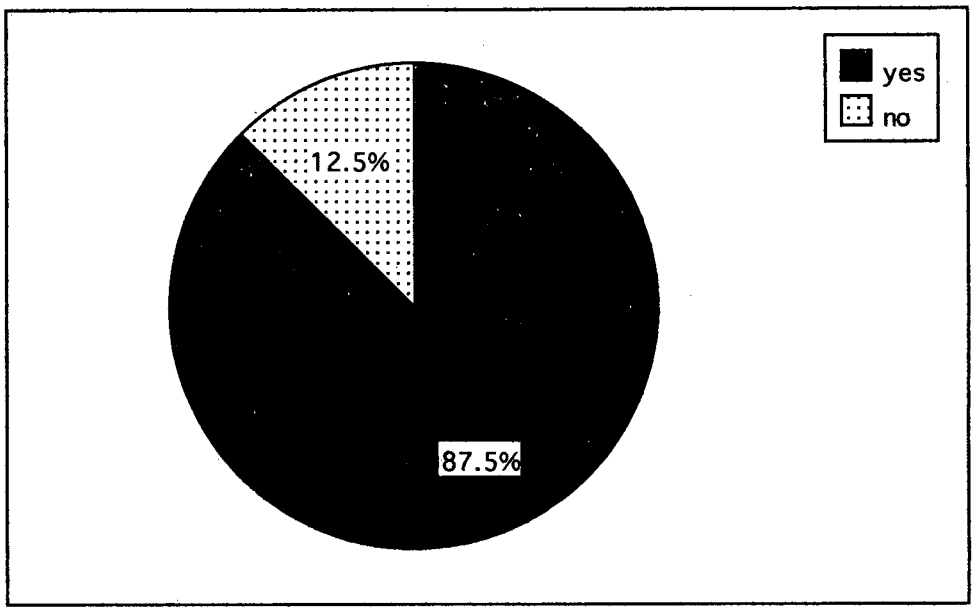


Figure 19: Computer lab access: Percentage of teachers whose students had access to a computer lab.

C. Hardware and Software Details

Question 1: School computer assignments

Figure 20 represents the data on how computers were assigned to teachers. The assignment of computers was done most often either on the basis of a combination of computer lab(s) and distributed computers and or on a one computer per classroom basis. Computer labs alone was the third most common type of assignment. The remainder of assignments consisted of either more than one computer per classroom, "tech pods" of 4-8 computers in designated areas outside of classrooms, travelling computers, sharing with another teacher and special needs children. It should be noted that in some cases, teachers responded in more than one category. Based on the data it is apparent that computers are housed in a variety of ways in the schools in this district but the distributed model of one computer per classroom and a combination of labs and distributed computers dominate the assignments.

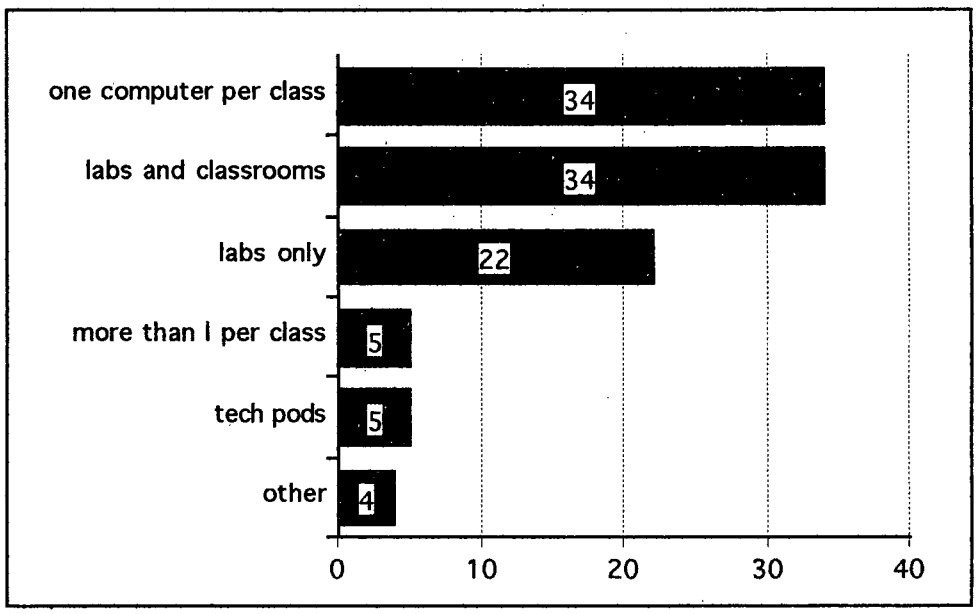


Figure 20: School computer assignments: How computers are assigned within schools.

Questions 2-5: How computers were acquired, types of computers, accommodating the computer, computer peripherals

Table 1 reveals the breakdown as to how teachers came to acquire the computer they have in their classrooms.

Table 1

How classroom computers were acquired.

1. Through school distribution	21
2. Through inheritance when teachers arrived in their classrooms	17
3. Dismantling/refurbishing of a school lab	12
4. Assistance from Parent Advisory Committees	9
5. Specific request	6
6. Offer from another teacher with more than one computer	3
7. Through the accumulation of credits from district workshops	3
8. Being next on the list to receive a computer in the school	2
9. Working in a portable	2
10. Having one or more special needs students in class	2

In three cases, respondents did not know how they came to acquire their classroom computer. These data suggest that computers in the classroom are becoming, or have become, one of the myriad of supplies found in classrooms. The number of classroom computers acquired through computer lab upgrading or dismantling reveals two possibilities. Firstly, that in an effort to recycle older models, computers are placed in classrooms which accounts for the number of outdated computers that are housed in classrooms. Secondly, the dismantling of some labs may be indicative of a trend or philosophy towards distributing computers to classrooms rather than housing them exclusively in labs.

All computers were models of Macintosh computers and included:

- LC models (36)
- Apple II GSs (10)
- Mac Classics (9)
- Performas or better (9)
- Mac Pluses (4).

Ten teachers indicated that they did not know what kind of computer they had other than it was a Macintosh and four respondents did not respond to this question. These data were subsequently categorized as old models (MacClassics, MacPlus and Apple II GSs), intermediate models (LC models) and new models (Performas or better) and are detailed in Figure 21. It is apparent that only a small percentage of teachers have access to a newer model computer in their classrooms. There is also one-third of teachers who are housing outdated computers in their classrooms for use with students.

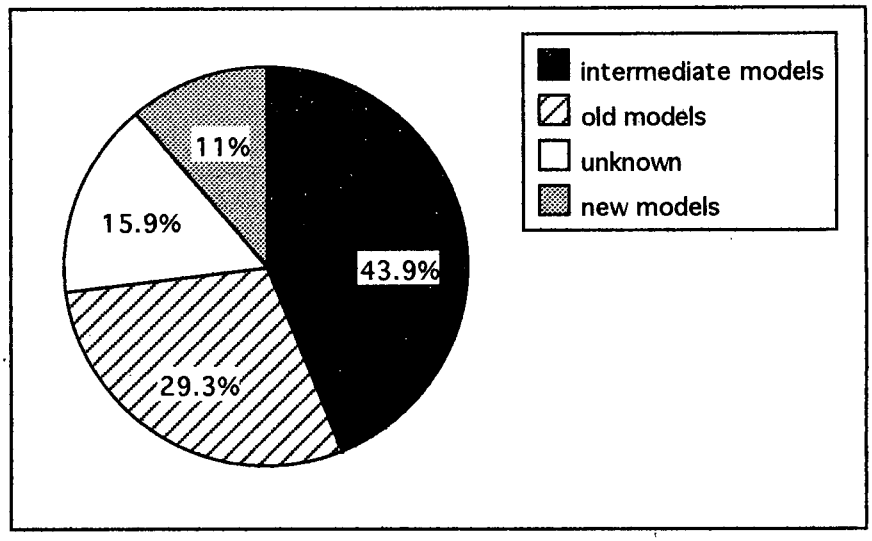


Figure 21: Model of computer: Types of Macintosh computers housed in classrooms by percentage.

With respect to making organizational changes in the classroom to accommodate the hardware, Figure 22 shows that the majority of teachers indicated that they did in fact have to make such changes.

The peripherals that most often accompanied the single classroom computer included:

- printers (43)
- CD Rom drives (36),
- modems (11)
- scanners (2)
- LCD panel for overhead projection displays (2).

Thirteen classrooms had no additional equipment beyond their monitor and hard drive.

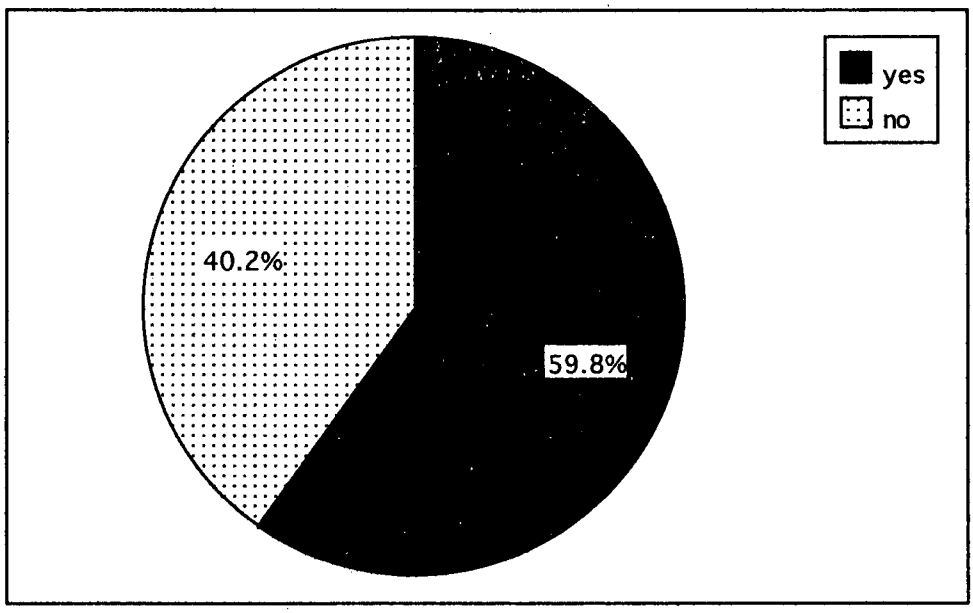


Figure 22: Organizational changes: Percentage of teachers who did and did not have to make changes within their classrooms to accommodate their classroom computer.

Question 6-7: Types of use, software titles

The raw data in Figure 23 show that the applications most frequently used in classrooms were games and word processing. Both applications require less sophisticated abilities on the part of the user than some of the other applications listed. The more sophisticated applications (e.g., database and spreadsheet applications) are used only infrequently among the classrooms in this study. The study did take place in elementary schools; therefore, the age of the students may account for the infrequent use of more complicated programs. Another possibility is that given the greater sophistication of these programs, teachers are less adept at using them and therefore, do not engage students in those types of use. Drill and practice applications and graphics and drawing programs also require less sophistication, in many cases, on the part of the user than some of the other uses listed. The moderate use of drill and practice programs may be accounted for by the number of older model computers that are accompanied by such software.

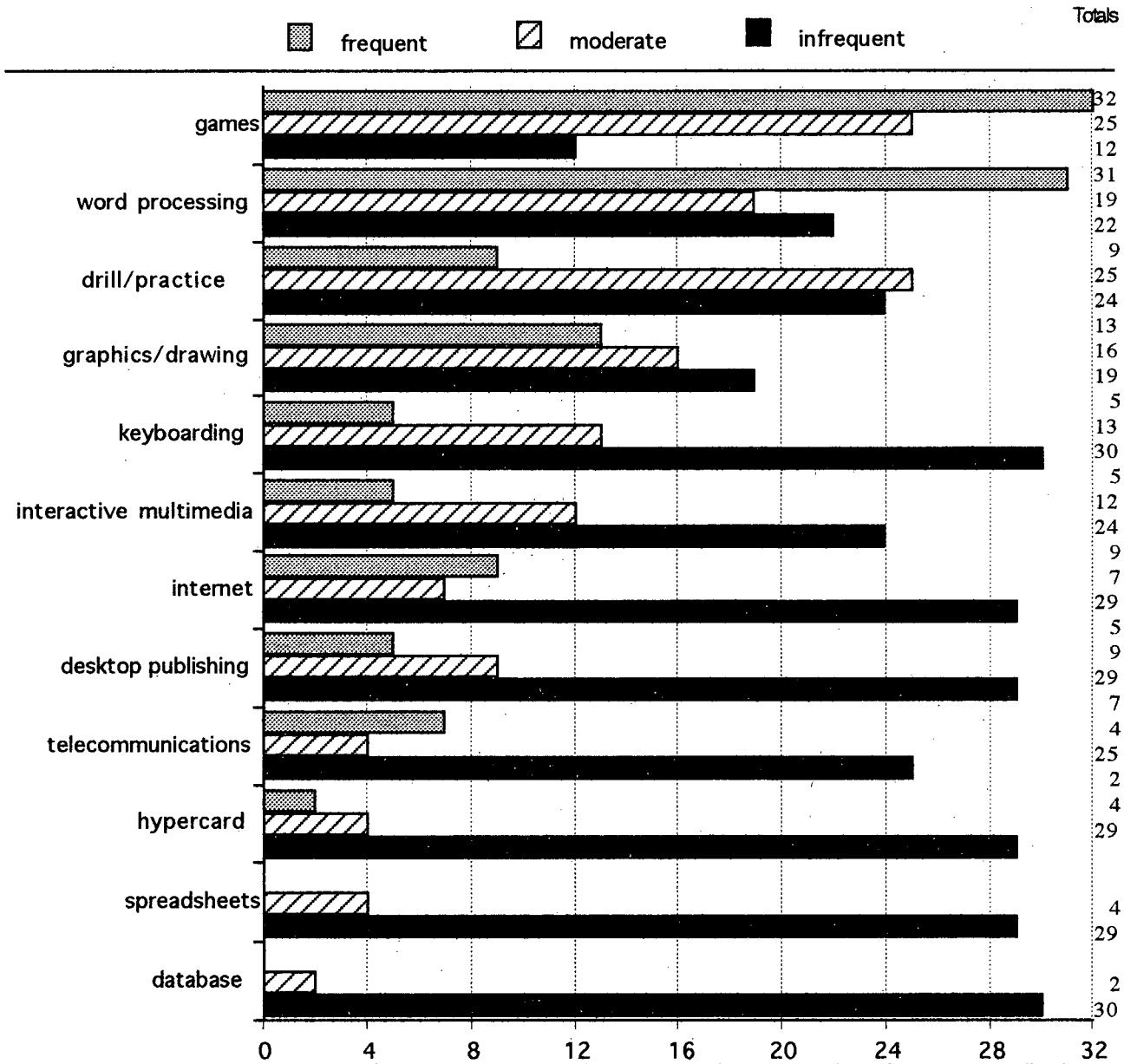


Figure 23: Computer uses: Teachers reported their frequency of use in a variety of computer applications.

Among the software reported to be most commonly used in classrooms for the various applications were ClarisWorks, MicrosoftWorks, Kidstime, Kidpix, Mathblaster, Number Maze, Oregon Trail, All the Right Type and Netscape Navigator. Similarly, when asked what their greatest successes with the classroom computer had been, teachers who were interviewed reported that word processing and games had provided the most success. The questionnaire results revealed that 60% of teachers used ClarisWorks for their word processing requirements. This is consistent with the use of MacIntosh computers in the district as MacIntosh models are often accompanied by a ClarisWorks package when they are purchased. There was not, however, a consistent type of software used for game purposes. Such a finding corresponds to the fact that there are a large number of titles to choose from among the games software available. Among the games most frequently reported to be used in the classroom with the single computer were Oregon Trail, Yukon Trail, Gizmos and Gadgets, Cross Country Canada, Where in the World is Carmen Sandiego, Sim City, Sim Ant, Kidstime and Swampgas. Although the games used varied from class to class, most of the games named by teachers have the potential to be educationally significant. The number of titles reported for drill and practice purposes was also varied.

Table 2 illustrates computer uses classified by grade level taught, years of teaching experience, gender, computer user ability and age of equipment. An examination of this table reveals that students at the intermediate grade level use word processing more than any other application, whereas primary classrooms

Table 2

Computer uses by grade level, years of experience, gender, computer user ability, age of equipment

		Grade Level		Years of Experience				Gender		Computer User Ability			Age of Equipment			
		Primary	Intermediate	0-2	3-5	6-9	10+	Female	Male	Expert	Moderate	Novice	Old	Intermediate	New	Unknown
Games	Frequent	22	10	1	4	5	22	27	5	1	21	10	6	21	3	2
	Moderate	15	11	1	2	5	18	20	6	0	21	5	9	9	3	5
	Infrequent	4	7	0	1	2	8	4	7	2	7	1	2	7	1	1
Word Processing	Frequent	11	20	2	3	4	21	19	12	2	24	4	5	19	4	3
	Moderate	11	8	1	2	4	12	14	5	1	13	5	6	9	2	2
	Infrequent	15	6	0	3	5	13	18	3	0	14	7	7	9	3	2
Practice Drills	Frequent	10	0	0	1	1	8	9	1	1	6	3	7	3	0	0
	Moderate	13	11	0	3	3	17	20	4	1	17	6	7	14	2	1
	Infrequent	14	11	1	2	4	18	24	11	2	18	4	3	14	4	4
Graphics	Frequent	10	5	0	2	3	10	9	6	3	10	2	3	8	2	2
	Moderate	9	5	1	1	3	9	10	4	0	12	2	5	5	1	3
	Infrequent	9	13	1	0	4	17	15	7	0	19	3	3	14	3	2
Keyboarding	Frequent	1	3	0	1	1	2	4	0	0	3	1	2	1	0	0
	Moderate	7	7	1	0	1	12	7	7	2	7	4	2	12	0	0
	Infrequent	18	9	1	2	6	15	18	6	1	19	4	5	11	4	4
Multimedia	Frequent	2	2	0	0	2	2	2	2	2	2	0	0	3	0	1
	Moderate	8	4	0	0	1	11	9	3	1	10	1	3	5	2	1
	Infrequent	12	12	1	3	4	16	15	9	0	19	5	6	11	4	3
Internet	Frequent	3	7	1	1	1	7	4	6	2	7	0	0	4	4	2
	Moderate	2	4	0	0	1	5	2	4	0	5	1	0	3	1	2
	Infrequent	13	15	0	3	6	19	22	6	0	23	5	7	15	3	3
Desktop Publishing	Frequent	3	2	0	1	1	3	3	2	1	3	1	0	4	1	0
	Moderate	5	5	0	0	3	7	7	3	1	6	2	2	6	1	1
	Infrequent	12	9	1	2	3	14	14	7	0	17	4	6	7	4	4
Telecom-munications	Frequent	2	3	0	0	1	4	3	2	1	3	1	0	3	1	1
	Moderate	1	3	0	0	0	4	2	2	0	3	1	0	2	1	1
	Infrequent	12	10	1	3	4	14	14	8	0	19	3	8	8	4	2
Hypercard	Frequent	1	1	0	1	1	0	1	1	0	2	0	0	2	0	0
	Moderate	1	2	0	0	0	3	1	2	0	3	0	0	2	0	1
	Infrequent	14	14	1	2	5	20	18	10	0	22	6	8	11	5	4
Spreadsheet	Frequent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Moderate	0	5	0	1	1	3	1	4	2	3	0	0	5	0	0
	Infrequent	15	12	1	4	4	18	18	9	0	21	5	7	11	5	4
Database	Frequent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Moderate	0	2	0	0	1	1	1	1	0	2	0	0	2	0	0
	Infrequent	15	15	1	5	4	20	18	12	2	23	5	7	14	5	4

engage the computer most often for games. As well, in intermediate classrooms, drill and practice "programs" are used moderately in some cases, but not frequently. Primary students use drill and practice "programs" on a moderate as well as a frequent basis. Drill and practice programs are also used most often in those classrooms housing older model computers. Graphics and drawing programs are used more with the primary ages as well. The more sophisticated applications (i.e., database and spreadsheet), although used only minimally, are used by intermediate students exclusively.

