AN ASSESSMENT OF MATHEMATICS TEACHER KNOWLEDGE AND ATTITUDES TOWARD THE USE OF COMPUTERS IN SENIOR HIGH INSTRUCTION

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An Assessment of Mathematics Teacher Knowledge and Attitudes Toward the Use of Computers in Senior High Instruction

© By

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Abstract

The question is no longer of whether or not computers have a place in mathematics education, but rather how to best get teachers to use the power of the computer in their instruction. The literature strongly suggests that teacher knowledge of computers and positive attitudes toward computers are imperative for the successful integration of computers in education.

The purpose of this research was to measure teacher knowledge and attitudes toward the use of computer technology in the teaching and learning of senior high mathematics. The study was confined to 329 teachers of senior high mathematics in the province of Newfoundland and Labrador. It was carried out by the use of a survey instrument which consisted of three components: (a) attitudinal statements; (b) knowledge; and (c) personal information. The data was analyzed by means of factor analysis, univariate and multivariate analysis, correlations, means, and standard deviations.

The results of the study revealed two extremes with respect to level of computer literacy among teachers of senior high mathematics. The results indicated that there were a small number of teachers with an average level of computer literacy. There were a large number of teachers with a high level of computer literacy but just as many with a low level of computer literacy. Teachers older than 45 were found to

have lower levels of computer literacy than younger teachers. Teachers younger than 46, more so than older teachers, felt more able to use a computer in their mathematics instruction. Teachers living in rural areas of the province were found to have a lower level of computer literacy than those living in urban areas. The same was not found with respect to attitudes toward computers. No significant sex differences were found to exist with respect to computer literacy or with respect to attitudes toward computers.

Teacher education is a necessary component of successful integration of computers in mathematics education, but just as important is the necessity of providing preservice and inservice programmes that will respond to the needs of those teachers to whom it is directed. Age differences, as well as urban/rural differences that were revealed in this study should not be overlooked in the design and implementation of possible teacher preservice and inservice programmes directed at teachers of senior high mathematics in Newfoundland and Labrador, with respect to computer technology.

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CHAPTER I

Statement of the Problem

Purpose of the Study

The purpose of this study is to determine the awareness of teachers of senior high mathematics in Newfoundland and Labrador concerning computer technology and the use of computers in senior high mathematics (refer to page 11) instruction and to assess their attitudes toward future use of computer technology in senior high mathematics teaching and learning. Specifically, answers to the following questions are sought:

1. How computer literate (refer to page 11) are the senior high teachers of mathematics in Newfoundland and Labrador?

2. What are the attitudes (refer to page 11) of teachers of senior high mathematics in Newfoundland and Labrador toward computers?

3. Is there any relationship between computer literacy and attitudes toward computers of teachers of senior high mathematics in Newfoundland and Labrador?

4. Are there any differences between teacher sex and level of computer literacy?

5. Are there any differences between teacher sex and attitudes toward computers?

6. Are there any differences between teacher age and level of computer literacy?

7. Are there any differences between teacher age and attitudes toward computers?

8. Are there any differences between urban/rural (refer to page 12) teachers and level of computer literacy?

9. Are there any differences between urban/rural teachers and attitudes toward computers?

Rationale

Computer technology has had a dramatic effect upon operations within the workplace. Methods of data storage and information processing are much more efficient than in years past. In spite of the fact that in the workplace computers are becoming as common as telephones, we still lack a valid methodology for introducing them into education. Mathematics, or more specifically, the instruction of mathematics in school, has yet to fully integrate computer technology into its curriculum. It would be rare to find a practicing mathematician, actuary, or statistician who would not be using a computer in their analysis, but few mathematics teachers today have exploited this technology (Newton, 1987). According to Fey and Heid (1984), "It seems clear that [school] mathematics must adapt to this changing scientific work place or loose its vitality" (p. 91). Mathematics teachers in Newfoundland and Labrador are usually the teachers who teach

Computer Studies 2206, but as of yet very few have integrated the technology into their mathematics classroom. Indeed many of these teachers have not received any training in teaching Computer Studies 2206. The computer has the potential to drastically change the process of education (Woodrow, 1987) as well as what can be learned within all subject areas (Moore, 1987). This can happen only if mathematics teachers are aware of and prepared for these changes (Billstein, 1985; Day, 1987).

This study is necessary to assess types of effective preservice and inservice training that will be required by teachers if successful integration of computers is to be obtained in senior high mathematics instruction in Newfoundland and Labrador.

Computer literacy and teacher attitudes toward computers.

Such changes will only be realized if a more fundamental matter is first addressed. This is the changing role of the teacher in the mathematics classroom (NCTM, 1984). Teachers must assume new roles if new technology is to support mathematical instruction. It is possible that teachers will have to alter instructional practices if they are to take full advantage of the educational potential of the computer (Norton, 1985; Wedman, 1986). Of greater significance are the attitudes of teachers toward educational computing (Reed, 1986) and their level of computer literacy (Moursund, 1979;

Inskeep, 1982; NCTM 1984; Cicchelli & Baechu, 1987). The use of computer technology may alter traditional methods of instruction but such changes must be made in such a manner that those who experience computer anxiety are given the necessary support. Limited research has been carried out to assess teacher attitudes in this area and little attention has been paid to the effects of inservice efforts on attitude change (Wedman, Heller & Strathe, 1986).

Jones and Wall (1985) found that high levels of computer anxiety were associated with low levels of computer knowledge and/or computer experience. In line with this, Stevens (1980) and Manarino-Lettett and Cotton (1985) found that successful integration of computers by teachers depends on two major factors: teachers' attitudes toward computers and their level of expertise with computers. Teachers in these studies (Maryland, Nebraska, North Carolina) expressed a strong desire to acquire the necessary computer knowledge to respond to a technological society.