D. Curriculum Integration

Question 1: Subject areas of computer integration

Figure 24 represents responses to the question of which subject areas teachers are integrating the computer into most often, sometimes or not at all. The subject area that the computer was integrated into least often was physical education. This could be predicted given that gym class usually occurs outside of the classroom. One possible explanation for the results is that teachers find it easier to integrate the computer into particular subjects and correspondingly are more aware of ways in which to integrate it in certain subject areas. Another explanation is that the focus of elementary teaching is geared more to language arts and hence the higher integration in that subject. As well, the availability of software in different subject areas in the various schools may dictate, to some extent, the subject areas in which the computer is integrated.

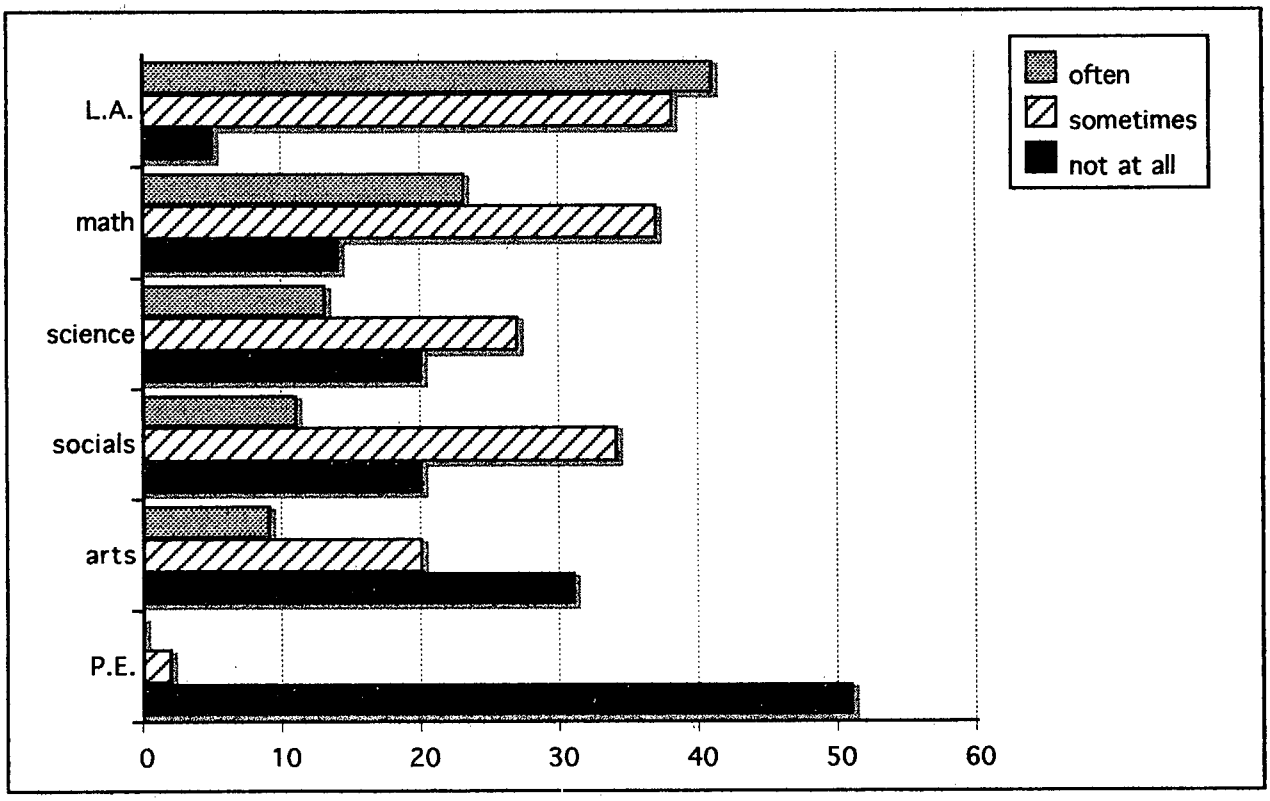


Figure 24: Subject areas of integration: Subject areas in which teachers are integrating the classroom computer.

Question 2-3: Advantages and disadvantages to computer use

Table 3 represents the responses of participants to the question of what benefits result from the use of the computer. It should be noted that in many cases, teachers indicated that more than one benefit resulted from computer use. The benefit most often acknowledged was that students would gain familiarity with computers. Opportunities for peer tutoring/cooperation ranked second, while reinforcement of learning and providing an alternative approach to teaching/learning were ranked third and fourth respectively. Very few teachers believed that these benefits were not important outcomes of having used the computer. The benefits listed illustrate two of Fullan's (1992) characteristics of an innovation, namely practicality and need. Gaining familiarity with computers, having their learning reinforced and developing problem solving skills would all

fulfil the needs of students. Opportunities to peer teach, having alternative approaches to teaching and learning, motivating students and individualizing instruction would all lend themselves to the quality/practicality aspects of using a computer.

Table 3

The benefits of using the computer

	Important	Moderately	Not important	Total
1. Students gain familiarity with computers	65	16	0	81
2. Opportunities for peer teaching/cooperation	48	29	0	77
3. Reinforcement of learning	50	24	1	75
4. Alternative approaches to teaching/learning	47	25	2	74
5. Children become more motivated	51	18	2	71
6. Development of thinking/problem solving	45	21	3	69
7. Individualization of instruction	41	21	6	68

Teachers were asked to rank the benefits listed as either important, moderately important or not important. Not all teachers rated each question. Some respondents chose to respond to only one benefit, while others chose to rate more than one benefit and still others rated all seven benefits. The majority of teachers ranked all seven benefits as being either important or moderately important. No teachers believed that gaining familiarity with computers or having opportunities for peer teaching was unimportant. Additional benefits specified by teachers who chose the "other" category included the following:

- parent involvement (1)
- the ability for students to see their own progress (1)
- the accommodation of special needs children (2)
- meeting a future need for computer literacy (2)
- speedy access to information (1)
- enrichment opportunities (1)
- learning from another medium (1)
- focuses children on a task (1).

Where negative outcomes were concerned, Figure 25 shows that there was a relatively even distribution of responses as to whether or not working with computers had negative consequences for students. The negative consequence most often listed was that working with computers had the potential to create a "laziness" in students or an overreliance on technology. The spell check feature of computers was often given as an example of this laziness, together with concerns over handwriting development. Another concern was the deterioration of social skills or opportunities for social interaction. When using computers, too much focus on "pizzazz" as one respondent noted, frustrations over "glitches" and a slow turnover with the ratio of children to computers were also considered to be negative outcomes when using the computer. Such explanations can be categorized into Fullan's (1992) category of need; when an innovation does not meet student or teacher needs, the innovation is less likely to be implemented. Set up time, tracking progress and cost were additional issues raised that can be considered issues of practicality as Fullan (1992) has described it.

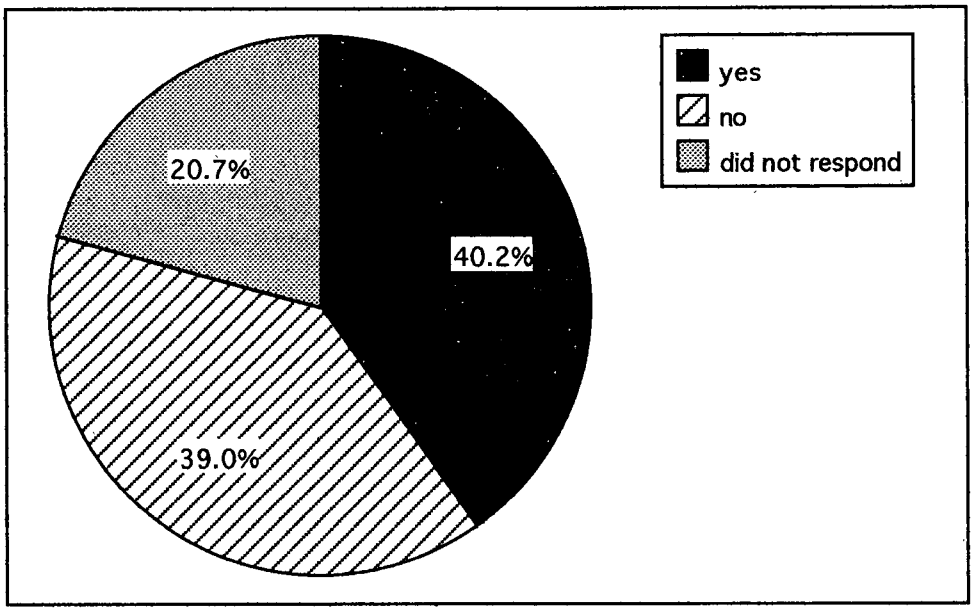


Figure 25: Does computer use have negative outcomes: Percentage of teachers who believed that negative outcomes did or did not result from using computers.

Question 4: How the computer should be used

Table 4 depicts the answers to what teachers believed the single classroom computer should be used for. Teachers, gave high ratings to all of the options offered. Some teachers responded to only one category, while others chose to select all categories. Enrichment was chosen most often (68), followed by integration with other subject areas (64), remediation (62) and non-structured free exploration (56). Teachers specified the additional uses of communications, drill and practice, research, talking books, facilitation of fine motor skills and enjoyment in the "other" category of this question. In addition, Table 4 indicates that more female than male teachers believed that computers should be integrated with other subject areas. Expert computer users also reported that subject integration was a priority for computer use. Given their expert status, these teachers may have had more experience and more of a knowledge base on which to discover ways to integrate the computer. In the case of enrichment,

remediation and free exploration, the percentage of teachers who believed the computer should be used for these purposes declined as computer user ability increased. There is, therefore, a possibility that as teachers acquire more knowledge and experience in using the computer, they also find different ways to use it. Table 4 also reveals that all teachers with three to nine years of teaching experience believe that the single computer should be used for enrichment purposes. As well, all novice computer using educators reported that the computer should be used for remediation. Novice users may not yet be as experienced in how to integrate the computer into other subject areas, given their beginner status. Also, remediation work on the computer often means using drill and practice software which requires less expertise on the part of the user. In addition, where remediation was concerned, more male than female teachers selected this use of the computer.

E. Factors Influencing Computer Use

Question 1: Sources of support

As Figure 26 shows, teachers received support for the use of their classroom computer most often from a colleague. Administrative support and the support of a technology coordinator were the second most common types of support received. Teachers described other kinds of support as coming from parents, the school board office, a secretary, family/friends/spouses, courses/workshops and self-support. The fact that so much technology coordinator support comes from outside of the school can be attributed to the fact that not all schools have a staff member who holds this title and so they must seek that form of support from outside their own school. Colleagues may be relied upon more often for support as they can be more readily available to teachers. As well, when teachers transfer schools, they

Table 4

Teacher beliefs about the use of the single classroom computer: Male and female respondents, years of teaching experience and expertise level are reported by the percentage of teachers who responded in each category.

Use	% male	% female	Teaching experience (%)				Expertise (%)			Total
			0-2	3-5	6-9	10+	novice	intermediate	expert	
Enrichment	85	82	67	100	100	77	90	82	60	68
Integration with other subject areas	65	82	67	89	54	82	86	75	80	64
Remediation	95	81	67	89	54	79	100	69	60	62
Unstructured free exploration	70	76	67	89	54	67	81	66	40	56

may maintain their relationships and continue to network with those they have established a relationship with and who provide a resource for their inquiries regarding technology.

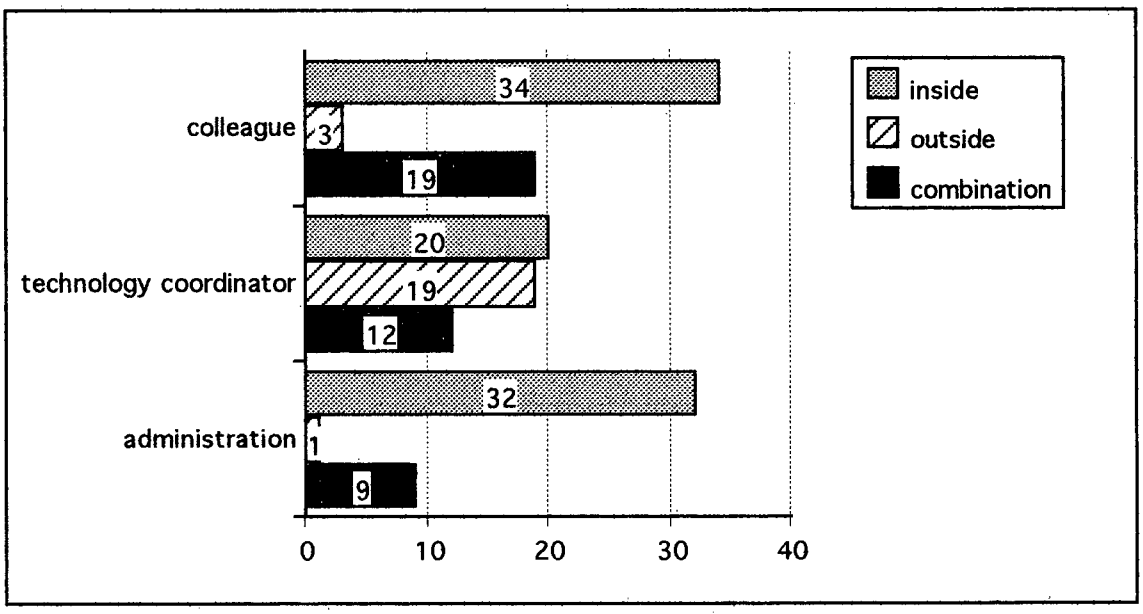


Figure 26: Sources of support for the classroom computer: Support was distinguished as coming from either inside the school, outside of it or from a combination of each.

Question 2: Factors affecting computer use

Figure 27 presents the degree to which a variety of obstacles affected the use of the classroom computer. Based on the number of responses in the very and moderate categories of this question, the majority of teachers chose time as the factor that most affected use (70). Inadequate or unreliable hardware (53) and software (52) as well as personal knowledge and training (53) were also factors that were deemed to affect use often. Class size (43), lack of technical support (42) and student needs/knowledge (42) were also cited as factors affecting use.

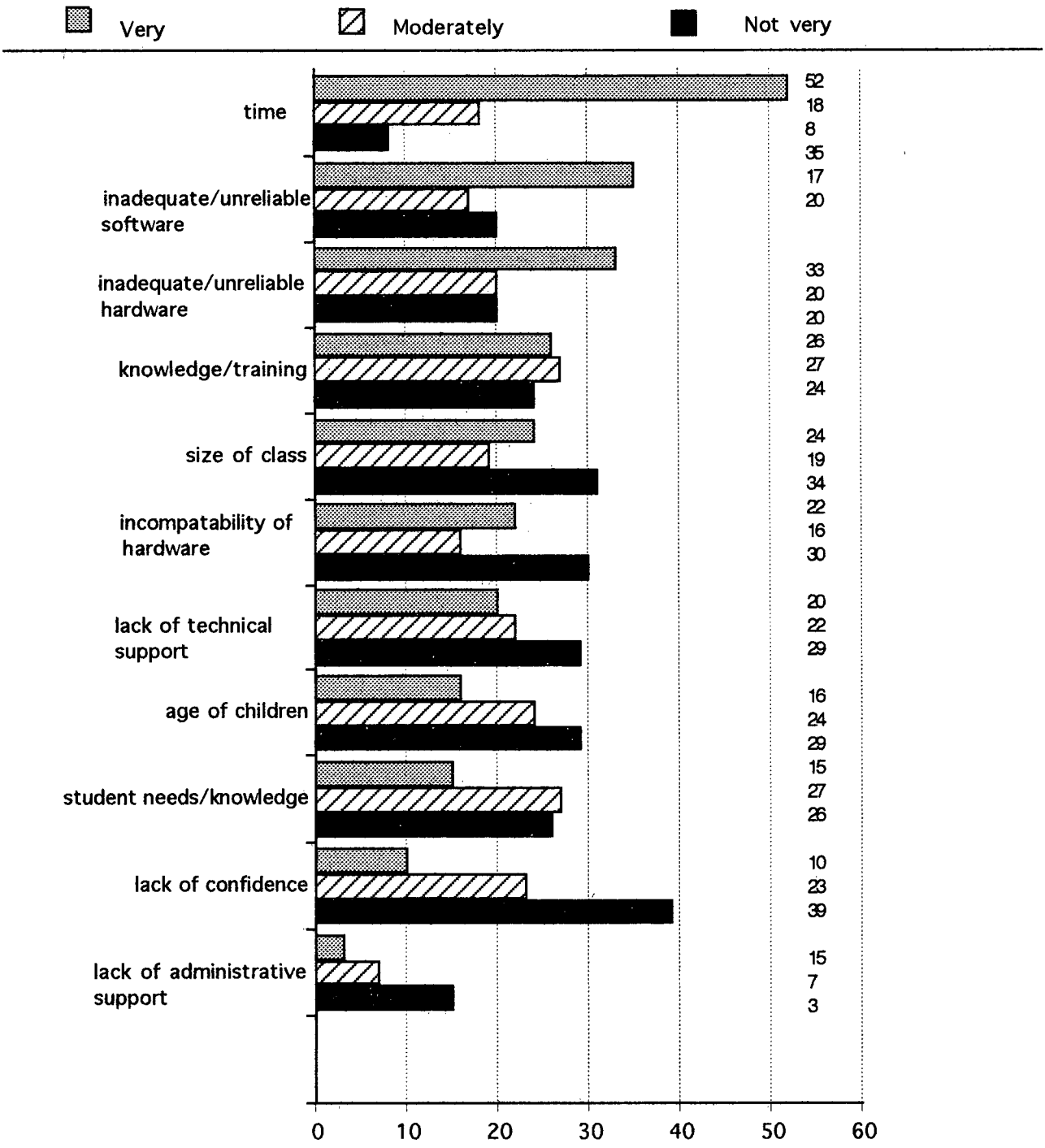


Figure 27: Factors affecting use: Teachers reported to what degree each factor impacted on the single classroom computer's use by indicating very, moderately or not very .

The age of children (40), incompatibility of hardware (38) and lack of confidence (33) were additional factors reported. Lack of administrative support (22) was cited least often as a contributing factor. This last finding may indicate that administrators are, in general, supportive of their staff's computer use and do not hinder teachers to any great extent in their efforts to use their classroom computer. Among the factors listed in the "other" category (5) were slow internet access, inadequate physical space, lack of memory, cost and the presence of special needs children. These findings are compatible with Fullan's (1992) factors of need, clarity, complexity and quality/practicality as each of the factors reported in this study can be categorized into at least one of Fullan's four factors. Time, for example, illustrates Fullan's factor of clarity. If teachers are provided with the time to learn how to use their computer and to explore and practice with it, they will gain more clarity about it and the computer's use in the classroom will be facilitated as a result.

Data from the interviews conducted in this study revealed that teachers' personal beliefs and enthusiasm towards using the computer were instrumental in their use of the classroom computer. Nine of the sixteen teachers interviewed reported that their personal commitment and philosophy towards technology facilitated their using it in the classroom with their students. The second most often reported factor among interview participants that facilitated the computer's use was student motivation. Eight of the sixteen respondents indicated that seeing how motivated their students were while using the classroom computer facilitated their using the

computer with their students. Similarly, observing the success that so many of their students experienced while using the computer provided additional impetus for their utilizing the computer.

Question 3-4: Requests for ease of use, more beneficial use

Figure 28 illustrates what teachers believed they required to make it easier for them to use the computer with their students. More or better software, more time, internet access and a new computer were among the most frequently requested requirements.

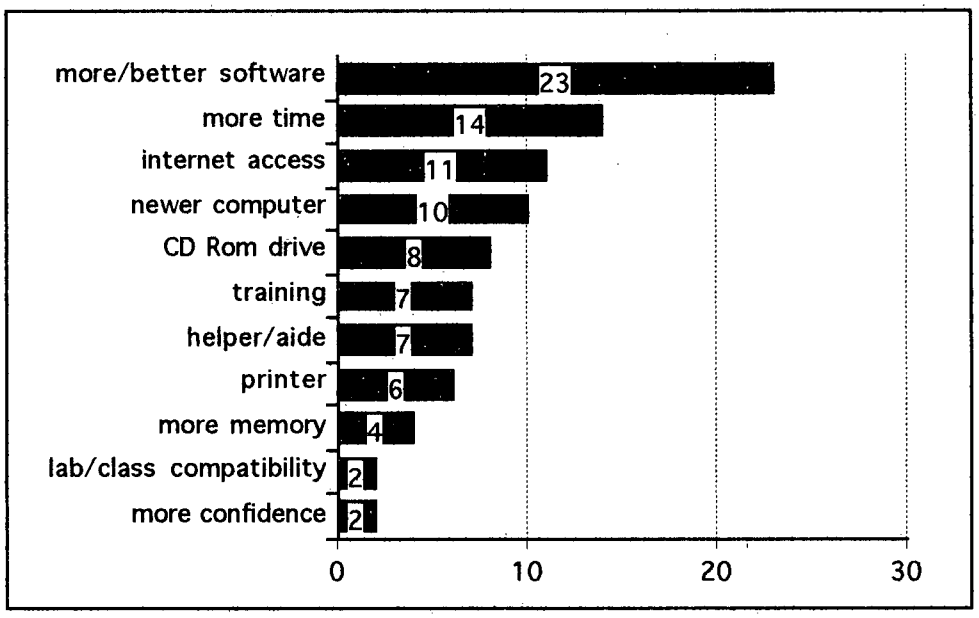


Figure 28: Making computer use easier: Things that would make it easier to use the classroom computer.

Of the sixteen teachers interviewed as to what kind of support they might want for their classroom computer, additional hardware was discussed most often (10); more and better software (5); additional memory (4); and access to or faster access to the internet (4) were all verbalized.

Figure 29 indicates the things teachers reported as needing in order to use the single computer more beneficially with their students. Once again, more and better software ranked high among teacher wishes. In this case, however, it was rated four times more necessary to benefiting use than the next highest ranked requirement of having an adult helper. When teachers were asked what they would request from an individual who would provide support to help them better utilize their computer, three needs were indicated most often. They included network access to the internet or the school district's interschool electronic mail system, troubleshooting and training.

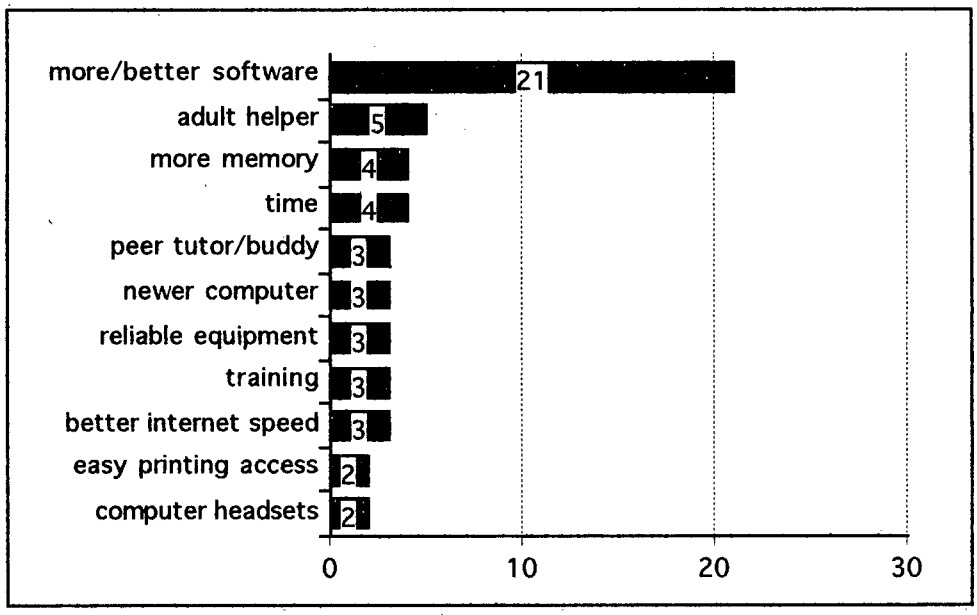


Figure 29: Requirements for more beneficial use: Requests to benefit use of the classroom computer.

Questions 3 and 4 were similar in that they both asked teachers what they needed in order to assist them in using their single classroom computer. That software dominated the responses in each case indicates that software plays an integral role in how the single classroom computer is used.

Question 5: Access to hardware/software

The equipment item that teachers wanted access to most often in order to facilitate their students' learning with a single classroom computer was a CD Rom drive. Among the reasons most frequently provided for this need were that it provides more software choices and ultimately more variety to the students. Table 5 illustrates teachers' needs in this area. That teachers reported CD Rom drives as a primary need is consistent with the finding that more and better software is also required. CD Rom drives provide teachers with the opportunity to use more up-to-date software as well as a wider range of software. That printers were ranked by teachers as second in terms of computer needs may indicate that many teachers already have access to or are in possession of a printer for their classroom computers.

Table 5

Equipment access

	very important	moderately	not very
1. CD Rom drive	34	14	1
2. printer	26	13	4
3. modem	16	11	7
4. scanner	7	16	19
5. LCD (liquid crystal display)	6	8	17

Question 6: Training

Table 6 reveals the preferences of teachers for further training or education on the use of their single classroom computer. The area most frequently selected in which teachers wanted to receive more training was in how to integrate the

classroom computer into other subject areas. Learning how to evaluate software and learning how to use the internet were also commonly cited training needs. A large number of teachers simply wanted training in basic computer skills. Training in these areas would address Fullan's (1992) issues of clarity and complexity. Training could serve to enhance clarity as to what teachers are able to do with the classroom computer and how it can be used and complexity would be reduced as training would provide greater ease of use as well as greater understanding of how to operate the equipment.

Table 6

Training needs

	very important	moderately	not very
1. How to integrate the computer into other subject areas	36	22	9
2. How to evaluate software	25	20	13
3. How to use the internet	19	19	15
4. Basic computer skills	12	20	21

Characteristics of Teachers Who Use the Single Classroom Computer

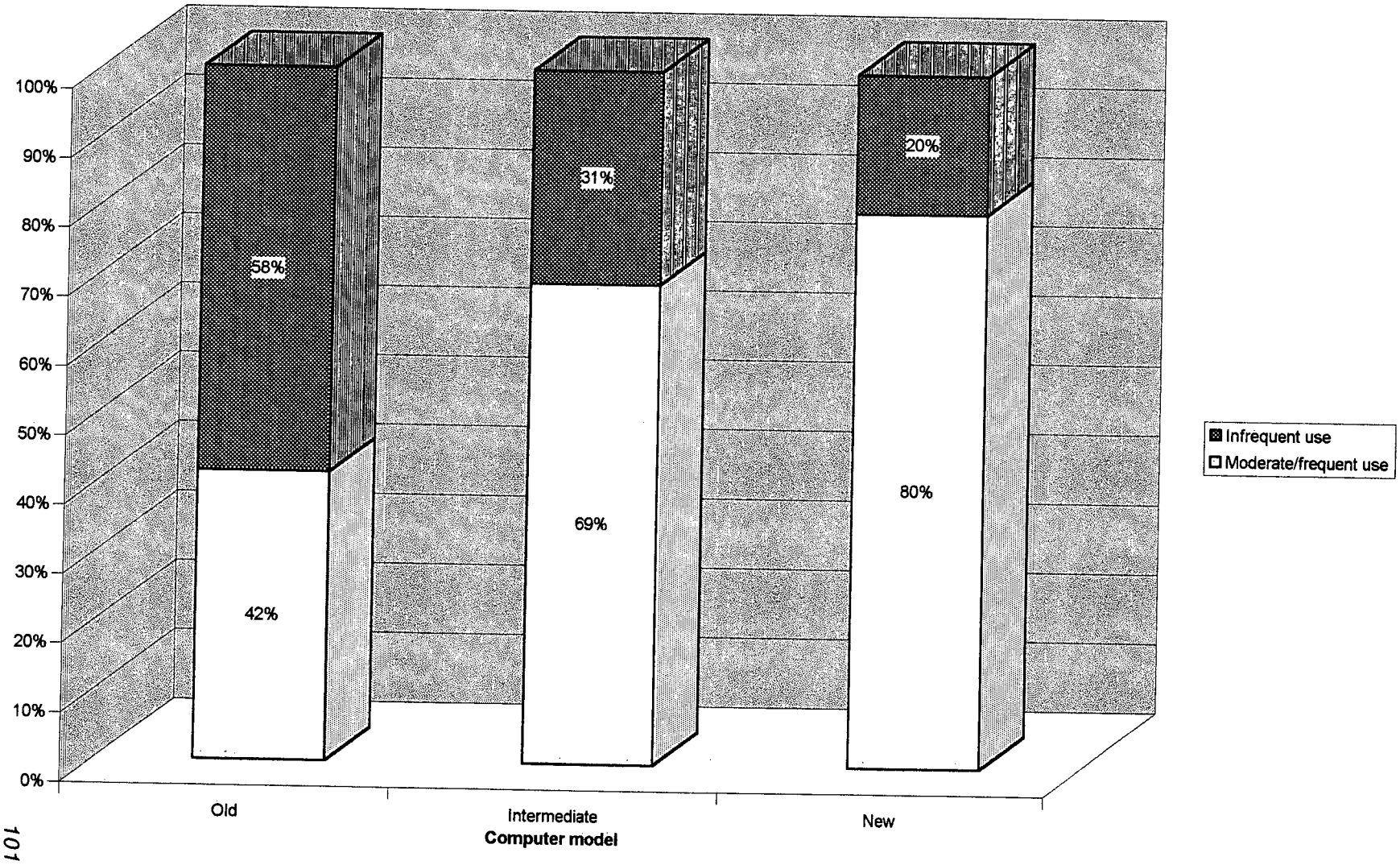
Respondents who completed the questionnaire reported on the frequency of use of the classroom computer by indicating whether use was frequent, moderate or infrequent. In order to determine the characteristics of teachers who use the single classroom computer on a regular basis, those teachers who utilized the computer with their students during class time for more than 30 minutes per day have been considered regular users (moderate or frequent use), while those who utilized the computer for fewer than 30 minutes per day have been distinguished as infrequent users. Several of the questions in the survey were then analyzed

based on whether teachers were regular users versus those who were more infrequent users. The variables considered for this analysis included the number of years of teaching experience, age group taught, comfort level with computers, number of years working with computers, how student time on the computer was allocated, type of hardware, teaching style,computer lab access, access to a home computer and teacher gender. As a result of this analysis some characteristics of teachers who use a computer more regularly in their classrooms were revealed together with the characteristics of those teachers who implement computer use in their classrooms less often.

Type of Computer

As noted earlier, a variety of Macintosh computers was used in respondents' classrooms ranging from Apple II GS's and MacClassics to various LC model machines to PowerMacs. Equipment was categorized as either old (Apple II GS, MacClassic, MacPlus), intermediate (LC models) or new (Performa or better). Figure 30 shows that among those teachers who had an older model Macintosh in their classrooms, 42% used them moderately or frequently. Of those who housed an intermediate model computer in their rooms 69% were regular users and 80% of those teachers with newer model computers were regular users. The data suggest that those teachers with intermediate or new machines in their classrooms engage their use more frequently than those who have an old or outdated piece of equipment available to them and their students. Such a finding may be attributed to Fullan's (1991) factors of complexity and practicality. Using intermediate or newer equipment entails having more options for use, fewer system break down difficulties and often reduces compatibility issues, thereby

Figure 30: Type of classroom computer and level of use: computers were categorized as either old, intermediate or new models. Moderate/frequent and infrequent computer use in classrooms with the various models is reported in percentages.



reducing complexity and increasing practicality of use. It is also possible that moderate or frequent users of the computer are requesting better equipment.

Years of Experience

Based on the data from the questionnaires, teachers were categorized as either having 0-2 years of teaching experience, 3-5 years, 6-9 years or 10 or more years of experience. Figure 31 reveals that 33% of teachers with 0-2 years of teaching background were regularly implementing technology in their classrooms; 50% of teachers with 3-5 years of teaching behind them used the computer regularly with their students; 69% of those with 6-9 years of experience were high users; and 66% of those with 10 plus years of teaching were high users. An examination of this data reveals that greater computer use is associated with a higher number of years of teaching experience. It should be noted that the total number of teachers with 6-9 years of experience who responded to this question was 13. The total number of teachers who responded in the 10 or more years of experience category was 56. It is possible that after a certain number of years of teaching experience (i.e., 6-9) frequency of computer use levels off. That years of teaching experience is associated with frequency of use suggests that teachers may achieve greater clarity as to what to do with the computer after a number of years of teaching or that they perceive a greater need to use the computer after a certain period of time. Both of these factors are included in Fullan's (1991) theory.

Computer User Abilities

Teachers categorized themselves during the course of completing the questionnaire as either novice, intermediate or expert users of technology. Figure 32 shows that 45% of the novice users were also using their classroom computer

Figure 31: Years of teaching expereince and level of classroom computer use: participants' years of teaching experience were categorized as 0-2, 3-5, 6-9, or more than 10 years of experience. Computer use in each category is reported in percentages.