It is not immediately clear that the Manarino-Lettett and Cotton (1985) study has any implications for senior high mathematics in Newfoundland and Labrador. The 1985 study was conducted with graduate students of education. The fact that they are pursuing a higher education, may indicate that they are positively oriented towards computers anyway. Only 4.34% (Jill Andrews, personal communication, July 14, 1989) of teachers in Newfoundland and Labrador possess a Bachelor of

Science degree with a major in mathematics. Of this group, only 27% (Jill Andrews, personal communication, July 12, 1989) have a masters degree in any area. As was reported in The Task Force on Mathematics and Science Teaching (Crocker, 1989) only 22% of secondary teachers in Newfoundland and Labrador have 6 or more courses in mathematics. This was deemed in the report to be inadequate for competent teaching at the high school level. Because statistics are no longer available on the number of teachers who teach senior high mathematics (versus the number of teachers who have a degree in mathematics), statistics on the percentage of teachers of mathematics in Newfoundland and Labrador who have completed a master's degree in education are not available. These statistics used to be compiled by Statistics Canada on a form called the Educational Staff Record. This form was discontinued in 1989. A new form to replace this has not yet been developed.

Each of these studies (Stevens, Manarino-Lettett and Cotton) were conducted in an area where a university is situated, indicating perhaps that many of these teachers had easy access to some kind of computer education. This is not the case in Newfoundland and Labrador where most schools are located in rural areas.

Dickey and Kherlopian (1987), found that in spite of 70% of mathematics teachers having access to a computer, very few had any training. A primary concern of the researchers was the failure of the mathematics teachers to use the computer even for demonstration. Clearly, this study (Dickey and Kherlopian, 1987) indicates that access to a computer will not necessarily guarantee its use.

Factors affecting computer literacy and attitudes toward computers.

Mathematics teachers are not a homogeneous group, yet there is a tendency to view teachers as such. Individual profiles of teachers indicate a range of concerns (Wedman, 1986). Fresko and Ben-Chaim (1986) found that teachers' needs vary according to their background characteristics. Their study, based on the inservice needs of a group of mathematics teachers of grades 7, 8 and 9 in Israel, suggested that inservice programmes which do not consider individual differences may be unsuitable for most teachers. This is an important consideration in Newfoundland and Labrador where many of the teachers of mathematics have a limited mathematics background. Clearly, inservice programmes must respond to the specific needs of those taught. Acknowledging the heterogeneity of teachers as a group suggests that the typical approach of delivering a single brief inservice programme can do more harm to the development of computer competency than no training at all (Kinmel, 1987). As well, teachers differ in their ability and willingness to adapt to change (Cannings & McManus, 1987), something often overlooked by many responsible for teacher inservice.

A frequently ignored dimension of teacher inservice design is that the learners are adults, not children (Orlich, 1983; Knowles, cited in Wedman, 1986; Rawitsch, 1987). Adults draw more heavily on past experiences than do children. If their past experiences with computers has been negative, inservice efforts may be impeded (Clement, 1981 cited in Gressard & Lloyd, 1985; McMeen, 1984, cited in Wedman, 1986). The Concerns Based Adoption Model (Appendix C) has been used systematically to research how adult learners respond to innovations and how responses change as a result of inservice efforts (Wedman, 1986). The model suggests that if inservice designers fail to consider at what point the teachers are in the process of acquiring new attitudes, understandings and skills, their efforts may be less than optimally successful (Loucks & Hall, 1977).

Age differences in teacher attitudes toward and knowledge of computers.

It may be possible that age is a factor in attitudes toward computers (Gressard & Lloyd, 1985; Jones & Wall, 1985). Older teachers, more so than younger teachers, may have less experience with computers and therefore perhaps may be more anxious about using computers in their mathematics instruction. Older teachers were probably not exposed to computers in their own schooling and therefore find it difficult to see any value that the computer may have in instruction. On the other hand, it should not be presumed that the younger teachers in Newfoundland and Labrador have considerably more computer experience. The use of computers in education in Newfoundland and Labrador is possibly too new to have given the younger teachers that much more computer experience.

Sex differences in teacher attitudes toward and knowledge of computers.

Research suggesting that there are sex differences in teacher computer literacy levels and computer anxiety is limited. The literature is abundant with evidence in support of sex differences in mathematics achievement and anxiety in students. Computers are often seen as being mathematical and it is possible that these feelings of anxiety in mathematics transfer to feelings of anxiety in working with computers. For some individuals this may be true, but if females are provided with the necessary experience with computers, they can be just as knowledgeable in the use of computer technology as their male counterparts (Harper & Kok, 1988). According to the literature, this increase in knowledge can reduce anxiety. In line with this, Jones and Wall (1985) found that after taking a course in computer technology, there were no significant sex differences in levels of computer anxiety. In opposition to this, Touchings (1989) found that regardless of level of computer literacy, male teachers have more positive attitudes toward computers than female teachers.

Urban/rural differences in teacher attitudes toward and knowledge of computers.

The present study is also concerned with whether or not the situation of a school (urban or rural) is a significant factor affecting teachers' knowledge of computers and attitudes toward computers. Using the Stages of Concern Questionnaire, a dimension of the Concerns Based Adoption Model, Cicchelli and Baechu (1987) found that rural schools are not being left behind by the technological revolution, was untrue. In terms of access to computers, there seemed to be no significant difference between urban and rural regions of South Carolina. Barker (1986) found that, on average, students in small schools received more computer time than students in large schools, indicating perhaps that the teachers in the small schools used computers more. It could also be argued that this may indicate a greater computer to student ratio in smaller schools. Since 54.8% (Jill Andrews, personal communication, July 14, 1989) of teachers in Newfoundland and Labrador teach in rural areas, urban/rural differences are an important consideration in the design and implementation of preservice and inservice programmes in this province.