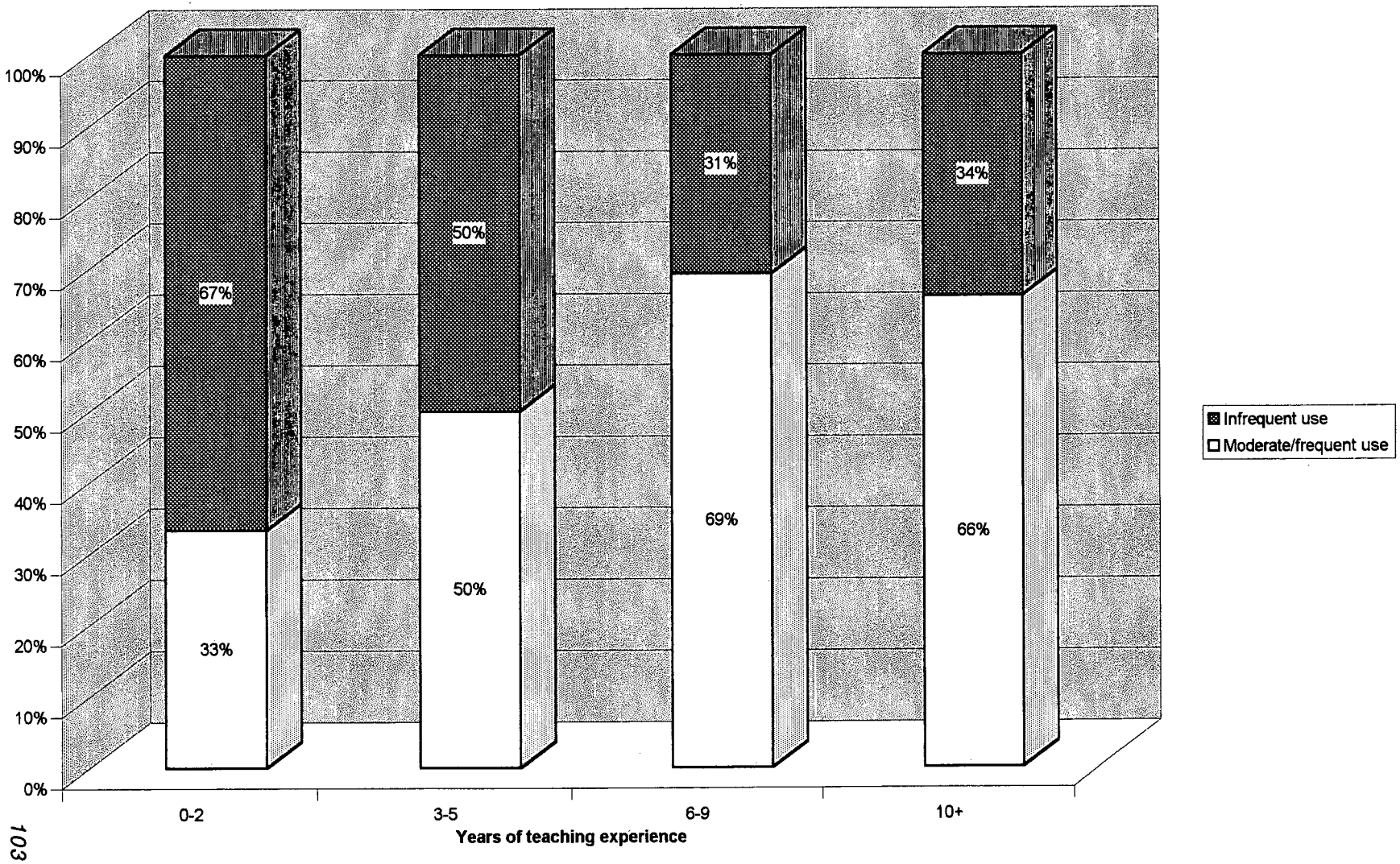
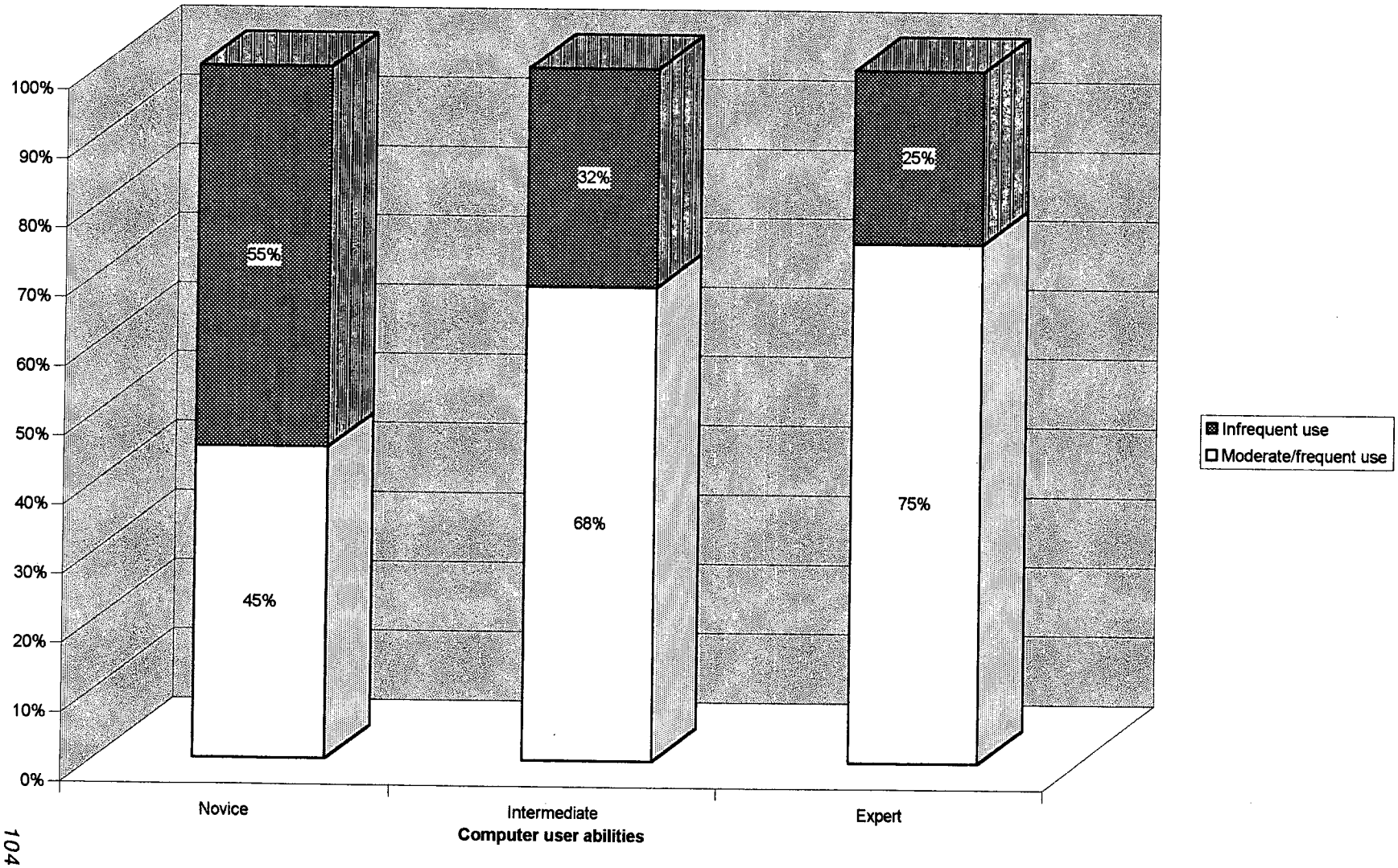


Figure 32: Computer user abilities and level of classroom computer use: teachers rated their computer abilities as either novices, intermediate users or experts. Moderate/frequent and infrequent use in each ability level is reported in percentages.

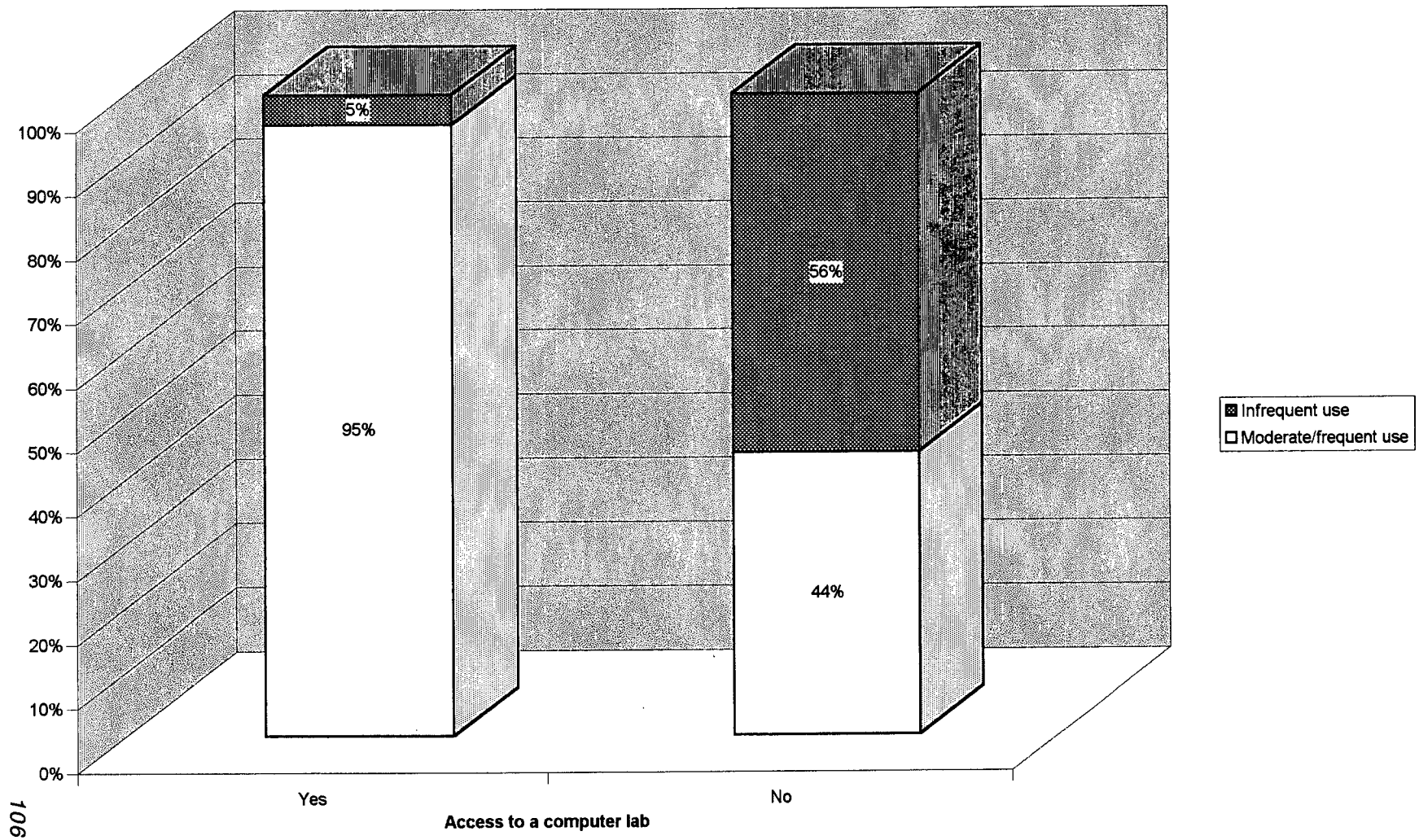


moderately or frequently; 68% of the self-reported intermediate users were also regularly implementing the use of their classroom computer; and 75% of those who rated themselves as experts were utilizing their classroom computer on a regular basis. These responses indicate that teachers who rate their computer abilities as novice are least likely to engage its use with their students; teachers who consider themselves to be intermediate users are more likely to utilize the computer and those with expert abilities are most likely to use it. Such a finding is consistent with Fullan's (1992) observation that as complexity is reduced and clarity is increased, computer use may increase. Novice teachers would likely find it more difficult to use the computer given their inexperience with it. Similarly, those teachers who considered themselves to be expert users would likely have achieved greater clarity as to what to use the computer for and how to use it with their students.

Access to a Computer Lab

Figure 33 demonstrates that among the teachers who were using their classroom computer moderately or frequently, 95% also had access to a computer lab in their schools. Of the teachers using their classroom computer infrequently, 44% also had access to a computer lab. One possible explanation for this data is that teachers who do not have lab access find it less practical to engage the classroom computer because opportunities to practice and become more proficient on the computer are reduced. Another possibility is that without a lab, the turnover for students to use a computer is substantially diminished, perhaps resulting in a corresponding dip in motivation. Such a finding is consistent with Fullan's (1992) conclusion that practicality of use is related to the implementation of an innovation.

Figure 33: Access to a computer lab and level of use of classroom computer: teachers indicated whether they had access to a computer lab. Moderate/frequent and infrequent computer use in classrooms with and without lab access is reported in percentages.



Computer Comfort Level

Teachers were asked to characterize themselves as either having a low, medium or high level of comfort when working with computers. Figure 34 illustrates that 63% of the teachers who ranked themselves as possessing a high comfort level were moderately or frequently using their classroom computers; 68% of those with a medium comfort level were also regularly implementing the use of their single computers with their students; and 50% of those with a low comfort level were using their computer frequently. That greater levels of comfort are associated with higher use should not be surprising given that motivation and knowledge may be the result of such comfort. Having achieved greater clarity or having complexity reduced could account for this finding. That the percentage of teachers with a medium comfort level who used computers regularly is higher than the percentage of regular expert users may be accounted for by the fact that 50 medium comfort teachers responded to this question and only 19 high comfort teachers responded.

Primary and Intermediate Teachers

Figure 35 reveals that 65% of the respondents who were primary teachers were also moderate or frequent computer users and 61% of intermediate teachers were engaging the computer in moderate or frequent use. That little difference was found among age levels taught could be explained by the fact that elementary practitioners are essentially generalist teachers and therefore teach a number of subjects in every grade. As such, they have similar opportunities to integrate the computer into the curriculum.

Figure 34: Comfort level with computers and level of classroom computer use: teachers rated their comfort level with using computers as low, medium or high. Moderate/frequent and infrequent computer use at each comfort level is reported in percentages.

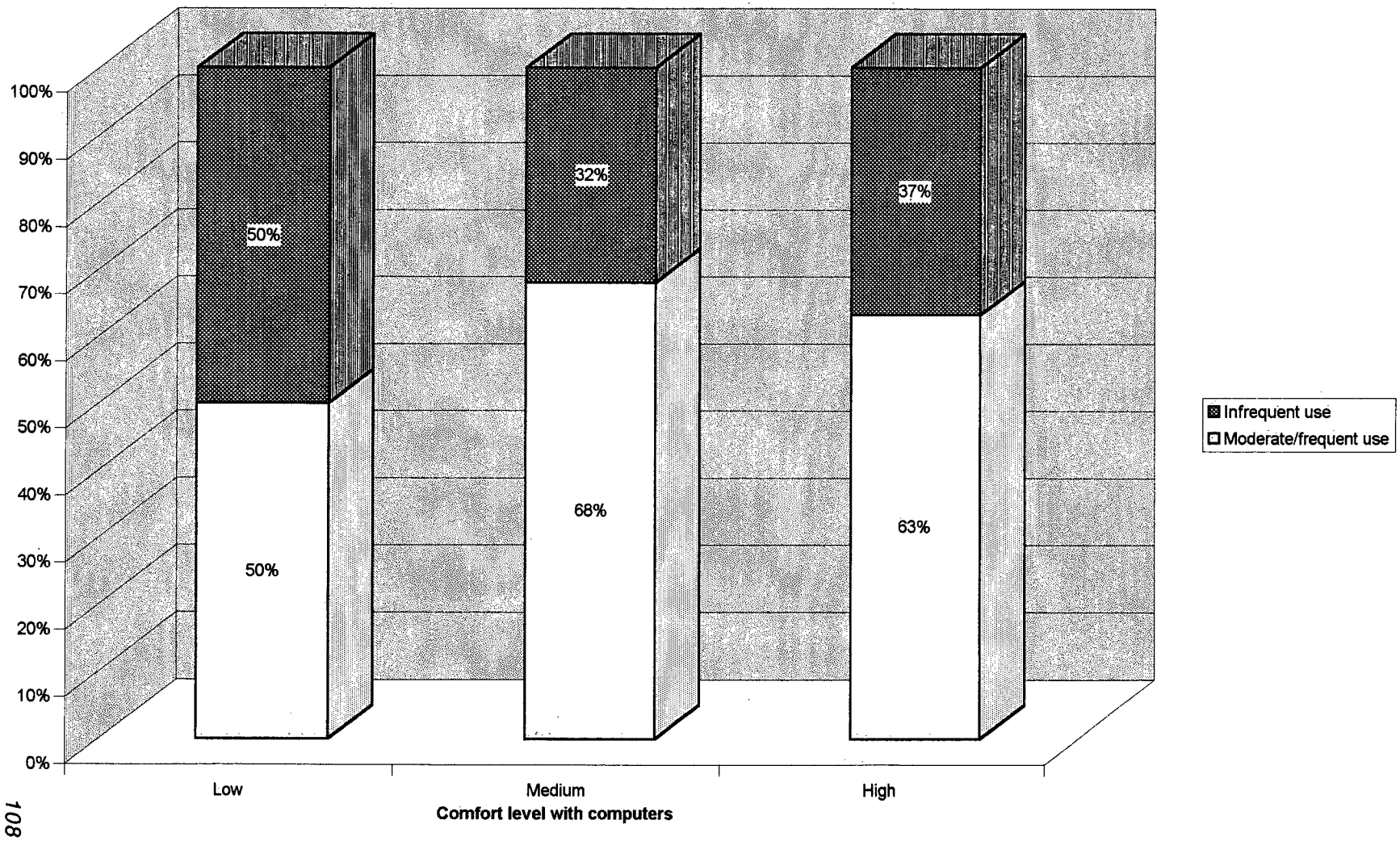
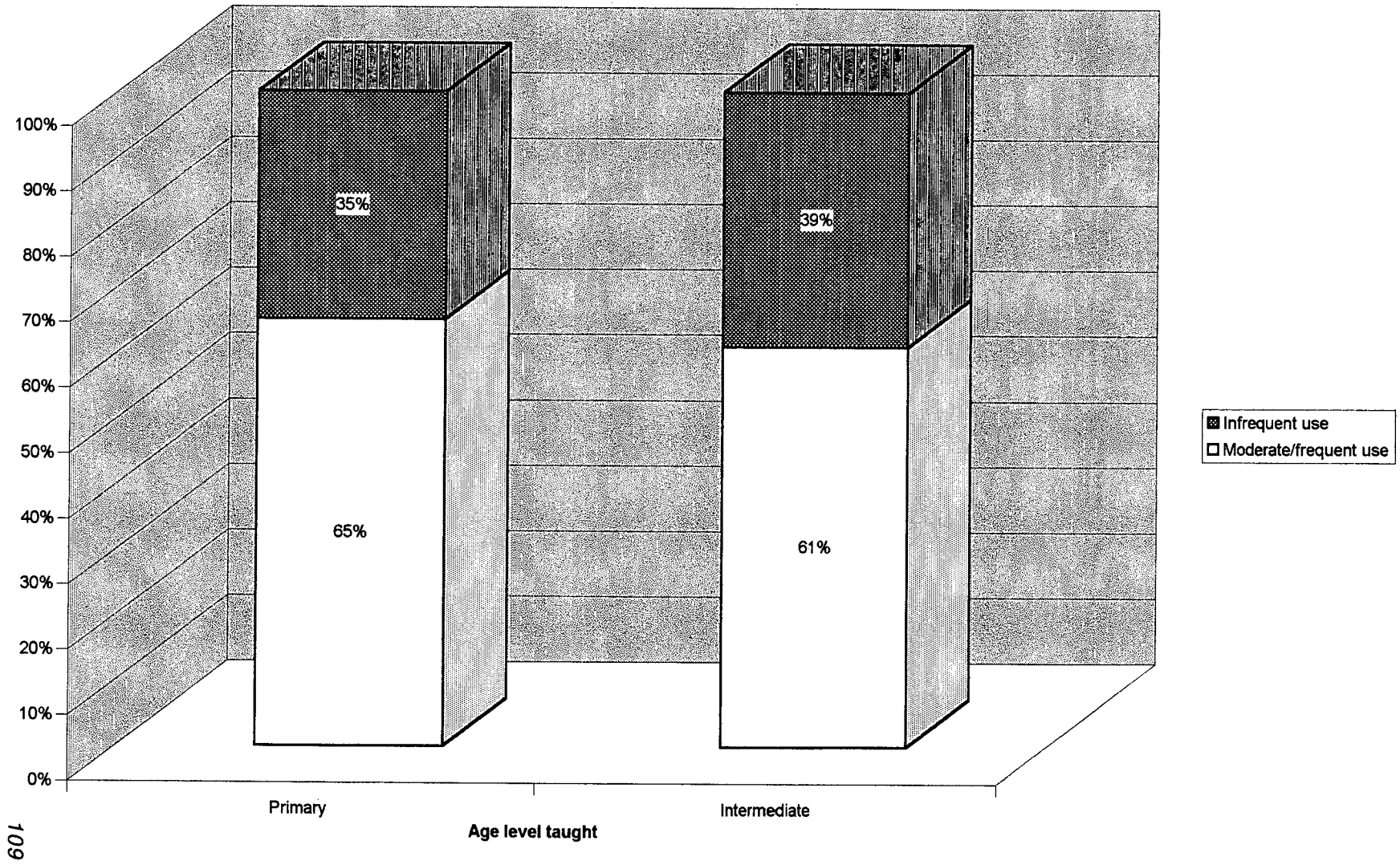


Figure 35: Age level taught and level of classroom computer use: participants were categorized as either primary or intermediate teachers. Moderate/frequent and infrequent use at each level is reported in percentages.



Teacher Gender

Figure 36 shows that 62% of the female respondents were using the computer regularly while 67% of the male teachers were engaging its use regularly. Such a finding suggests that there is little difference in use among male and female teachers where computers are concerned. A possible explanation for this finding is that both sexes have had opportunities to learn how to use their classroom computers. The widespread distribution of computers may have allowed both genders to practice and explore computer uses on an equal basis. As well, the number of reported home computers may also contribute to teachers becoming more fully versed in the use of the computer.

Years of Working with Computers

Figure 37 shows that of those teachers with 3-5 years of experience with technology, 63% were regular users; 62% of teachers with 6-9 years of computer experience were also regular users; and 66% of those with 10 or more years of working with technology were regular users. There would appear to be little difference in use based on years of computer experience. This finding suggests that once teachers have spent a certain number of years working with computers, an increase in years of working with computers is not necessarily commensurate with greater frequency of use. The implication of this is that teachers can achieve clarity with respect to using computers, as well as have the complexity surrounding them reduced, with as little as 3-5 years of experience in working with them.