Conclusion.

The introduction of computer technology into mathematics instruction requires change on the part of teachers. Inherent to the process of change is resistance to change. In support of this Fullan (1982) has stated that "... real change, whether desired or not, whether imposed or voluntarily pursued, represents a serious personal and collective experience characterized by ambivalence and uncertainty" (p. 26).

Unfortunately, computers have largely been introduced in grossly inappropriate ways. Computers have sometimes been purchased without any clear planning as to how they will be integrated into various programmes or who in fact will be responsible for the integration. It seems that the integration of computers in education has been done in the face of societal and political pressure. Clearly, careful planning has not gone into the implementation of computer technology in mathematics education. Computers are not going to be used well until teachers have time to learn how to use them. Possible changes in the teaching and learning of mathematics will not take place simply because computers are available. Therefore, teacher education is a necessary component of successful implementation.

As with any teacher education programme, effectiveness of any computer education program will depend on the extent that it is seen as a need by teachers. If inservice and preservice education are to be appropriate and effective in the professional development of mathematics teachers, the needs and concerns of those teachers must be identified (Kinmel, 1987). Since the classroom teacher is the means through which success of innovation is ultimately to be attained, teachers' level of awareness and attitudes towards computers in mathematics education must be determined.

<u>Definition of Terms</u>

Senior High Mathematics: Senior high mathematics refers to mathematics in Levels I, II, and III as outlined by the Newfoundland and Labrador Department of Education (Appendix B).

Computer Literacy: Computer literacy refers to one's level of knowledge in the daily operation of a computer as well as one's ability to evaluate and use educational software.

Computer Attitudes: Positive and negative attitudes toward computers will be inferred from responses to items contained in the questionnaire.

Urban: The definition of urban for this study is of Statistics Canada which classifies urban as "Any community or census agglomerate of communities whose population exceeds 5,000 . . ." (Appendix A).

Rural: The definition of rural for this study is any community which is not urban.

Scope and Limitations of the Study

This study deals with teacher knowledge and attitudes toward the use of computer technology in the teaching and learning of mathematics. The research is directed at teachers of senior high mathematics.

A major limitation of this study is a mailout type of questionnaire survey which usually has a very low response rate. Although every effort was made to ensure a good response rate, the large geographical area in which the questionnaire was administered made personal followup and visits impossible.

Although every effort was made to avoid any ambiguity of statements or phrases in the survey, ambiquity is possible with any research. No doubt this holds true for the present study.

Significance of the Study

This study is designed to measure teacher knowledge and attitudes toward computers as it relates to the teaching and learning of mathematics at the senior high level. The significance of the study is its function as a needs assessment of teacher education in this area. It is hoped that this work will prove beneficial to the design and implementation of preservice and inservice programmes for teachers of senior high mathematics.

CHAPTER II

Review of the Literature

The Process of Change

Although many of us strive for stability, change is essential for the survival of the individual or organization in a rapidly changing society. Today, technology is changing the way that we view knowledge, for what we learn today may be obsolete tomorrow. In terms of education, changes in the curriculum must be such that education meets the needs of society (Haynes & Blomstedt, 1986). The onset of computer technology has created the potential for significant changes and improvements in the way that mathematics is currently taught. In most instances this will mean changes in the curriculum. For example, the introduction of the calculator into school mathematics requires that decimals be introduced in the curriculum at a much earlier age. Changes in curriculum in turn lead to changes in our conceptions of effective teaching strategies and learning.

Fullan's (1982) definition of educational change encompasses three components or dimensions:

1. Materials: the possible use of new or revised materials.
2. Teaching approaches: the possible use of new teaching approaches, teaching strategies or activities.

3. Beliefs: the possible alteration of beliefs (e.g., pedagogical assumptions and theories underlying particular new policies or programs). (p. 30)

Fullan contends that all dimensions are important but that not all teachers will necessarily be successful at implementing all components. In other words, "... it is possible to change 'on the surface' by endorsing certain goals, using specific materials, and even imitating the behavior without specifically understanding the principles and rationale of the change" (p. 33).

Change is influenced by at least three factors. The process of change is determined by what the change is, the number of changes to be made at one time, those individuals that will be affected and the interactions between these factors (Steigelbayer et al., 1986). Forces which act upon the status quo create pressure for the school to change as well as pressure for the school to remain the same. Tradition, which is a very powerful force, can sometimes be positive or negative. It can be positive if it prevents us from taking hold of the latest fad. It is negative when a new idea is suggested and it is viewed negatively simply because it is new. Acting in the opposite direction of tradition are global forces. These include social forces, changes in knowledge, growth and development, and learning.

<u>Strategies for change</u>.

The Concerns Based Adoption Model (Appendix C) describes the types of interactions that are necessary to facilitate change from the point of view of the facilitator and those who will be affected by the change. Also, those responsible for planning change must differentiate between the change itself and the process of changing. The nature of change can be said to evolve for it happens as a result of growth, maturation and learning. Change can also be viewed as dramatic as in the case of acquired new knowledge. For example, principles of adult learning can change the professional development of teachers. New knowledge in many different areas may lead to changes in various aspects of school practice (Miller & Sellar, 1985).

Underlying any strategy for change is the assumption that teachers must understand the rationale for the change, what it is for and what it may accomplish. Effective communication is essential. Teachers need support and confidence; without them, resistance to change is almost certain to occur.

<u>Teachers and resistance to change</u>.

LaPorte (1986) argues that the very nature of teacher's jobs makes teachers natural innovators. But what is also true is that they can make it appear as if a program is in place when in reality it is not. Arguing in the same manner, Haynes and Blomstedt (1986) contend that change is chiefly influenced by human forces and that teachers will support only those changes that they help to create. If teachers are asked to comply with predetermined change, they are more likely to develop resentment because they perceive themselves as being manipulated. Fine (1986) contends that: "... no matter how much benefit a proposed change will bring to the organization, no matter how meticulous the planning strategy, some individuals will resist the change, either through active aggression or passive retreat" (p. 83).

To appreciate a teacher's resistance to change, we must recognize the difficulties of teaching itself. Huberman (cited in Fullan, 1982) states the following three dimensions of classroom teaching:

1. Multidimensionality: the classroom as a crowded place with several activities and functions to be carried out (discipline, instruction, relationships).
2. Simultaneity: interacting with one pupil and monitoring the others, preparing the next question or exercise, directing simultaneous groups, etc.
3. Unpredictability: anything can happen; a well planned lesson may fall flat, what works for one child is ineffective for

> another, classes have different 'personalities' from year to year. (p. 27)

In light of this, Fullan (1982) suggests that teachers really have no reason to believe in change. Fullan further contends that when those planning the change ignore the culture of the school and classroom, two types of non-change occur, 'false clarity' and 'painful unclarity':

> False clarity occurs when people think that they have changed but have only assimilated the superficial trappings of the new practice. Painful unclarity is experienced when unclear innovations are attempted under conditions which do not support the development of the subjective meaning of change. (p. 28)

It seems probable that if we can understand how teachers assess change we can better explain the problem that they have with the meaning of change. According to Fullan (1982), the research reveals 3 main criteria that teachers use when assessing change:

1. Does the change potentially address a need? Will students be interested? Will they learn?
2. How clear is the change in terms of what the teacher will have to do?
3. How will it effect the teacher personally in terms of time, energy, new skills, sense of

excitement and competence, and interference with existing priorities? (p. 113)

An appreciation of teachers' resistance to change is essential in any change process. According to Fullan, many teachers feel that the real difficulties inherent to the teaching process (discipline, large numbers, individual differences), will never be eliminated by any type of innovation. In light of this, at least as far as teachers can see, no change, no matter how desirable it may be, will eliminate the many frustrations that are inherent in the teaching process.

Fine (1986) views this resistance to change in a somewhat more favorable light. Fine feels that it is just as important as the acceptance of change for it guards against change just for the sake of change.

Conclusion.

Change does not necessarily imply progress. It must always be judged in relationship to the specific values, goals and outcomes that it serves. The large number of societal factors that influence education make it crucial that the system not respond to every new fad as well as not just support the status quo (Fullan, 1982).

Change is a dynamic process and must be viewed as such. It is a learning process and it is difficult. It creates feelings of insecurity. Until educators take the time to examine carefully the process, rather than the change itself, will a proposed change have a chance of becoming a reality. The advent of computers in our schools represents not only possible changes in the mathematics curriculum, but also a challenging opportunity to study efforts at change. According to Glass (1984),

> Although the responsibility for computer education does not, and should not, rest solely with mathematics education, the innate mathematical basis of the technology - and experience with its use as a mathematical problem-solving tool - place a heavy burden on mathematics educators to provide leadership and chart direction for computer education. (p. 10)

Teacher Attitudes Toward Computers

Teacher acceptance is seen by many as the biggest challenge facing educational innovation today. Teacher acceptance of computers will be directly affected by their attitudes toward computers. This work will focus on teacher attitudes toward computers in particular, and it must be noted from the start that much of the available information on the topic is new and not specific to any particular group of teachers. It is nonetheless hoped that some insight from the literature may be relevant to teachers of senior high mathematics in Newfoundland and Labrador. Prior research strongly suggests teacher attitudes are the greatest single influence on how the computer is used in the classroom. Changing teacher attitudes will involve educating teachers on the value of the computer in the teaching/learning process. As with any new phenomenon, it seems plausible that the more experience that one has with computers, the less anxious one will feel towards computers (keeping in mind of course that less anxious does not necessarily mean more positive). Stevens (1982) and Manarino-Lettett and Cotton (1985), found that successful integration of computers by teachers depends on two major factors: teachers' attitudes towards computers and their level of expertise with computers. Most of the teachers in these studies felt that the computer could enhance the teaching learning process, but because of their limited knowledge, many of them preferred the more traditional methods of teaching. These two studies did not support Steven's (1980) finding that almost half of the teachers were not interested in acquiring computer knowledge necessary to respond to a technological society. This is not surprising since the 1982 study simply replicated the 1980 study for the purpose of determining if changes were needed in preservice and inservice programmes that were designed as a result of the original study. Perhaps this change in teacher attitude was a result of positive preservice and inservice programmes.

As well, Jones and Wall (1985) studied the hypothesized relationship between computer experience and computer anxiety.

The investigation involved two pilot studies. Results of the first study indicated that high anxiety scores were related to low literacy scores. The multi-group pre-posttest design, involved 43 graduate students of education who were administered standardized measures of computer anxiety and computer knowledge. The article did not indicate what type of computer experience the participants had. Results of the second study indicated a significant negative relationship between amount of computer experience and level of anxiety. In this study, 129 undergraduate students (47% Male, 53% Female) enrolled in the same course "Fundamentals of Computing", were administered only the anxiety scale. These studies seem to direct our attention to the value of providing computer experience to enhance teacher attitudes towards computers.

Overall, educators seem less enthusiastic about the role of computers in society than the general public (Lichtman, 1979). The researcher found that 55% of the educators as compared to 37% of the general public felt that computers dehumanize society and that computers isolate people by preventing normal social interaction. The study, which replicated a survey that was conducted on public attitudes toward computers in society (Ahl, 1976, cited in Lichtman, 1979), involved 189 educators in summer programs at the university of South Carolina. The study did not specify the term 'general public' and so it is difficult to suggest reasons for these results. Fifty-eight percent of the teachers felt that the computer could teach mathematics but only 47% felt that computers could teach reading. Lichtman suggests that this indicates that the computer was regarded as more of a mathematical tool than as universal general symbol processing. Taking into consideration the date of the study, this is not surprising. The educational software base at that time was very limited. According to Chambers and Sprecher (1980) of the four thousand computer programmes (CAI) available for education, 96% were judged unacceptable by faculty in their areas. This may not be the case today given the development of and demand for educational software all across the curriculum. According to the U.S. Government Publishing Office (1989) there are now ten thousand computer programmes (CAI) available for education.