Figure 36: Teacher gender and level of classroom computer use: male and female teachers were categorized as either moderate/frequent or infrequent computer users. Levels of use among males and females are reported in percentages.

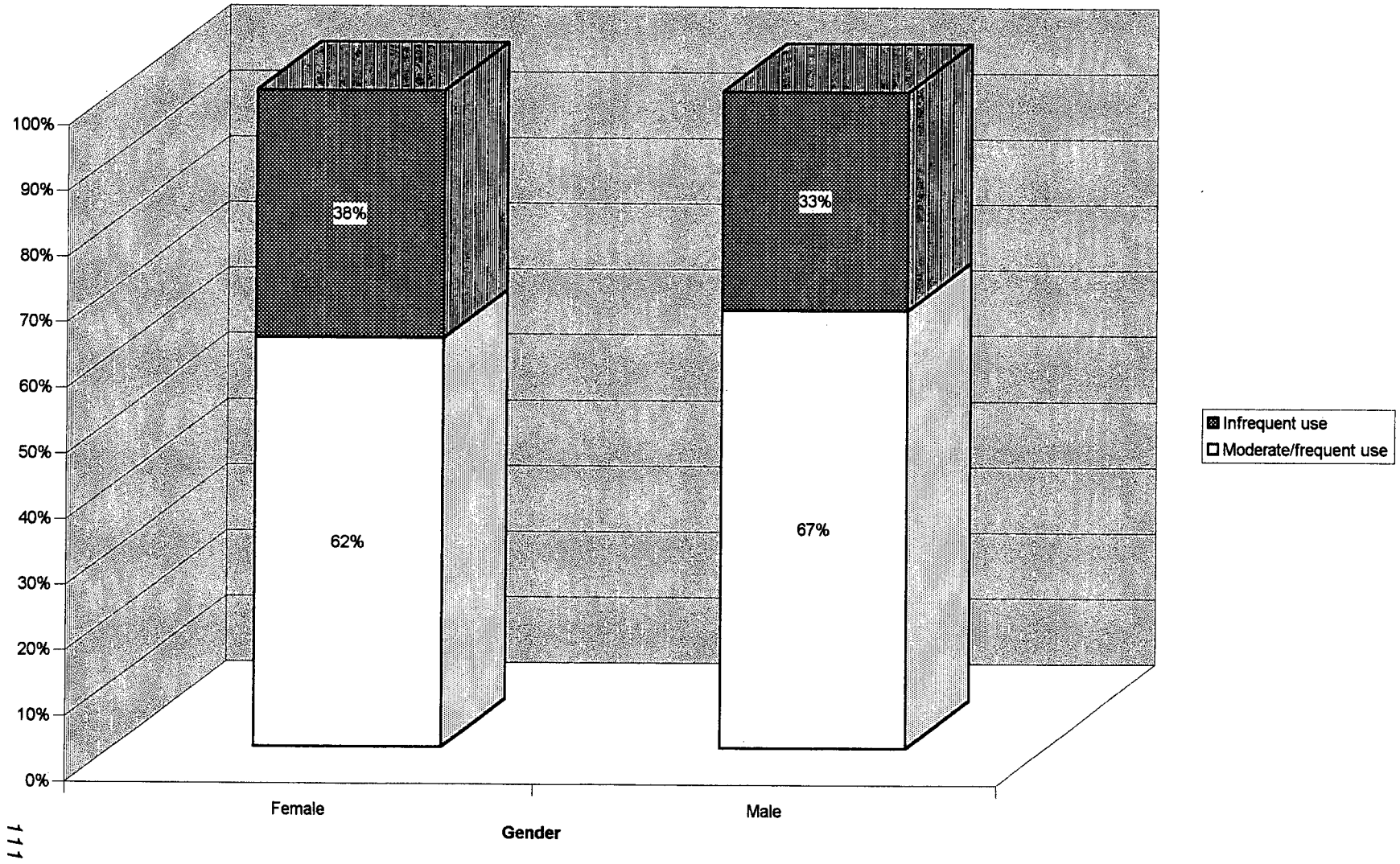
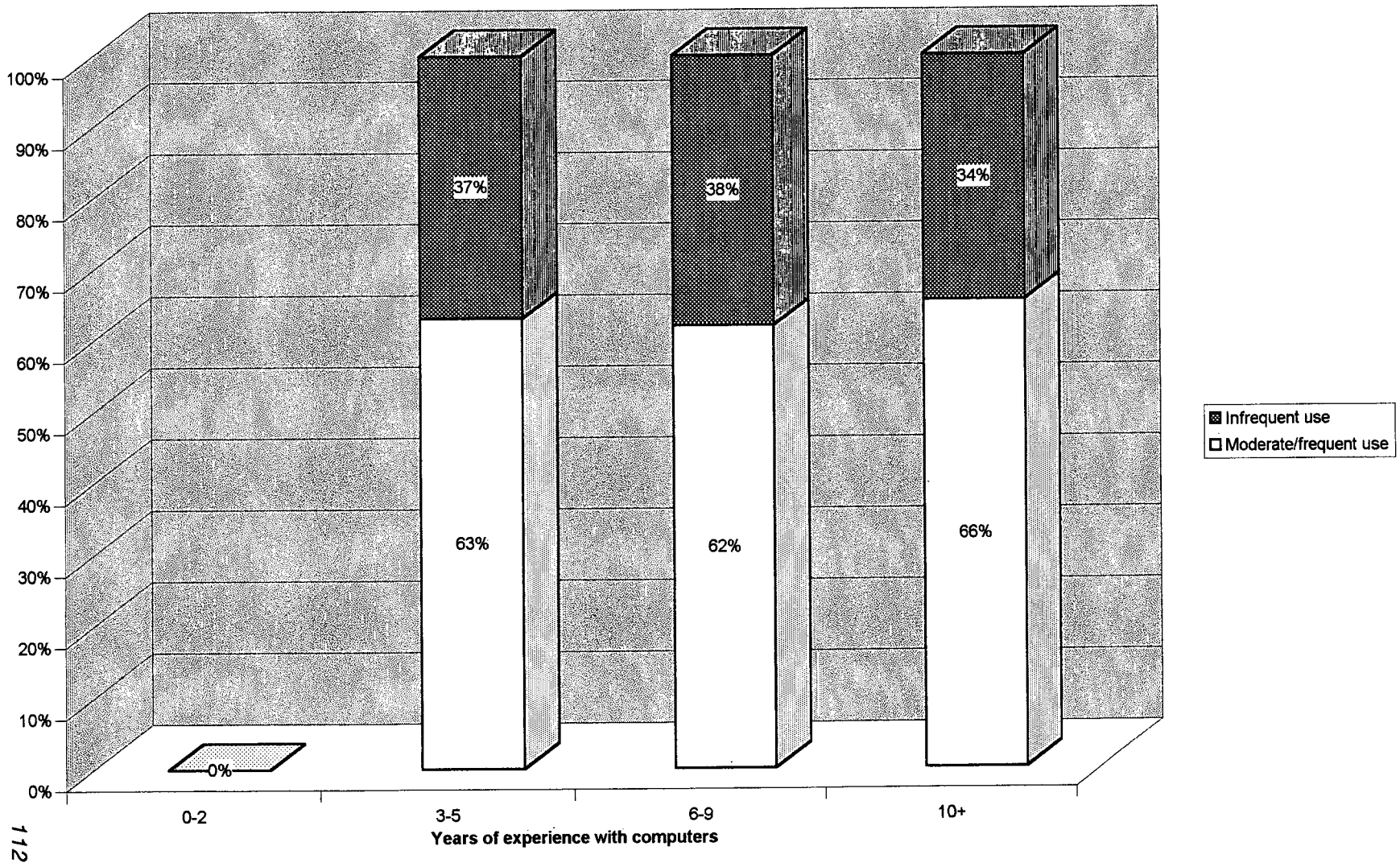


Figure 37: Years of working with computers and level of computer use: teachers reported the number of years they had been working with computers. Moderate/frequent and infrequent computer use in each category is reported in percentages.



Home Computers

Figure 38 indicates that of the teachers who did have access to a computer at home, 61% were also moderately or frequently using their classroom computers. Among those teachers who did not have access to a home computer, 70% were using their classroom computers on a moderate or frequent basis. Those teachers without access to a home computer could be using their classroom computers more because they don't have one at home. It should be noted however, that only eight respondents did not have access to a home computer. Opportunities to use a computer at home could increase clarity of use and reduce complexity of use, two of Fullan's (1992) factors of change.

Allocating Student Time on the Computer

When asked how student time was allocated at the single classroom computer, teachers indicated that either a posted schedule was used, students determined use, random use occurred or a combination of these took place. Figure 39 reveals that in the classrooms in which a posted schedule was used, 85% of the teachers were high users; in classrooms where students determined when they would use the computer, 64% of teachers used it moderately or frequently; and where a random use method was employed, 58% of teachers were using it regularly. It is apparent that the structure of a schedule or the motivation of the children who determine its use can account for higher rates of use than a random procedure. The posted schedule contributes to the practicality of use as it leaves little doubt as to whose turn it is at the computer. In addition, where students are determining the computer's use, their need to use the computer is being fulfilled.

Figure 38: Access to home computers and level of classroom computer use: teachers reported whether they had access to a home computer. Moderate/frequent and infrequent computer use in each category is reported in percentages.

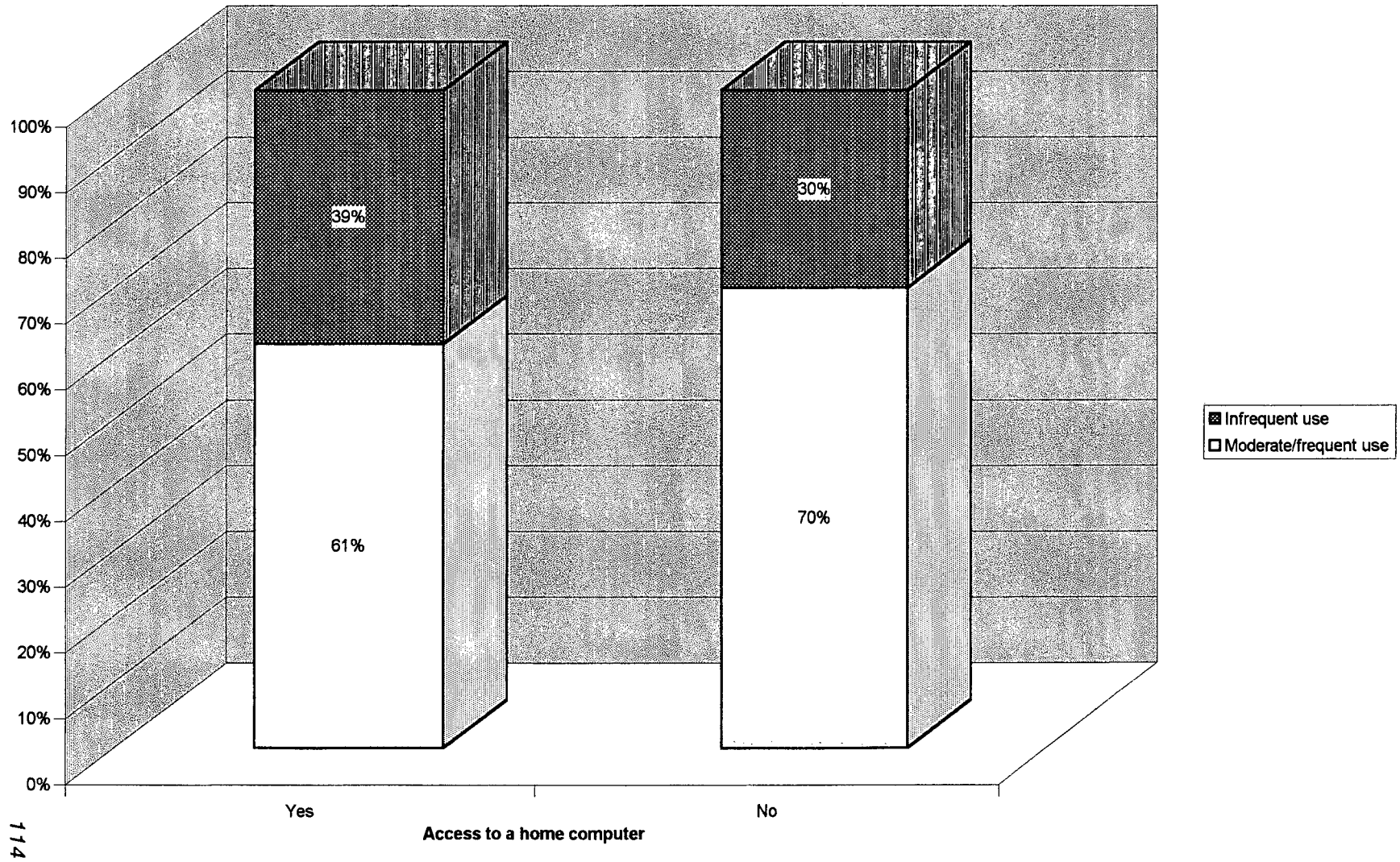
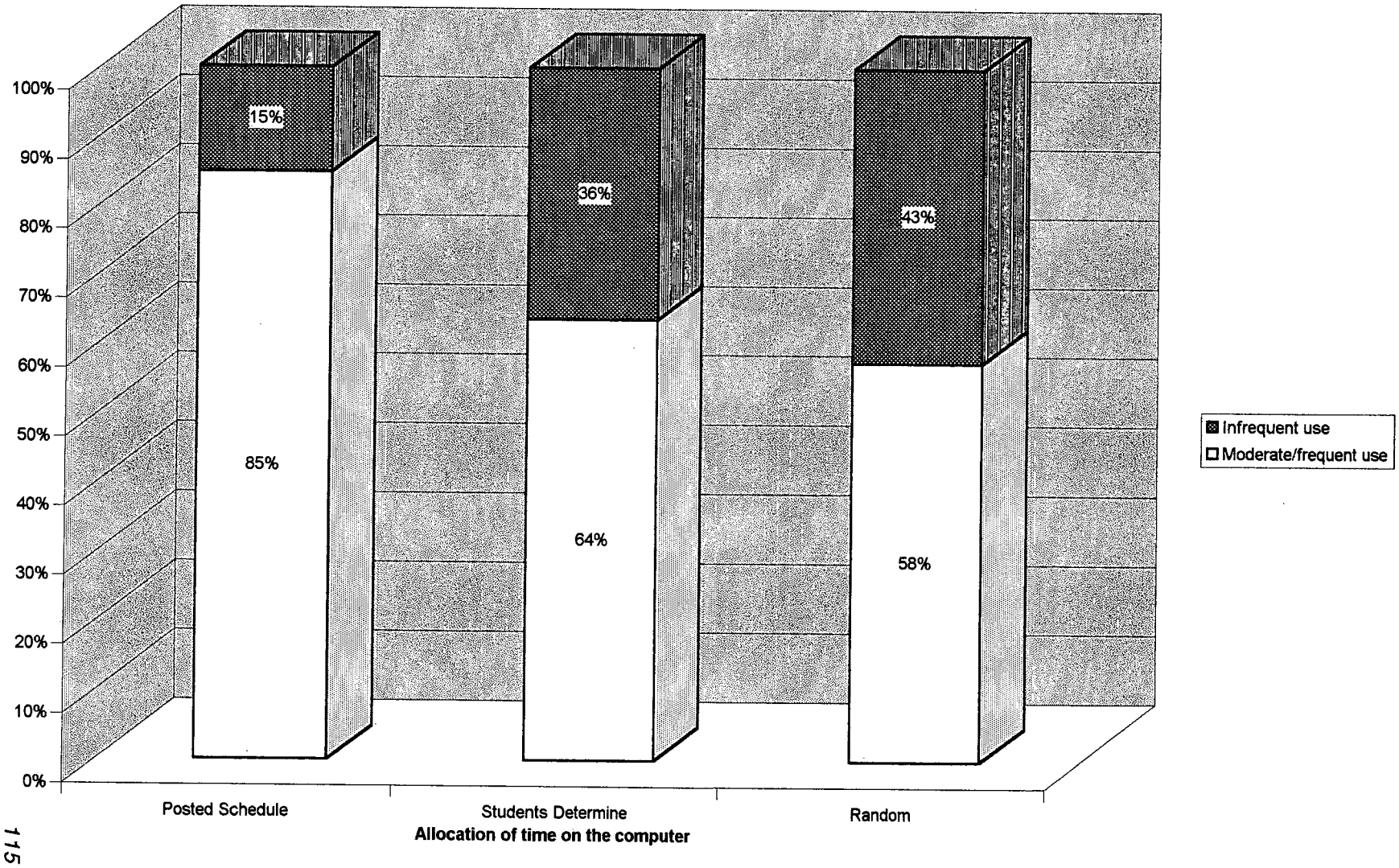


Figure 39: Allocation of computer time and level of classroom computer use: student time at the computer was determined by a posted schedule, by students or randomly. Moderate/frequent and infrequent computer use is reported in percentages.



Interview Results

As noted earlier, the interviews in this study indicated that word processing and games dominated computer use in the single computer classroom. The interviews revealed that teachers also experienced success in using the computer for enrichment and remediation activities. When asked what they required in order to better utilize their classroom computers, teachers reported that access to the internet and access to the district's electronic mail system were among their priorities. Equally important to teachers was the need for additional training in the use of their computer equipment. As previously outlined, requests for upgraded equipment and additional or current software were listed most frequently as requirements for supporting the computer's use in the classroom. In response to the question as to what teachers believed students should be doing at the classroom computer, eleven of the sixteen teachers interviewed stated that enhancement of the curriculum and reinforcement of basic skills was ideal. That the computer should be a "tool" for learning and extending learning was frequently cited.

Eight of the 16 teachers interviewed indicated that they were able to use their classroom computer to its full potential. Six teachers reported that they felt there was a gap between what the computer was capable of and what they were able to do with it. Regardless of their knowledge of their computer's potential, 14 of the 16 teachers interviewed expressed positive feelings towards having a computer in their classrooms. Teachers' responses to having access to their classroom computers was similar to those of the students they taught. Teachers revealed that in the majority of cases, their students were keen to use the computer. Similarly, their students' motivation often provided teachers with a rationale for using their

single computers. They also believed that the computer extended children's learning, improved the quality of student work and was a labour-saving device that reduced student frustrations in editing work. For half of the teachers interviewed, their ideas for how to use their computers came from either observations of or conversations with their colleagues. Developing their own ideas for use was also frequently discussed.