In an attempt to study the potential use of micro-electronic technology in accomplishing the major goals of schooling (the major goals of schooling were taken verbatim from Goodlad's (1979) What Schools Are For), two of several questions addressed by Moersch and Klein (1988) included were:

1. What are the perceptions of computer-using educators regarding the capabilities/limitations of microelectronic technology toward accomplishing the major goals of schooling?

2. To what extent do these computer-using educators rate the potential utility of computers differently and consistently based on background variables?

Of the respondents (51.7%) 70.8% had been teaching for at least ten years and 66.2% had claimed the ability to program in one or more languages. Based on these background characteristics it is not surprising that these computer-using educators perceived microelectronic technology as being capable of accomplishing both intellectual and vocational goals of schooling. They were, however, less optimistic about the computer accomplishing the social and personal goals of schooling. Although an important consideration, the study did not state why the social and personal goals of schooling were perceived this way. When the percentage of time of computer use within the classroom, the number of years teaching experience, and the number of computer related classes/seminars taken were considered as background variables, there was no significant difference in perception toward the potential of the computer in accomplishing the major goals of schooling. Again, based on the background characteristics of the sample this is not surprising.

The background characteristics of the sample used in this study (Moersch and Klein 1988), are certainly not representative of the population of senior high mathematics teachers in Newfoundland and Labrador. Nonetheless, as a whole the study revealed that the more training a computer using educator had, the less likely he/she would be to perceive the computer as being capable of accomplishing the goals of education. Perhaps this is because they realize the work and planning required for successful implementation.

Computerphobia is a term that has been used to describe teachers' fear of computers (Blank & White, 1984; Gressard & Lloyd, 1985; Manarino-Lettett & Cotton, 1985). Many teachers lack the confidence that comes with an understanding the technology. For example, some fear that the integration of computers will eliminate their jobs. According to Jay (1986), computerphobia appears in the form of negative attitudes toward technology. Examples of such negative attitudes range from the fear that one could damage the computer or ruin what is inside, to feeling threatened by students and others who do know something about computers. Jay has suggested that failure on the part of the teacher to keep abreast of technological advances that affect his or her life is one cause of computerphobia as well as the failure of the school or school board to plan for the integration of computers in terms of assessing teacher attitudes and knowledge. Although Woodrow (1987) in a more recent study of teacher attitudes toward computers found that computerphobia is no longer a major problem among educators and suggested that the increased presence of computers in the schools makes them less threatening to teachers. This may be true but not being fearful of computers does not necessarily indicate positive attitudes towards computers.

Teacher needs directly affect teachers' attitudes.

According to Wedman and Heller (1984) inservice training designers often fail to take into account the affective needs of teachers. Using the Concerns Based Adoption Model (Appendix C), which hypothesizes that teachers move through different stages of concern as they gain more experience with an innovation, Wedman and Heller addressed this problem by identifying and describing the concerns of teachers as they begin a computer inservice activity. The study included 87 inservice teachers who voluntarily enrolled in a two-credit-hour course. The study did not elaborate on what was meant by a two credit hour course for it seems unreasonable to receive two credits for that type of course. The course was offered at 5 different university campus sites across the state of Iowa. The Stages of Concern Questionnaire (SoCQ) was used to measure teacher attitudes toward the use of computers in education. The scoring of the questionnaires provided graphical representations or "concerns profiles" for teachers at each site (Figure 1, Wedman and Heller, 1984, p. 36) as well as for the total group (Figure 2, Wedman and Heller, 1984, p. 37). The results indicated that the concerns were particularly intense for teachers at stages 0, 1, and 2. Two of the sites had high collaboration concerns, but the total group profile did not reflect this. As with each site profile, the total group profile showed relatively low level concern for something better than the innovation. The researchers contend that teachers new to the area of computers have concern profiles similar to that of stages 0 and 1. The researchers also contend that if teacher education through

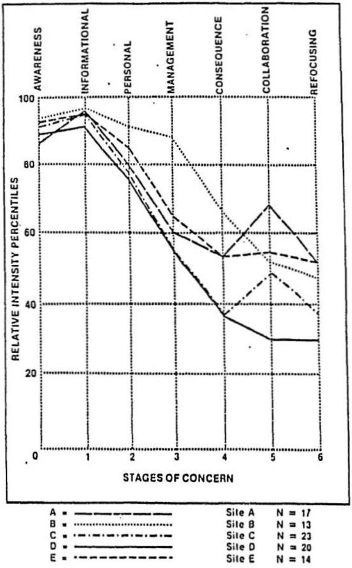


Figure 1. Stages of Concern Profile for Each Group

inservice fails to meet these needs of awareness and information first, the net affect will be teacher frustration and

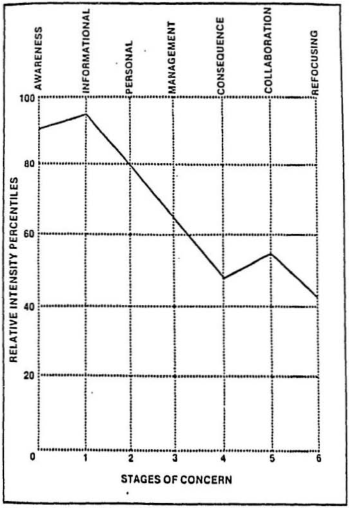


Figure 2. Stages of Concern Profile for the Total Group

non-utilization of the computer. The model predicts that as teachers become experienced with computers, their concerns will shift and that if inservice training is to be effective, it must change as the concerns of teachers change. The lack of effective follow-up to teacher inservice is a commonly perceived problem in Newfoundland and Labrador.

In a study of business teachers' attitudes toward computers, Harmon (1986) found that role classification affects attitudes and it helps explain why business teachers' attitudes are becoming more positive toward computers. The main focus of their teaching is in business and industry, where computer use is quite common. Teachers of mathematics as a group are often seen, at least by other teachers, as being knowledgeable of and interested in computers simply because they are mathematics teachers. Is this true or simply an uninformed opinion as a result of incorrect role classification? The latter is probably the case. The teachers in Harmon's study also had both less students and more computers in their classrooms and so this may be a factor contributing to their positive attitudes. Small numbers of students and large numbers of computers are not typical of most Newfoundland and Labrador classrooms.

Harper and Kok (1988) found that mathematical skill was a significant factor in predicting computer knowledge, but the effect of mathematical skill was significantly reduced after the completion of a computer course. This seems to imply that, given the opportunity, teachers of other disciplines are equally capable of acquiring computer knowledge. This finding is quite relevant to this present study as many teachers of senior high mathematics in Newfoundland and Labrador have a limited mathematical background. The sample was comprised of 376 student teachers at the Institute in Education in Singapore enrolled in a 30 hour 'Computers in Education' course that was integrated througout the year.

Fresko and Ben-Chaim (1986) hypothesized that teachers' needs varied according to their background characteristics. Taking into account professional and educational background, the researchers analyzed the perceived needs of a group of 246 mathematics teachers in Israel. Those teachers involved signed up for one of seven summer workshops each addressing a different topic in the teaching of school mathematics. The research instruments used included a needs measure as well as questions relating to teachers' educational background and professional background. The needs assessment was representative of the following areas: familiarization with curriculum materials, instructional planning and use of teaching aids, classroom strategies, information about work in the field and subject matter. Teacher background data was described by the following three variables:

1. Type of post-secondary education.

2. Specialization-whether teachers majored or minored in mathematics.

3. Experience teaching mathematics.

Without considering teacher background traits, the teachers expressed similar interest in all the proposed areas. They felt a need for help in everything. When background characteristics were considered, the group was not as homogeneous with respect to needs as might be concluded from the data on the group as a whole. The study clearly indicated that teachers' perceived needs as well as the priorities they attribute to different types of inservice activities, according to education and experience, are traits that need to be considered when needs are assessed for the purpose of inservice. Given the limited mathematical background of teachers of senior high mathematics in Newfoundland and Labrador, it is hoped that this present study will lead to recommendations that will meet the needs of these teachers.

Prior research certainly suggests that unless teachers value the computer as an instructional device, the computer simply will not be used. In turn, teachers of senior high mathematics in Newfoundland and Labrador need experience with computer technology before they can see any value in computer innovation. Apart from experience with computers, the research indicates background factors that may influence teacher attitudes toward computers: subject area taught and amount of teaching experience. The present study will look at age, sex, and location of school to help explain any differences in teacher attitudes and knowledge of computers.

Definition of Computer Literacy

Most members of first world societies at some point attend school. A computer literate society will have roots in the schools. Crocker (1989), in a summary report of The Task Force on Mathematics and Science Education, states:

> While it is possible to find many examples of events which mark the fundamental ongoing transition in society, the advent of the microcomputer is clearly the one which stands out most clearly ... Those unfamiliar with the principles, operations, uses, and limitations of microcomputers are already at a disadvantage in the workplace. This disadvantage can only increase with time, unless large numbers of future workers can be educated in such a way that they can adapt to the ever changing environment created by these machines. (p. 4)

This implies that schools must have teachers who are computer literate. It is important to recognize the relationship between computer literacy and instruction. If teachers or student teachers of senior high mathematics in Newfoundland and Labrador are to use computer technology effectively in their instruction, then they must be computer literate.

Computer literacy is difficult to define and there seems to be no consensus as to how this educational goal should be achieved (Ford, 1984). Clearly, if we cannot agree on what something is, we will certainly not agree on how to achieve it.

Moursund (1979) contends that an individual should have a working knowledge dependent upon the discipline involved. If so it is difficult to define computer literacy in a universally acceptable manner or in a way that it lends itself to easy measurement. Even in 1989, this is still the case.

After a review of various definitions in the literature, Lockheed et al (1983) defined computer literacy as whatever a person needs to know in order to function competently in a computer based society. The definition includes the ability to use computers in learning, problem solving and managing information. It also includes knowledge of computer capabilities as well as social implications and issues. This definition seems somewhat general.

According to Stevens (1980) a computer literate teacher should be able to use appropriate criteria for the selection and evaluation of commercial software and also play a dominant role in the development or modification of software to meet specific classroom needs. With the increasing supply of educational software, this aspect should not be overlooked.

Barker (1986), in a study of the role of the microcomputer in rural schools, distinguished between 'computer literacy' and 'computer awareness'. Computer literacy was defined as one's familiarity with how the microcomputer functions as well as the ability to write simple or complex programs. A problem can be found with the aspect of the definition that deals with the ability to write complex programs. Knowing what programming is, being able to point out good and bad features of a particular program and the ability to write a simple program is sufficient. The majority of people in our society including teachers of senior high mathematics in Newfoundland and Labrador will never need to write complex programs. Computer awareness was defined as one's familiarity with how the computer can be applied as well as the ability to access and use software programs. Undoubtedly, this is a major component of computer literacy.