Consistent with the questionnaire data in this study, time was mentioned as the factor impacting computer use most often. Twelve of the 16 interview participants listed time as a barrier to use. Also consistent with questionnaire responses was the finding that inadequate and unreliable hardware and software was a frequent impediment to use. Requirements for CD Rom drives, faster network connections, internet access, printers, current software and upgraded equipment were all raised by interview respondents. Lack of personal knowledge and training, the absence of a support person on staff and logistical concerns such as noise, class size, class management and the age of kids were also reported. Factors that facilitated computer use most often included teachers' own personal beliefs regarding technology and their enthusiasm towards using it; their own expertise and training experiences; and witnessing their students' motivation levels when using the computer. Having the support of their administrator, having technical support and having a newer computer in their classroom were all factors that enhanced teachers' use of the computer.

Summary

The data in the present study reveal that, based on gender and average number of years of teaching experience, the participants involved were generally

representative of elementary school teachers in the province. The majority of the teachers in this study had ten or more years of teaching experience. As well, the vast majority of respondents considered themselves to be intermediate users of computers in terms of ability. Similarly, teachers most often rated their comfort level in working with computers at a moderate or medium level. Among the explanations most commonly attributed to comfort level were assistance from colleagues and self-teaching or self-help.

Teachers' reported that instruction styles were largely made up of facilitative and direct methods of teaching and more than three-quarters of the respondents surveyed indicated that computers had not changed their teaching style. Where teachers reported that a change in teaching style had occurred, a greater comfort with students being independent was most often cited as a change that had resulted. Teachers reported a number of professional uses for their single classroom computer. The preparation of report cards dominated those uses. Additionally, more than 90% of teachers also had access to a home computer. The home computer was reported to be used for a variety of professional as well as personal purposes.

The most common methods for allocating time on the computer were random use and by means of a posted schedule. The most typical periods of time during which the classroom computer was used was for 1-30 or 30-60 minutes. Students whom teachers classified as frequent users of the computer spent an average of 65 minutes per week at the computer. When students used the computer they most often did so on an individual or paired basis. In most cases, the tasks performed at the computer were determined jointly by teachers and students. The majority of

classrooms also had access to a computer lab on an average of 54 minutes per week.

The most common types of computer assignments within schools in this district were either a distributed model of one computer per classroom or a combination of labs and distributed computers in individual classrooms. The most typical means through which teachers came to acquire their classroom computers was through school distribution, inheritance from previous teachers and the dismantling or upgrading of a computer lab. A variety of computers were housed in teachers' classrooms including older, intermediate and new versions of MacIntosh computers. The majority of teachers did report having to make some organizational changes in their classrooms in order to accommodate their classroom computers. The peripherals that were most commonly reported to accompany their computers were printers and CD Rom drives. Games and word processing were used most frequently in the classroom.

Language arts was reported to be the subject area in which the computer was integrated into most often. Teachers in this study believed that a number of benefits resulted from using the computer. That students would gain familiarity with computers was cited most often as a benefit. When queried as to how the computer should be used, enrichment was reported to be the use preferred by respondents.

Support for the classroom computer came most often from a colleague. The factors that impacted use were numerous. The factor most frequently cited as affecting use was time. Inadequate and unreliable hardware and software as well

as personal knowledge and training were were also reported to be frequent hindrances to use. Teachers' ideas as to what would contribute to ease of use of their classroom computer included requests for more and better software as well as more time. Their most often cited requirement for more beneficial use was also more or better software. The equipment they reported to be most in need of was a CD Rom drive, in order to have access to a greater variety of software. And where training was concerned, learning how to integrate the computer into other subject areas was their top priority for further education on the use of the computer.

CHAPTER V

DISCUSSION

> Raw data have no inherent meaning; the interpretive act brings meaning to those data and displays that meaning to the reader through the written report. (Marshall & Rossman,1995, p. 113)

The purpose of this study was to provide insights into how the single classroom computer is being used in one B.C. school district and the factors that facilitate as well as impede that use. Literature and research relating to this subject was reviewed in an effort to make comparisons with the present study. An exploration was also made of the literature on curriculum implementation and change theory with respect to technology, in order to assess how one theory of implementation is reflected in the findings of this project. Michael Fullan's (1991, 1992) theory of change was used as the conceptual framework on which to base the present study. The following is a discussion of the primary findings of this study. The summary is followed by the conclusions drawn from the results and the findings are then integrated with the findings of previous research. Finally, the implications of this study for theory, future research and professional practice are outlined, together with recommendations for educators.

Summary

In order to describe the types of uses to which the single classroom computer is being used, information was gathered from participants by means of questionnaires and in-depth interviews. The results of the study indicate that at both the primary and intermediate grade levels, computers are being used in a

variety of ways. The applications that dominate are games and word processing. In addition, a number of factors were found to influence the use of the classroom computer. Time was reported to be a primary concern of teachers in their efforts to implement the use of their single computer. Based on the data, one can infer that computers are being underutilized in classrooms because of a number of factors, including time and inadequate and unreliable hardware and software, which work against implementation. The findings in the present study support Fullan's (1992) theory that change is multidimensional and that when too many factors are working against implementation, success is less likely. If, for example, inadequate software hampers computer use it is what Fullan (1992) would categorize as a matter of practicality and/or complexity. If such a factor hinders use, therefore, it is because it has made computer use less practical or more complex.

Overview of Significant Findings

A variety of computer applications are being utilized in the one-computer classroom. Games and simulations top the list with word processing, drill and practice programs and graphics and drawing applications ranking second, third and fourth respectively. It was also evident that there are teachers at all levels of comfort and user ability who use computers routinely in their classrooms. And although some resistance to computers may be inferred from teachers who participated in this study, the majority of teachers provided students with opportunities to use the classroom computer in varying degrees. The data on frequency of use based on minutes per day at the computer, as well as data on the average amounts of time students spend at the computer is evidence of the varying degrees of use.

Despite the varieties of use for the single computer, the variety of peripherals that accompany many computers, and the widespread acknowledgement by teachers of the benefits of using computers, the data suggest that the single classroom computer is being underutilized. Once again, responses concerning the frequency of use were perhaps the best indicator of this. When the computer is used, language arts is the subject area in which the computer is most frequently integrated.

Despite the widespread distribution of computers in B.C. elementary schools (B.C. Ministry of Education, 1995a) there are a number of obstacles hindering their use in the classroom and their integration into the curriculum. Among the myriad of factors affecting the use of the single computer, time was the most frequently cited factor. Concerns around the issue of time were identified on several dimensions including being overwhelmed with an ever-increasing number of curriculum subjects to be taught, finding time to undertake training to become more computer literate and finding the time to explore on the computer. Other elements of time involved finding the time to discover the ways to integrate the computer into the classroom and the curriculum, time to evaluate software, time to devise lesson plans and finding time for student use during an already busy day. The following is a sample of some typical comments made by teachers.

> *I would like time to learn, hands-on, the nuances of computer technology. Most of my training has taken and is taking place in a crisis mode. I have to say that the time it takes for me to address computer glitches is not always ideal. It does add extra stress to the classroom environment, particularly when the class is made up of*

several students with behaviour and/or special needs. And it (the computer) can be an added stressor. [grade 3 teacher]

I suppose the biggest thing is the time. I mean, time is of the essence in here anyway and we're just so short of time and I'm not talking about time for the training, I'm talking about—there's just too many things to be done. [grade K-1 teacher]

You know, you have so much to do at the end of the day and the last thing you want to do is spend time trying to figure out the computer . . . I'm not prepared to sit down with manuals and figure it out. It's not a priority for me. [grade 4 teacher]

Both lack of personal knowledge or training and unreliable or inadequate hardware and software were the second most frequently cited factors influencing use. The school district in which the present study took place offered after school workshops which meet the needs of some teachers. Other teachers expressed a need for entire professional days and ongoing training in the use of computers. The teaching priority most frequently reported was learning how to integrate the computer into the curriculum. As one teacher noted,

I just feel fairly inadequate as far as what we should be doing with it (the computer), simply because as much as I say, well, we do this and we do that, there are still a lot of days when it doesn't get turned on, just because I can't see how to use it in the situation. [grade 4 teacher]

The issue of the adequacy and reliability of hardware and software available to teachers in their classrooms had a number of dimensions. Among them were concerns over troubleshooting, accessing quality software that fit with the curriculum and ease of use. What teachers expressed most often as needing in order to better use their classroom computer was more or better software and time. In order to provide the most benefit to students, teachers indicated, once again, that more and better software was most advantageous. Among the most frequent wishes for equipment were a CD Rom drive, a printer and a modem. Such devices can improve productivity, allow access to more software and provide opportunities to use the Internet. On many occasions, teachers alluded to the fact that more than one computer in the classroom would be more ideal than their current one-computer classroom configuration. Greater turnover in use among students and expediency issues were behind teachers' rationales for wanting more than one computer.

Change Theory

Based on Fullan's (1992) ideas on the implementation of change, the factors impacting use were categorized as either issues of clarity, complexity, quality/practicality or need. The following discussion provides a brief summary of the dimensions of those categories as they pertain to technology use and lists the factors discovered in this study in the corresponding category. In some cases, the factors discovered in this study can be classified into more than one category.

Clarity

Fullan (1992) has described the issue of clarity and technology implementation as revolving around the elements of opportunity and time: the time to become

immersed in the innovation and to plan for its use and the opportunity to work with it and discuss its use with others. Clarity, he maintains, may also be sought as to what the effective use of the change looks like and how it can be used educationally. Teachers need to know what to do differently as a result of the innovation and they require clarity about the goals involved in the computer's use. Clarity also arises with respect to understanding which software programs should be used, how they actually work and what their role will be in instruction (Fullan, 1992). Opportunities, therefore, are also needed to discover the answers to these questions, whether they come in the form of training, materials or some other medium.

Among the factors found to facilitate the use of the single classroom computer that related to the issue of clarity were personal knowledge and training. If teachers had achieved clarity with respect to how to use the computer they were more likely to engage its use with their students. Data reported regarding years of teaching experience, computer user ability and comfort level with computers were associated with greater computer use in the classroom. Similarly, more than half of the teachers interviewed indicated that personal beliefs and enthusiasm facilitated the use of their single computers. Those teachers who believed that using computers with children was beneficial and who were keen to use the computer as another learning medium reported higher use. Their clarity of beliefs, therefore, was associated with computer use. Factors that hindered use that could be characterized as clarity concerns were insufficient time, lack of support and lack of knowledge or training. Once again, interview participants reported that if time to learn or explore or prepare for lessons using the computer was lacking, clarity was less likely to be achieved and as a result, computer use was less likely.

In the absence of support or training through which clarity about the computer could be gained, use of the classroom computer was hindered. For example, teachers with lower levels of comfort or expertise in using the computer engaged its use less often.

Despite the fact that a curriculum for information technology is now in place teachers revealed that they continue to grapple with what constitutes the effective use of computers. Understanding how the computer can be used for educational purposes is central to the issue of clarity. Achieving clarity may continue to be problematic for teachers implementing technology. Because clarity where "effective uses" is concerned has yet to be determined and may, in part, be left to teachers to determine, clarity will remain central to issues of technology implementation.

In order for teachers to achieve clarity they need to be shown and be given opportunities to discover the answers to what effective and meaningful uses of computers are, as well as what can be accomplished with the materials involved. The mere existence of materials may not yield the clarity and understanding about the new curriculum unless teachers are provided with ideas on how to change their teaching practices (Fullan, 1992). Fullan (1992) observed that initially, many teachers experienced difficulty and frustration in attempts to use computers. He found that the Ministry of Education, in the case of his Canadian study, attempted to standardize hardware and software which may have actually distracted from what Fullan believes is the key to clarity–the identification and development of appropriate teaching practices.

Complexity

The complexity of a change impacts on teachers' implementation of the innovation. The complexity of using technology with children results from the difficulty of using it or using it for educational purposes (Fullan, 1992). The complexity of use and the complexity of skills required in order to implement the innovation are central to this factor. Technical assistance or support may be needed, hardware and software compatibility may be at issue and troubleshooting may be necessary. In order to address the complexity factor, Fullan (1992) has also related complexity to the alteration of teaching practices (e.g., teaching and learning activities, classroom organization and evaluation).

Factors which teachers felt facilitated their using the classroom computer and, therefore, reduced the complexity involved in using the computer in this study were having a newer model computer, having internet access and a printer, having ready access to hardware and software and having acquired the knowledge to use the computer. The task of using the classroom computer could be made less complex when a newer computer was present because it provided more options in the form of more or better software, more memory for more applications and fewer troubleshooting or compatibility issues. Access to a printer would reduce the complexity of having to travel to another location in the school to print student work and could provide the immediacy of results to students when the ability to reproduce a product was available. Having the knowledge to use the computer would reduce complexity as well. Among the factors hindering use that were related to complexity were inadequate or unreliable software, slow network access, the lack of printers and CD Rom drives, outdated equipment and lack of knowledge surrounding troubleshooting issues. Software that presented user

difficulties made using the computer more complex as teachers did not always possess the knowledge or expertise to assist students with the problems encountered. Internet access that was too slow made the job of using the computer more complex as the turnover of students at the computer was reduced, therefore, requiring extended periods of time for individuals to complete assignments. The absence of printers meant travelling elsewhere in the school for a printed product or limiting the computer's use to tasks in which a printed product was not the end result. Not having a CD Rom drive was equated to limited software choices. The issue of complexity was also revealed when teachers indicated a need for more or better software, more training and support in the form of a technician.

Complexity results from how different teaching with technology is from current beliefs, practices and materials. Fullan (1992) maintains that the complexity of equipping schools with computers has neglected the complexity involved in using computers once installations are complete. He also believes that what needs to be considered is that there is a great deal of complexity involved even for highly motivated and willing teachers with access to high quality equipment and substantial support. Teachers, therefore, are much more likely to embrace change when it is not overly complex and when they understand clearly what they are to accomplish with computers (Fullan, 1992). The pedagogy of technology as Fullan (1992) has noted, is not well specified, developed or even known.

Quality/practicality

The quality and practicality of the change is connected to the need to fulfill expectations of what Fullan (1992) has termed "technical certainty." These

expectations, he contends, are synonymous with the "how to do it" and "how to use it" requirements of teachers. The materials involved, whether curriculum resources or equipment, need to be adequate and access to the technology needs to be practical too. According to Fullan (1992) integrating technology into the classroom and instruction can impact timetables, physical space or class size. Quality and practicality also refer to teachers acquiring the skills to integrate the computer, the compatibility of the equipment and the time to do all that is required to implement the change (Fullan, 1992). Overload, he maintains, is a widespread concern and teachers recognize that they need sufficient time to learn and plan for the use of computers in the classroom. As Fullan (1992) has noted, combining the use of computers with appropriate software does not happen instantaneously.

In the current study responses to what facilitated classroom computer use in the area of quality and practicality included student motivation, having a new computer or more than one computer, accessability to hardware and software, having internet access, good software selection and having a printer. As far as hindrances were concerned, a number of issues were indicated that surrounded logistical types of issues including the age of the children and class size. The organizational factors that Fullan (1992) refers to such as timetables and physical space were evidenced in teacher concerns that were revealed during interviews. Issues of noise, class management, difficulties in signing out school software for classroom use and the fact that other children might miss whole class instruction while they were working at the computer were all reported in the present study.

Inadequate or unreliable hardware or software has implications for practicality as well as complexity. The lack of a CD Rom drive or printer, the need for faster

network access, access to the internet, outdated equipment and technical difficulties that require a troubleshooter all impact on the practicality of computer use. Limited software choices, the inability to produce hard copies of students' work and the lack of technical support to reduce frustration levels can all contribute to diminishing a computer's use. Requests for more and better software could also be considered issues of quality/practicality. If use is limited by the availability or quality of software, using the computer becomes less practical. As well, having a newer computer usually means greater ease of use (practicality), more options and better software (quality). Concerns over cost and the lack of social interaction among students were also issues of practicality and quality. Easy access to equipment makes the use of computer more practical and printer availability makes for more practical use as well.

Need

Fullan (1992) has said that teachers must perceive a significant need to implement the innovation and determine its importance. The change, therefore, must be seen to meet student as well as teacher needs. In the present study, what facilitated teachers using the classroom computer with their students where the category of need is concerned, were teachers' personal beliefs and enthusiasm and the students' motivation to use the computer. Believing that using the computer enhanced learning could also be placed under this heading. The following comments are representative of teachers' beliefs as to the need to use the computer:

They are so thrilled with what they do. For instance, the stories we've done and done off the printer is a real equalizer because even my lowest kid's story looks as nice as my top kid's story. Although it's shorter and the content is different, the actual presentation looks as good. [grade 3 teacher]

They love it. I watch them and they're learning—it's okay. At times there will be five kids standing around—one person working and five standing around. But I'll see they're all engaged so I just leave them be. [grade 2-3 teacher]

It's a realm that's changing so fast and coming on. I thought the kids could not escape it in the future. Even if I could escape a fair bit of it, they can't . And so I felt it was necessary. [grade 3 teacher]

Teachers reported that if they perceived that using computers with children was important and they themselves were interested in using the computer, use was facilitated. Among the obstacles to use that revolved around need were the age of the students and the lack of social interaction. Some teachers felt that using computers with certain age groups of children was inappropriate or not needed while others determined that social skills suffered when using the computer, therefore the need to use it was diminished or absent. As far as teacher needs were concerned, the large number of teachers who reporting using the classroom computer for the preparation of report cards suggests that they have a need to use the computer as well.

Characteristics of Regular Classroom Computer Users

The results of this study have indicated that a number of teachers have learned to implement the use of their classroom computers into the curriculum in a myriad of ways. An analysis of the data revealed that there are a number of characteristics associated with teachers who employ the use of the single classroom computer on a moderate or frequent basis. Among the variables found to be related to regular use (i.e., moderate or frequent use) were type of equipment, years of teaching experience, computer user abilities, lab access and teacher comfort level. An additional factor associated with frequency of use, this one determined by the teacher, was how students were allocated time on the computer. Classrooms in which intermediate or newer models of Macintoshes were housed experienced more computer use than classrooms housing outdated or antiquated computers. Such a finding can be categorized as a matter of practicality and/or complexity. If, for example, a computer is outdated and is accompanied by limited software or peripherals, is incompatible with other pieces of hardware and has a limited ability to be integrated into various subject areas, it becomes less practical to engage its use. Similarly, intermediate or new models of computers can be associated with fewer technical difficulties or compatibility issues, therefore reducing complexity. With respect to years of teaching experience, teachers reported that as their years of teaching experience increased, so too did computer use in the classroom. A greater number of years of teaching experience may be associated with a greater likelihood of teachers perceiving a need to use the computer with their students. As well, greater clarity as to how to use the computer with students may be achieved over time. It was also found that the higher the rating of computer user ability among teachers, the greater the use of the computer. Similarly, the greater the teacher's comfort level with computers, the

greater the use enjoyed by the students and the teacher. Both of these results indicate that complexity was reduced and/or clarity was increased. Access to a lab was also associated with higher computer use in the classroom. Having access to a lab could make using the classroom computer more practical and more opportunities to complete work and practice using the computer would be possible from having time in a computer lab. And lastly, when computer time was allocated using a posted schedule or when students determined the computer's use, use of the computer in general was greater. Such a finding can be categorized as one of either practicality or need, as described by Fullan (1991, 1992); using a schedule is a practical way to have many students use the computer over a period or time and student determination of use suggests that students use the computer on an as needed basis.