The present study refers to computer literacy as one's level of knowledge in the daily operation of a computer as well as one's ability to evaluate and use educational software. For the purpose of this study a teacher who is computer literate need not be proficient in any programming languages or to be able to repair a computer system. A computer literate teacher need only be aware that different programming languages are available, and know the basics of how a computer system works.

Age as a Factor Affecting Computer Attitudes and Knowledge

It is possible that age may be a factor in teachers' attitudes towards computers as well as teachers' knowledge about computers. Older teachers may be more anxious about using computers in their mathematics instruction, but this may be because older teachers may have less experience with computers. Adults draw their knowledge from years of experience. New learning experiences may be an attack on their confidence and therefore the suggestion of change is not always welcomed.

Jones and Wall (1985), found that older students had less experience with computers and that those with the least experience were the most anxious toward computers. Standardized tests of computer anxiety and knowledge were administered to 43 graduate students, 21 of whom were instructional technology students. The mean age of the respondents was not stated, making it difficult to interpret this study and the effect it may have on the situation in Newfoundland and Labrador. It is interesting to note that the researchers included 21 instructional technology students for the sample. It is possible that with or without experience an individual who is enrolled in this program is probably not that anxious about computers anyway.

Reaching a similar conclusion, Hattie and Fitzgerald (1987) found that the regular users of computers tended to be new teachers. This is not surprising since the newer teachers were probably exposed to computers in their own schooling.

However, in a much earlier study of Stevens (1982), it was found that older teachers may have the least experience but student teachers were the ones most conservative in their attitudes toward and knowledge of computers. The researcher contends that perhaps this group of student teachers was the generation gap in the era of technology. This could very well be the case, but not to the point that they are significantly more anxious than older teachers.

Gressard and Lloyd (1985) in a study to investigate the effects of age and experience on attitudes toward computers, found age not to be a factor in computer attitudes of teachers. Gressard and Lloyd also reported that this situation was in contrast to that found in the business community. This study did not say why this was so. It is conceiveable that older businesses achieved success without the help of computers and therefore felt that they could continue to do so without computers.

Morris (1989) found age and education to have a direct effect on attitudes towards computers. As well, age was found to be indirectly linked through education. It seems that the younger someone is, the more formal education they have and the more formal education an individual has, the more positive they feel towards computers. The sample (n = 380) was obtained through a computer program which randomly selected telephone numbers. Each respondent was interviewed over the phone. The mean age was 44 with 55.5% of the sample female. The mean age does not seem to be that young, but the sample included individuals that were less than 20 as well as individuals that were older than 85. Given this large range in ages it is not that surprising that the results turned out as they did. Whether this is the case with senior high teachers of mathematics in Newfoundland and Labrador is not clear. The assumption can be made that range in age is not that large.

Clearly, the little research that has been completed on age as being a factor affecting computer attitudes and knowledge is inconsistent. It is hoped that the present study as it relates to the senior high teachers of mathematics in Newfoundland and Labrador, will make some contribution to the resolution of these inconsistencies.

Sex Differences as a Factor Affecting Computer Attitudes and Knowledge

Research on sex differences in teacher computer literacy levels and computer anxiety is limited and inconsistent. The literature is abundant with evidence in support of sex differences in mathematics achievement and anxiety. As computers are often seen as being mathematical, it is possible that these feelings of anxiety transfer to computers. Begle (1979, cited in Blank & White) and Munbey (1980, cited in Blank & White) contend that there is a strong association between female attitudes towards mathematics and their attitudes and achievement with computers. Now, ten years later, it is possible that this is changing for the computer is so prevalent throughout society. We now have areas in the work force that rely on computer technology but are female dominated. Computer technology is no longer considered only as part of mathematical domains and concomitant traditional dominance by males.

In line with the above and addressing the problem of women's attitudes toward computers, Winkle and Mathews (1982) suggest that females require special consideration, because society may create anxiety in females toward computers and their use, in the same way anxiety is felt by females toward mathematics. There is a concern that computers may be discriminating against females, such that in a few years time, females are going to be even more disadvantaged in jobs and society because of lack of familiarity with computers.

Collis (1987) suggested that students attitudes toward mathematics were correlated in their attitudes toward computers; knowing a student's attitude toward mathematics would have given a reasonable prediction of his or her attitude toward computers. For the males, those who expressed feelings of frustration toward mathematics were also likely to express a disinterest in computers. For the males, feelings of self confidence in mathematics were related to feelings of pleasure in computer use. The patterns are different for the female students. For the grade 8's in this study, feelings of frustration toward mathematics tended to be associated with "you have to be smart to use computers". For the grade 12's, "I would be embarrassed to tell my friends that I would like to join a computer club". These differences in female responses between the grade 8's and the grade 12's seems to support Hattie and Fitzgerald's (1987) finding of sex differences increasing with age. Female grade 8 students did not associate positive feelings toward mathematics with any computer-related feelings. Also, the relationship between the use of computers in mathematics and attitudes toward computers was significant for the males but not significant for the females. In spite of this study being directed at students it has strong implications for this present study, for obviously some female students will become teachers of senior high mathematics.

Not relating mathematics, but in contrast to Collis (1987), Jones and Wall (1985) found no significant sex differences in levels of computer anxiety. The sample for this study consisted of 47% male and 53% female. The mean age of the respondents was 24.7. This mean age is relatively young. The mean age of teachers of senior high mathematics in Newfoundland and Labrador is not available, but is probably not quite this young, it is difficult to compare this 1985 study to the present study. With respect to computer knowledge, Harper and Kok (1988) investigated sex as a background factor that could determine such. Pretest results indicated that sex was a predictive factor for computer knowledge, but the same was not found in the posttest. This seems to imply that females can be just as knowledgeable about computers given the same opportunity. As well, Morris (1989) found sex to have no effect on attitudes toward computers.