Other Related Factors

The majority of teachers and students sampled in this study have access to a computer lab. During the course of interviews, teachers' philosophies towards having computer labs versus distributing computers to classrooms became a topic of discussion. The majority of teachers felt that having a school lab as well as computers in the classroom was ideal. As one teacher pointed out,

> *The computer lab enables a whole class to go in and for everybody to receive instruction on those things that are important enough to get instruction on. . . . So you can go in and teach the kids some word processing skills, a little bit of spreadsheet, a little bit of database, a little bit of drawing, a little bit of painting and things like that. Common denominator type things and then back in the classroom where*

hopefully you've got one of the more powerful computers in the school, you can do follow-up activities or you can do enrichment activities that are sort of higher end things than what you might do in the lab where you might have say one or two sessions a week and you'll do basic stuff that's challenging to make sure that everybody in the class receives instruction on the various aspects of word processing that are important to you. But if you do it in the lab, you can do it once with the whole class; you can do some follow-up review stuff next week and you can go on to something else. So I think you need both. [grade 6 teacher]

Overall, the teachers in this study seem to be saying that having access to a computer lab makes using a single classroom computer more practical as students can learn the basics or learn new computer uses as a class in the lab and can then apply the skills, learned on a group basis, both in the lab as well as in the classroom. If instruction and practice are confined to a single classroom computer, productivity, and therefore practicality, is reduced.

The present study did not reveal evidence of differences in gender where the frequency of use of the classroom computer was concerned, either with regard to teachers or students. However, in a handful of instances, teachers reported differences in types of use preferred by male and female students. The topic of gender arose during the course of interviews when teachers were asked if they had observed any differences in use among boys and girls in their classrooms. Twelve of the sixteen participants reported that they had observed no differences in frequency of use among girls and boys, although ten of them reported

observing differences in computer user ability as well as comfort level. Two teachers indicated that the girls and boys in their classrooms differed in the types of uses that each preferred. Of the remaining four teachers, three reported that girls used the computer less often than the boys in their classes and one teacher was not able to comment as she had not made any observations regarding this issue. The following is a sample of comments taken from interview transcripts:

> *The girls in my class are excellent students and bright. But the boys get on the computer and are less intimidated by it . . . In past years I've had just about 100% of kids having computers at home, but it's still the boys that, you know, they get on and I don't know if it's just the web sites I have that interest the boys more or the boys are just–gee that's cool. The girls–it's okay, but they don't, I don't know, they just don't use it the same ways as the boys. I don't know why.* [Grade 7 teacher]

> *As many boys would love to do fiddley art projects as girls. But with the computer, I've noticed more of a difference. The boys are into the fast games and the building games and the science games. The girls are happy with the drawing, paint, Kidsart and Spellbound. . . .They like those kinds of games with the math and the figuring out and the boys–they especially like Gizmos and Gadgets and Oregon Trail.* [Grade 2/3 teacher]

> *The boys want to play the games and the girls want to use the computer for different reasons. They like the internet, they like word*

processing–they might want to print out something–where the boys want a game in particular more often. [Grade 3 teacher]

Consideration of Findings in Light of Existing Research

The findings of the present study can be considered in light of the literature on the subject of classroom computer use and its related topics. The interviews and questionnaires used in this project provided insight into our understanding of how teachers are using their single classroom computers. The findings reported in the present study, in many cases, parallel those of other studies that have examined the use of computers with students in lab situations as well as the classroom. This study, however, is specific to the single classroom computer and as such represents a previously little-documented phenomenon where empirical studies are concerned.

The findings in the present study that computers are being used in a variety of ways with students is consistent with the findings of a number of other recent studies (B.C. Ministry of Education,1995a; Nicol & Butler, 1996; O'Donnell, 1996; Sheingold & Hadley, 1993; Ungerleider, 1997). Sheingold and Hadley's (1990) survey of accomplished computer using teachers found that word processing and drill and practice were among the most frequent types of use among teachers with their students. Word processing was also found to be the most common use in the B.C. Ministry of Education's report (1995b). Additionally, Nicol and Butler (1996) concluded that word processing and drill and practice applications were used most frequently in B.C. elementary schools. The findings of the present study revealed that games and simulations surpassed word processing and that drill and practice applications ranked third in frequency of use. Although the findings

of this study indicate that language arts was the subject area in which the computer was most frequently integrated into and math was second to it, O'Donnell (1996) found the reverse to be true. In that study math ranked first followed by reading and writing. One possible explanation for the contrasting findings is that O'Donnell's study included kindergarten through to grade 12. The data in the present study also mirror the conclusion made by the B.C. Ministry of Education's (1995a) technology survey that determined that technology is being underutilized where teachers are not both comfortable and adept at using it.

Lack of time was the obstacle most frequently cited as representing a barrier to technology implementation. Such a finding is consistent with those of other studies (Becker, 1994; Chiero, 1997; Hope, 1995; Means & Olson,1995; Nicol & Butler,1996; Poy, 1992a; Sheingold & Hadley,1993; Zammit,1992). And as in the present study, training or lack of personal knowledge where technology use is concerned was also a recurring theme in the literature (B.C. Ministry of Education, 1995b; Butzin, 1992; Chiero, 1997; Hope, 1995; Maddux, Johnson & Willis, 1997; Schofield, 1995; Strudler, 1996; Sheingold and Hadley, 1990; Zammit, 1992). Factors of software availability, access to equipment and the reliability and adequacies of hardware and software were identified as factors impacting computer use in a number of studies (Becker, 1994; Butzin, 1992; Chiero, 1997; Mandinach and Cline, 1996; Poy 1992b; Strudler, 1996; Zammit, 1992). In the present study the reliability and adequacy of hardware and software were frequently reported. In other studies lack of knowledge or training revolved around issues of not knowing how to use the computer, not knowing how to integrate it into the curriculum and instruction and not knowing how to troubleshoot when problems arose. These were also concerns for the teachers in this study.

Implications of the Study for Theory

The purpose of this study was to contribute data about computer usage in elementary schools and the factors that influence that use in order to examine the implications for the implementation of a change. The findings of this project can be viewed from the conceptual framework on which this study was premised. The results described support the theory that change is a multidimensional process. Curriculum implementation and change theory, as found in the works of Fullan (1991, 1992), suggests that the implementation of technology is contingent on a number of factors.

The findings of this study are consistent with Fullan's belief that change is difficult to accomplish given the number of factors that are impacted. That there can be a gap between the innovation and actual practice is evidenced in the findings of this study. The findings presented here confirm that there are a number of factors that impact on the success of an implementation and that, to a certain extent, these factors interact. These findings demonstrate the complexity of effecting change where technology is concerned.

Implications for Further Research

The present study has a number of implications for future research. Firstly, because there may be a difference between the reported and actual use of the computers for instruction in the case of either the interviews or the questionnaires, further research on the subject could incorporate classroom observations as a means of data collection in order to determine if such a discrepancy exists. This

next step is critical to any future examinations of the subject. As well, the response rate in this study indicates that personal contact with potential respondents is advantageous. Such contact provides an opportunity to explain your research and its importance and allows potential respondents to clarify any concerns or issues at the outset. In the case of this study, personal contact also served, in several cases, to dispel some teachers' misconceptions that only teachers who were well versed in using computers with their students were to be recruited for the research. That teachers with varying levels of comfort and expertise be included in such a study should be emphasized to potential respondents in any future studies. In addition, any future research might define terms such as novice, intermediate and expert computer users in order to ensure that respondents rate themselves more accurately.

In addition, this study raised some questions that may be investigated in the future. During the course of interviews, a frequent topic of discussion surrounded the issue as to whether computer labs or computer distributed in classrooms was most beneficial to students. Such discussions are consistent with the debates currently taking place in research literature. An exploration of this debate may warrant closer scrutiny in subsequent research. The topic of gender and computer use also arose during interviews. Although the majority of the teachers reported that frequency of computer use among the genders was similar, a difference in types of use was observed by teachers.This topic might also be the subject of future examinations of computer use and students. And finally, the question as to why teachers chose particular applications and pieces of software over others is deserving of study. Why teachers used games and word processing most often in the classroom could be explored. Whether this is due to the type of equipment

available to them, their expertise or lack of it, the software they have access to or some other variable remains to be seen. Similarly, the question as to why specific software titles were chosen over others might be addressed. In one case, for example, a teacher revealed that all of the software she housed in her classroom had been personally purchased because she believed that the schools's software was outdated and did not fit well with the curriculum she was teaching. Other teachers likely utilize particular pieces of software because of school or district purchases of specific software titles.

With respect to the theoretical framework used in this study, because Fullan (1991) maintains that change is a process and not an event, future research might consider how teachers come to acquire their practices, beliefs and materials and how those elements of their teaching change when an innovation, such as technology, is introduced. Changes in behaviours and beliefs could be investigated in a longitudinal study. And given that behaviour and actions occur within a context, perhaps more than the individual teacher could be considered in the implementation of a change. Fullan's (1991) theory of change does include local characteristics (i.e., district, community and principal) which could provide some of the context for change. As such, they are factors that might be considered in future research. The norms and structures of the organization or culture of the school, as exemplified by the workplace or institutional perspective of change, may warrant examination as well.

Implications of the Study for Professional Practice

There are a number of practical implications of the findings of this study. Data collected in this study reveal that a number of obstacles to the implementation of

computers need to be overcome in order to make the implementation of computers more successful. The present study illustrated that these teachers believe in the benefits of teaching with technology; however, they also express concerns that need to be considered in order to make the implementation of computers more likely. The barriers teachers listed in this study pose a threat to the successful implementation of the computer if they are not addressed because teachers are overwhelmed with an ever increasing list of daily tasks that have become a part of their profession. The complete integration of computers in the classroom in this school district cannot be realized unless the obstacles found to inhibit that integration are addressed. Teachers reported that they require CD Rom drives and current software in order to better utilize their single classroom computer. They also require internet access or faster internet access. They have indicated that hardware upgrades are needed as well.

The present study also has implications for the future training of teachers, both pre-service and in-service. The field of computer technology is growing and constantly changing. How teachers are to be trained in the use of technology, as well as how they will progress to meet the demand of advancements in this realm, requires careful consideration. Teachers indicated that training in the use of the computer, how to integrate it into the curriculum and how to evaluate software was necessary. Perhaps it is best to think of the implementation of technology in terms of costs and benefits. As Fullan (1992) has noted, there is often a trade-off between the costs of time and effort required to learn how to use the computer and the benefits of remaining involved with computers. The data revealed in this study suggest that the benefits teachers associate with computers don't necessarily outweigh the costs of working with technology where the single

classroom computer is concerned. Although teachers acknowledge the benefits of using a computer with their students, they are ultimately faced with costs where their time is concerned as well as the obstacles of inadequate or unreliable hardware and/or software and lack of training.

Recommendations for Educators

The findings of this study have implications for the implementation of computers in classrooms. Based on the findings, the following recommendations can be made. Firstly, it becomes apparent that those involved in establishing implementation policies and providing the resources for that implementation need to consider a host of factors in order to take steps to overcome the obstacles that hinder computer use and support teachers in their efforts to integrate technology into their classrooms and the curriculum. As noted earlier, Werner (1988) has maintained that program developers frequently neglect or remain oblivious to the multidimensional nature of change. Where teachers are using their classroom computer infrequently, therefore, it may simply be a case of too many factors working against implementation. The present study has demonstrated the difficulty of implementing a change. Without increasing or preserving the factors that facilitate the use of technology, the promise of technology may not be realized. Teachers cannot be expected to learn how to use their single computer and integrate it into the curriculum on their own time. The data in this study also indicate that more powerful computers are required by teachers and that, ideally, more than one computer is required in the classroom.

Given the premium put on the adequacy and reliability of computer equipment by teachers, it becomes apparent that some consideration needs to be given to the

quality of the technology currently distributed in our elementary schools. For example, where teachers are using antiquated equipment, its use is more limited. The variety of equipment that exists among classrooms suggests that finances are constraining the purchase of current software and updated equipment. In addition, some thought needs to be given to the professional development of teachers where computer use is concerned. The diversity among teachers in terms of their computer user abilities, comfort levels and types of applications they are using suggests that training in particular areas of computer use needs to be addressed.

For those teachers who may be faced with a decision about whether or not to house a single computer in the classroom, the findings of this study suggest that there are a number of benefits for both students and teachers when using a computer. As mentioned earlier, the majority of teachers expressed positive feelings towards their single classroom computer and the kinds of things they could achieve with it. The following are excerpts taken from the interviews conducted in this study:

> *It's a valuable tool. It's an extremely enabling tool that enables students and teachers to do a whole lot of stuff easier, faster and better and sometimes things that you simply could not do at all otherwise. So, I try to make it as available as possible to everybody.* [grade 6 teacher]

> *Not all children learn the same way. One way will work for one and the computer may work for another. For me to leave the computer and not look at that possibility–it's not fair to the kids.* [grade 2 teacher]

Final Remarks

The theme that technology is a promise that remains unfulfilled is one that runs throughout the literature reviewed. As Nicol and Butler (1996) in their study of the use of computers in B.C. elementary schools remind us, "in spite of the promise of technological evolution in elementary schools with the enormous potential that computers have for student learning, the current reality is that it is a promise waiting to be fulfilled" (p. 26). And Zammit (1992) remarked that,

> whether the technological promise will be fulfilled depends on teachers receiving expert guidance in policy development and implementation, the essential financial support and long-term professional development. Effective learning materials to take advantage of the ever-more powerful hardware are likewise imperative. (p. 66)

Admittedly, there is no one way or right answer as to how to view the implementation of technology. Whichever perspective is chosen merely serves to sensitize those involved in decisions that surround the innovation (W. Werner, personal communication, July, 24, 1997). But as Fullan (1992) has commented, "the implementation perspective warns us that we need to think through the change process and address the key factors known to impact on the likelihood of success" (p. 57).

Fullan's contributions are underscored in the behavioural approach to change. When an innovation is introduced, not all people will adopt the innovation for use, or they will adopt it to varying degrees, even if it is specifically intended for their

situation (Fullan, 1992). The consequence of the underutilization of computers is that there may never be the opportunity to realize the expectations for educational computing. Having the technology may not be enough to persuade teachers to use it. It becomes quite clear that the difficulties of implementing change concerning technology curriculum include the significant degree of difficulty it entails for teachers who need to adjust their practices, their teaching materials and their beliefs. As one teacher, when asked what computers should be used for, commented,

> *Doing the kinds of things that help them do a better job of doing the things that they're supposed to be doing while they're in school. And that can range from their communication skills to their math skills to their social studies, science, everything. It should be just a tool to meet curriculum needs . . . It's like—well not completely synonymous with pen or pencil. . .it's an enabling tool that enables students and teachers to do a whole lot of stuff easier, faster and better and sometimes things that you simply could not do otherwise.* [grade 6 teacher]

Comments such as this were typical of the majority of opinions expressed by teachers who participated in this study. Despite the factors they cited as negatively impacting the use of their classroom computers, in general their motivation to use them remained high. How long that motivation will persist in the absence of efforts to alleviate their concerns remains to be seen. If issues of need, clarity, quality and practicality as well as complexity surrounding computer use are addressed, perhaps more of the expectations of technology in education can be realized.

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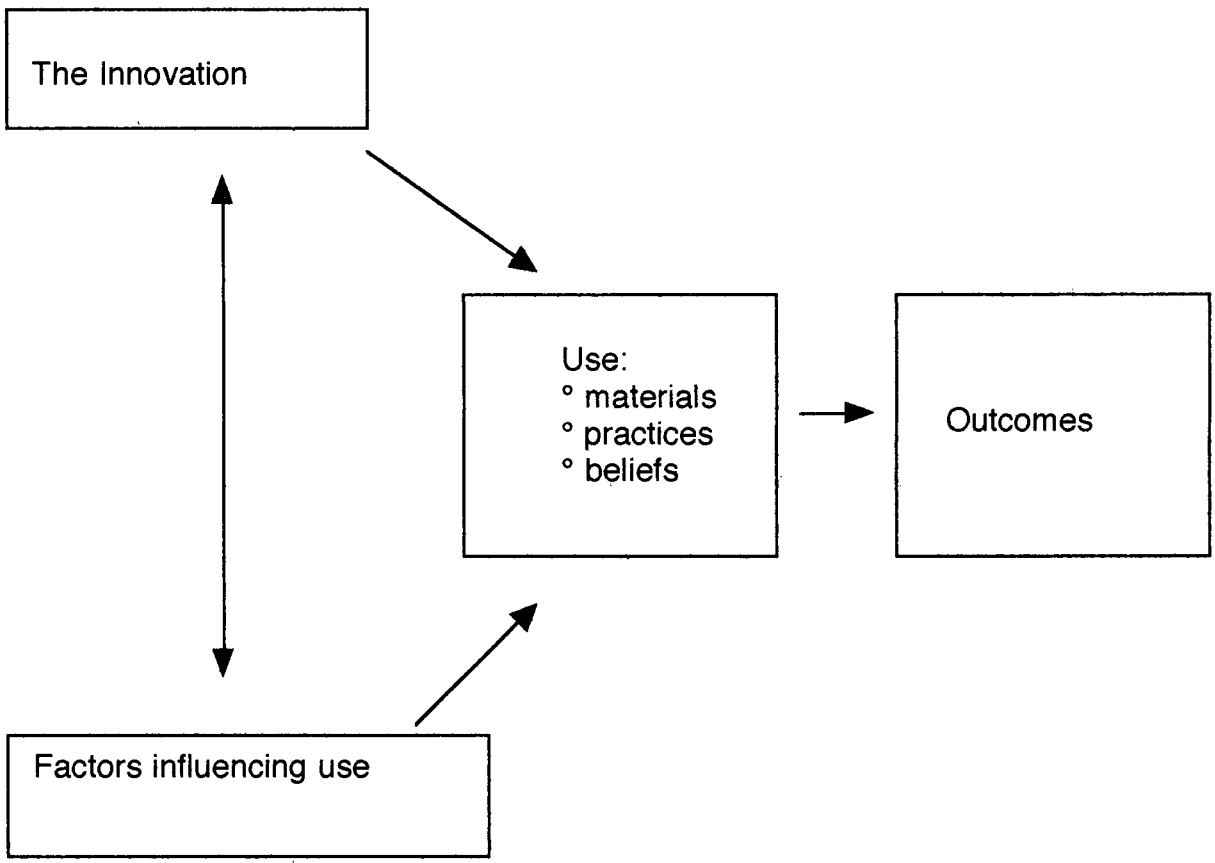
Appendix A

An Overview of Implementation



(Fullan, 1992)

Appendix C
Final Questionnaire

A. PERSONAL DATA AND BACKGROUND:

1. What grade(s) do you currently teach? _____

2. How many years of teaching experience do you have? _____ years

3. Are you male or female? ☐ male ☐ female

4. How would you rate your computer user abilities?

☐ expert ☐ intermediate ☐ novice

5. How long have you been working with computers?

_____

6. Which of the following best describes your comfort level with computers?

☐ high comfort ☐ moderate comfort ☐ low comfort

7. To what do you attribute your level of comfort?

☐ a. technical support
☐ b. training or in-service
☐ c. help of colleague(s)
☐ d. assistance of student(s)
☐ e. self-help
☐ f. other (please specify) _____

_____

8. Which of the following styles dominates your teaching in the classroom?

☐ a. direct instruction
☐ b. facilitator
☐ c. coach
☐ d. other (please specify) _____

_____

9. Has teaching with technology changed your teaching style? If so, please explain.

_____ ☐ yes ☐ no

_____

_____

10. Has your classroom computer changed your teaching in any of the following ways. (Check all that apply)

- ☐ a. I spend more time with individual students
- ☐ b. I'm more comfortable with students working independently
- ☐ c. I'm better able to present more complex materials to my students
- ☐ d. I'm better able to tailor instruction to students' individual needs
- ☐ e. I spend less time lecturing to the entire class
- ☐ f. I'm more comfortable with small group activities
- ☐ g. I spend less time with the whole class practicing or reviewing material
- ☐ h. other (please specify) _____

_____

_____

11. If you use your classroom computer for professional tasks, which of the following tasks do you use it for? (Check all that apply)

- ☐ a. report cards
- ☐ b. student records
- ☐ c. class newsletters
- ☐ d. network access (e.g. school to school communication, email, internet)
- ☐ e. lesson plans/tests
- ☐ f. other (please specify) _____

_____

12. If you have access to a computer outside of your school, which of the following tasks do you use it for? (Check all that apply)

- ☐ a. report cards
- ☐ b. network access (e-mail, internet)
- ☐ c. lesson planning
- ☐ d. games and entertainment
- ☐ e. activities with my own children
- ☐ f. I don't use a computer outside of school
- ☐ g. other (please specify) _____

_____

_____

B. STUDENT COMPUTER USE:

1. How do you allocate student time on the classroom computer?

☐ a. posted schedule
☐ b. students determine use
☐ c. random use
☐ d. other (please specify) _____

_____

2. On average, for how many minutes a day is your classroom computer in use?

	0 minutes	1-30 minutes	31-60	61-120	more than 121
a. in class time	☐	☐	☐	☐	☐
b. at lunch	☐	☐	☐	☐	☐
c. after school	☐	☐	☐	☐	☐
d. other _____	☐	☐	☐	☐	☐

3. If you divide your class into three groups:

a. the most frequent users of the classroom computer spend approximately __ minutes per week at the computer
b. the middle third of the class uses it for approximately __ minutes per week
c. the least frequent users use it for approximately __ minutes per week.

4. In what kinds of groupings do your students usually work at the computer?

☐ a. individually
☐ b. in pairs
☐ c. in small groups
☐ d. in large groups
☐ e. for whole class instruction
☐ f. a combination of groupings (please specify) _____

_____

5. Who decides what the students do on the computers?

- ☐ a. myself
- ☐ b. the students
- ☐ c. myself and the students
- ☐ d. administration
- ☐ e. other (please specify) _____

_____

6. Do your students have access to a computer lab? ☐ yes ☐ no

7. If yes, for how many minutes (on average) per week do they use the computers in the lab?

_____

C. HARDWARE AND SOFTWARE DETAILS:

1. On which basis have computers been assigned to teachers in your school?

- ☐ a. computer lab(s)
- ☐ b. one computer per classroom
- ☐ c. more than one per classroom (please state the number) _____
- ☐ d. a combination of computer lab(s) and distributed computers
- ☐ e. other (please specify) _____

_____

2. How did you come to acquire the computer in your classroom?

_____

_____

3. Describe the computer you have in your classroom (include make, model and memory capacity, if known).

_____

_____

4. Have you made any special organizational changes (physically) in your classroom to accommodate your classroom computer. If so, please explain.

_____ ☐ yes ☐ no

_____

5. Please indicate which computer peripherals or speciality features accompany your classroom computer.

- ☐ a. printer
- ☐ b. CD Rom drive
- ☐ c. modem
- ☐ d. scanner
- ☐ e. LCD panel (liquid crystal display for overhead projection)
- ☐ f. other (please specify) _____

_____

_____

6. For what kinds of work do your students use the classroom computer? (Check all that apply)

	frequent use	moderate use	infrequent use
a. word processing	☐	☐	☐
b. keyboarding	☐	☐	☐
c. drill and practice	☐	☐	☐
d. games/simulations	☐	☐	☐
e. database	☐	☐	☐
f. spreadsheets	☐	☐	☐
g. internet access	☐	☐	☐
h. telecommunications (email)	☐	☐	☐
i. hypercard/hyperstudio	☐	☐	☐
j. desktop publishing	☐	☐	☐
k. interactive multimedia	☐	☐	☐
l. graphics/drawing/painting	☐	☐	☐
m. other _____	☐	☐	☐
n. other _____	☐	☐	☐
o. other _____	☐	☐	☐

7. Please indicate (if known) the titles of the software you use for the following applications.

a. word processing _____
b. keyboarding _____
c. drill and practice _____
d. games/simulations _____

e. database _____

f. spreadsheets _____

g. internet access _____

h. telecommunications _____

i. hypercard/hyperstudio _____

j. desktop publishing _____

k. interactive multimedia _____

l. graphics/drawing _____

m. other _____

n. other _____

o. other _____

D. CURRICULUM INTEGRATION:

1. In which of the following subject areas have you been able to integrate your single classroom computer?

	often	sometimes	not at all
a. language arts	☐	☐	☐
b. mathematics	☐	☐	☐
c. science	☐	☐	☐
d. social studies	☐	☐	☐
e. fine arts	☐	☐	☐
f. physical education	☐	☐	☐
g. other (please specify) _____	☐	☐	☐

2. What benefits do you feel may result from having your students use a computer in the classroom? (Check all that apply)

	important	moderately important	not important
a. development of thinking/problem solving skills	☐	☐	☐
b. individualization of instruction	☐	☐	☐
c. students gain familiarity with computers	☐	☐	☐
d. reinforcement of learning in variety of subjects	☐	☐	☐
e. alternative approaches to teaching/learning	☐	☐	☐
f. opportunities for peer teaching/cooperation	☐	☐	☐
g. children become more motivated and enthusiastic about learning	☐	☐	☐
h. other (please specify)			
_____	☐	☐	☐
_____	☐	☐	☐

3. Do you see any negative outcomes that may result from having your students use computers? (please be specific)

_____

_____

_____

_____

_____

_____

4. What do you think a single computer in the classroom should be used for?

- ☐ a. integration with other subject areas
- ☐ b. non-structured free exploration
- ☐ c. enrichment
- ☐ d. remediation
- ☐ e. other (please specify) _____

_____

_____

_____

E. FACTORS INFLUENCING COMPUTER USE:

1. From what sources do you receive support for the use of your classroom computer? (Check all that apply and indicate whether the support is received from inside your school, outside of it, or a combination of both.)

	inside	outside	a combination
a. administration	☐	☐	☐
b. technology coordinator	☐	☐	☐
c. colleague(s)	☐	☐	☐
d. other (please specify)			
_____	☐	☐	☐
_____	☐	☐	☐

2. To what degree do the factors below effect the use of your single classroom computer?

	very	moderately	not very
a. time	☐	☐	☐
b. lack of administrative support	☐	☐	☐
c. lack of technical support	☐	☐	☐
d. personal knowledge/training	☐	☐	☐
e. inadequate or unreliable hardware	☐	☐	☐
f. inadequate or unreliable software	☐	☐	☐
g. incompatibility of hardware/software	☐	☐	☐
h. the age of the children in my class	☐	☐	☐
i. lack of confidence	☐	☐	☐
j. size of my class	☐	☐	☐
k. student knowledge/needs	☐	☐	☐
l. other (please specify)			
_____	☐	☐	☐
_____	☐	☐	☐

3. What would make it easier for you to use your single classroom computer with your students?

_____

_____

_____

_____

4. How could the single computer be used more beneficially with your students?

_____

_____

_____

_____

5. What pieces of hardware and/or software would you like access to (that you don't currently have), to facilitate your students' learning with the single classroom computer?

	very important	moderately	not very
a. printer	☐	☐	☐
b. CD Rom Drive	☐	☐	☐
c. modem	☐	☐	☐
d. scanner	☐	☐	☐
e. LCD panel (liquid crystal display)	☐	☐	☐
f. other (please specify)			
_____	☐	☐	☐

Please explain the reason(s) for your selections: _____

_____

_____

6. In what areas would you like to receive more training or education regarding your classroom computer?

	very important	moderately	not very
a. basic computer skills	☐	☐	☐
b. integration into other subject areas	☐	☐	☐
c. how to evaluate software	☐	☐	☐
d. how to use the internet	☐	☐	☐
e. no training required	☐	☐	☐
f. other (please specify)			
_____	☐	☐	☐
_____	☐	☐	☐

F. ADDITIONAL COMMENTS:

Please use the space below to include any information you wish to add:

_____

_____

_____

_____

Appendix D
Pilot Questionnaire

A. PERSONAL DATA AND BACKGROUND:

1. What grade(s) do you currently teach? _____

2. How many years of teaching experience do you have? _____ years

3. Are you male or female? ☐ male ☐ female

4. How would you rate your computer user abilities?

☐ expert ☐ intermediate ☐ novice

5. How long have you been working with computers?

_____

6. Which of the following best describes your comfort level with computers?

☐ high comfort ☐ moderate comfort ☐ low comfort

7. To what do you attribute your level of comfort?

☐ a. technical support
☐ b. training or in-service
☐ c. help of colleague(s)
☐ d. assistance of student(s)
☐ e. self-help
☐ f. other (please specify) _____

_____

8. Which of the following styles dominates your teaching in the classroom?

☐ a. direct instruction
☐ b. facilitator
☐ c. coach
☐ d. other (please specify) _____

_____

9. Has teaching with technology changed your teaching style? If so, please explain.

_____ ☐ yes ☐ no

_____

_____

10. Has your classroom computer changed your teaching in any of the following ways. (Check all that apply)

- ☐ a. I spend more time with individual students
- ☐ b. I'm more comfortable with students working independently
- ☐ c. I'm better able to present more complex materials to my students
- ☐ d. I'm better able to tailor instruction to students' individual needs
- ☐ e. I spend less time lecturing to the entire class
- ☐ f. I'm more comfortable with small group activities
- ☐ g. I spend less time with the whole class practicing or reviewing material
- ☐ h. other (please specify) _____

_____

_____

11. If you use your classroom computer for professional tasks, which of the following tasks do you use it for? (Check all that apply)

- ☐ a. report cards
- ☐ b. student records
- ☐ c. class newsletters
- ☐ d. network access (e.g. school to school communication, email, internet)
- ☐ e. lesson plans/tests
- ☐ f. other (please specify) _____

_____

12. If you have access to a computer outside of your school, which of the following tasks do you use it for? (Check all that apply)

- ☐ a. report cards
- ☐ b. network access (e-mail, internet)
- ☐ c. lesson planning
- ☐ d. games and entertainment
- ☐ e. activities with my own children
- ☐ f. I don't use a computer outside of school
- ☐ g. other (please specify) _____

_____

_____

B. STUDENT COMPUTER USE:

1. How do you allocate student time on the computer?

☐ a. posted schedule
☐ b. students determine use
☐ c. random use
☐ d. other (please specify) _____

_____

2. On average, for how many minutes a day is your classroom computer in use?

	1-30 minutes	31-60	61-120	more than 121
a. in class time	☐	☐	☐	☐
b. at lunch	☐	☐	☐	☐
c. after school	☐	☐	☐	☐
d. other _____	☐	☐	☐	☐

3. If you divide your class into three groups:

a. the most frequent users of the classroom computer spend approximately __ minutes per week at the computer
b. the middle third of the class uses it for approximately __ minutes per week
c. the least frequent users use it for approximately __ minutes per week.

4. In what kinds of groupings do your students usually work at the computer?

☐ a. individually
☐ b. in pairs
☐ c. in small groups
☐ d. in large groups
☐ e. for whole class instruction
☐ f. a combination of groupings (please specify) _____

_____

5. Who decides what the students do on the computers?

- ☐ a. myself
- ☐ b. the students
- ☐ c. myself and the students
- ☐ d. administration
- ☐ e. other (please specify) _____

_____

6. Do your students have access to a computer lab? ☐ yes ☐ no

7. If yes, for how many minutes per week do they use the computers in the lab?

_____

C. HARDWARE AND SOFTWARE DETAILS:

1. On which basis have computers been assigned to teachers in your school?

- ☐ a. computer lab(s)
- ☐ b. one computer per classroom
- ☐ c. more than one per classroom (please state the number) _____
- ☐ d. a combination of computer lab(s) and distributed computers
- ☐ e. other (please specify) _____

_____

2. How did you come to acquire the computer in your classroom?

_____

_____

3. Describe the computer you have in your classroom (include make, model and memory capacity, if known).

_____

_____

4. Have you made any special organizational changes (physically) in your classroom to accommodate your classroom computer. If so, please explain.

_____ ☐ yes ☐ no

_____

5. Please indicate which computer peripherals or speciality features accompany your classroom computer.

- ☐ a. printer
- ☐ b. CD Rom drive
- ☐ c. modem
- ☐ d. scanner
- ☐ e. LCD panel (liquid crystal display for overhead projection)
- ☐ f. other (please specify) _____

_____

_____

6. For what kinds of work do your students use the classroom computer? (Check all that apply)

	frequent use	moderate use	infrequent use
a. word processing	☐	☐	☐
b. keyboarding	☐	☐	☐
c. drill and practice	☐	☐	☐
d. games/simulations	☐	☐	☐
e. database	☐	☐	☐
f. spreadsheets	☐	☐	☐
g. internet access	☐	☐	☐
h. telecommunications (email)	☐	☐	☐
i. hypercard/hyperstudio	☐	☐	☐
j. desktop publishing	☐	☐	☐
k. interactive multimedia	☐	☐	☐
l. graphics/drawing/painting	☐	☐	☐
m. other _____	☐	☐	☐
n. other _____	☐	☐	☐
o. other _____	☐	☐	☐

7. Please indicate (if known) the titles of the software you use for the following applications.

a. word processing _____

b. keyboarding _____

c. drill and practice _____

d. games/simulations _____

e. database _____

f. spreadsheets _____

g. internet access _____

h. telecommunications _____

i. hypercard/hyperstudio _____

j. desktop publishing _____

k. interactive multimedia _____

l. graphics/drawing _____

m. other _____

n. other _____

o. other _____

D. CURRICULUM INTEGRATION:

1. In which of the following subject areas have you been able to integrate your single classroom computer?

	often	sometimes	not at all
a. language arts	☐	☐	☐
b. mathematics	☐	☐	☐
c. science	☐	☐	☐
d. social studies	☐	☐	☐
e. art	☐	☐	☐
f. physical education	☐	☐	☐
g. fine arts	☐	☐	☐
h. other (please specify) _____	☐	☐	☐

2. What benefits do you feel may result from having your students use a computer in the classroom? (Check all that apply)

	important	moderately important	not important
a. development of thinking/problem solving skills	☐	☐	☐
b. individualization of instruction	☐	☐	☐
c. students gain familiarity with computers	☐	☐	☐
d. reinforcement of learning in variety of subjects	☐	☐	☐
e. alternative approaches to teaching/learning	☐	☐	☐
f. opportunities for peer teaching/cooperation	☐	☐	☐
g. children become more motivated and enthusiastic about learning	☐	☐	☐
h. other (please specify)			
_____	☐	☐	☐
_____	☐	☐	☐

3. Do you see any negative outcomes that may result from having your students use computers? (please be specific)

_____

_____

_____

_____

_____

_____

4. What do you think a single computer in the classroom should be used for?

- ☐ a. integration with other subject areas
- ☐ b. non-structured free exploration
- ☐ c. enrichment
- ☐ d. remediation
- ☐ e. other (please specify) _____

_____

_____

_____

E. FACTORS INFLUENCING COMPUTER USE:

1. From what sources do you receive support for the use of your classroom computer? (Check all that apply and indicate whether the support is received from inside your school, outside of it, or a combination of both.)

	inside	outside	a combination
a. administration	☐	☐	☐
b. technology coordinator	☐	☐	☐
c. colleague(s)	☐	☐	☐
d. other (please specify) _____	☐	☐	☐

2. To what degree do the factors below effect the use of your single classroom computer?

	very	moderately	not very
a. time	☐	☐	☐
b. lack of administrative support	☐	☐	☐
c. lack of technical support	☐	☐	☐
d. personal knowledge/training	☐	☐	☐
e. inadequate or unreliable hardware	☐	☐	☐
f. inadequate or unreliable software	☐	☐	☐
g. incompatibility of hardware/software	☐	☐	☐
h. the age of the children in my class	☐	☐	☐
i. lack of confidence	☐	☐	☐
j. size of my class	☐	☐	☐
k. student knowledge/needs	☐	☐	☐
l. other (please specify) _____	☐	☐	☐

3. What would make it easier for you to use your single classroom computer with your students?

_____

_____

_____

_____

4. How could the single computer be used more beneficially with your students?

_____

_____

_____

_____

5. What pieces of hardware and/or software would you like access to (that you don't currently have), to facilitate your students' learning with the single classroom computer?

	very important	moderately	not very
a. printer	☐	☐	☐
b. CD Rom Drive	☐	☐	☐
c. modem	☐	☐	☐
d. scanner	☐	☐	☐
e. LCD panel (liquid crystal display)	☐	☐	☐
f. other (please specify)			
_____	☐	☐	☐

6. In what areas would you like to receive more training or education regarding your classroom computer?

	very important	moderately	not very
a. basic computer skills	☐	☐	☐
b. integration into other subject areas	☐	☐	☐
c. how to evaluate software	☐	☐	☐
d. how to use the internet	☐	☐	☐
e. no training required	☐	☐	☐
f. other (please specify)			
_____	☐	☐	☐
_____	☐	☐	☐

F. ADDITIONAL COMMENTS:

Please use the space below to include any information you wish to add:

_____

_____

_____

_____

_____

_____

_____

PLEASE RETURN THIS QUESTIONNAIRE IN THE ATTACHED ENVELOPE NO LATER THAN:

Appendix E

Interview Schedule

1. What have been some of your greatest successes where your single classroom computer is concerned? What is working well and why?

2. If someone were to help you to better utilize your classroom computer, what would you ask them to do?

3. If you could have any kind of support for your classroom computer, what kinds of things might you want.

4. What do you think your students should be doing at your classroom computer?

5. What is your classroom computer's potential? Do you feel you are able to use it to its full potential?

6. What is your rationale for using a single computer in your classroom?

7. What are your students' responses to using the classroom computer?

8. Have you observed any differences in use among boys and girls in your classroom?

9. Where do you get your ideas for how to use your classroom computer? (eg. colleagues, lesson aids, Information Technology IRP, etc.)

10. How did you feel when you first learned that you would have a single computer in your classroom?

11. What kinds of conversations have you had with your colleagues about the use of your classroom computer?