In contrast to the above studies (Jones & Wall; Harper & Kok; Morris) but with more relevance to the present study, Touchings (1989) found that regardless of level of computer literacy, teaching area, or grade level taught, male teachers had more positive attitudes toward computers than female teachers. The sample for this study consisted of 487 teachers from grade kindergarten to grade 12, selected from seven school boards located on the Avalon Peninsula of Newfoundland.

It is very difficulty to find many articles that go beyond opinion and conjecture concerning sex differences and computers is very difficult (finding research in this area specific to teachers of mathematics is even more difficult). It has not been an area that has been systematically researched in the literature (Hattie & Fitzgerald, 1987). In light of this, Hattie & Fitzgerald (1987) conducted a meta-analysis of sex differences in computer attitudes and achievement, but only 19 articles had an adequate level of data to permit them to be even used in the analysis. Results indicated that there was at best a small difference between males and females, but the differences did become noticeably stronger with age. There were no differences relating to achievement outcomes. The effect size for attitude outcomes was not indicative of substantial differences between males and females, but it was suggested that if differences between males and females did become stronger with age, the discrimination against females could develop into a substantial effect. This is an important consideration when we consider differences between male and female teachers of senior high mathematics.

In two Australian studies Hattie and Fitzgerald (1987) studied differences between boys and girls, male and female teachers, and male and female parents, in computer attitudes and usage. Results from the first study indicated no sex differences in the perceptions as to the problems of introducing computers into the classroom and only small differences between male and female attitudes towards computers. Based on a sample of 385 teachers from 32 schools where 50% of the teachers were regular users, this result is not surprising. The schools involved had been using computers for a number of years and were in the capital city. It is interesting to note that users were mostly secondary teachers and teachers of mathematics or science.

Independent of the first study, the second study used a detailed questionnaire that was sent to 1000 schools throughout Australia (82% response). As in the first study, there were small differences between male and female attitudes towards computers.

With respect to these two studies and as in the meta-analysis, the little research that was located was supportive of small differences in attitude, with males more positive toward computers. On the other hand, after some exposure to computers females achieve equally well as their male counterparts.

Sanders (1984) speculates that one explanation for observed differences in male and female students' voluntary computer use is that male teachers and counsellors tend to be more enthusiastic and knowledgeable about computers than female teachers and counsellors, creating a negative role model effect for females. This theory has not been studied in the literature and is therefore simply conjecture. Of the many reasons that Sanders (1984) has cited as reasons for sex differences in computer usage, Hattie and Fitzgerald contend that those that can be accepted include:

1. The association between machines and masculinity.

2. Males appear to be more competitive.

3. Females prefer alternative forms of reinforcement, and different social organizations dealing with computers.

4. Software, advertising and books appear to be sexist.

5. Female students (male teachers and male parents) do not perceive computers as important in female students' future lives.

According to Hattie and Fitzgerald, there are a number of reasons that can also be rejected;

1. Differences between boys and girls on spatial skills and self-concept.

2. Female teachers not very enthusiastic.

3. Lack of role models.

4. An association between mathematics and computers.

5. A difference in a desire to use computers.

Urban/Rural Differences as a Factor Affecting Computer Attitudes and Knowledge

Many of Newfoundland's schools are situated in rural areas of the province. But whether or not a school situated in an urban or rural community has any significant affect on teachers attitudes toward and knowledge of computers has not been reported a great deal in the literature.

Dickerson and Pritchard (1981) found a relationship between size of a school district and computer usage. The larger the school district, the more likely computers were used in instruction. None of the small districts (0-2000) used computers in their instruction whereas all of the larger districts (over 25000) did. Given the present year 1989, this is probably no longer the case. Given society's concern today for equal educational opportunity, this extreme of none or all is possibly no longer true.

On the other hand, Barker (1986) found that 20.1% of teachers in small high schools were 'computer literate' as compared to only 14.5% of the teachers in the large high schools. Also, the student/computer ratio was lower in small high schools. In this study, a small school was one with enrolments of less than 500 students, whereas a large school was one with an enrolment in excess of 1000 students. This study is not comparable with the present study for two reasons. First, the study did not specify whether or not the small schools were actually located in rural areas. Second, the study was based on a self-administered questionnaire sent to school principals. This seems to be a very subjective measure of teacher computer literacy. It was interesting to note in the results that the response rate was 67.2% for the small schools but only 38.9% for the large schools. Could this possibly suggest a more positive attitude on the part of administrators in smaller schools?

Marshall and Bannon (1985) found that students and educators in rural settings have 'positive attitudes' towards computers. With respect to computer knowledge over half of the educators scored at the 'advanced awareness level'. The instrument was developed by the authors with the highest level of computer literacy being reflected in programming capability. This is in contrast to the definition of computer literacy used in this present study, which does not place high importance on the ability to program. In this present study, importance is placed on the ability to use and evaluate educational software. It was also found that male students were more computer literate than the female educators. It was suggested in the study that this difference between male students and female educators indicates a possible sex equity problem concerning computers in rural schools.

Dickey and Kherlopian (1987) found that the idea that rural schools are being left behind by the technological revolution is untrue. In terms of access to computers there seemed to be no major difference between urban and rural regions of South Carolina. If urban and rural regions of South Carolina are comparable to urban and rural regions in Newfoundland, these results are encouraging, but just because teachers have access to computers does not mean that they are going to be used.

The Need for Teacher Training

Teachers' knowledge of instructional computing is essential for positive attitudes among teachers, which is in turn imperative for successful integration of computers into the curriculum. This has been well documented in the literature (Moursund, 1979; Gressard & Lloyd, 1985; Wedman, Heller & Strathe, 1986; Madsen & Sebastiani, 1987; Dickey & Kherlopian, 1987).

The Association for Computing Machinery (ACM) Elementary and Secondary Schools Subcommittee (Moursund, 1979) has identified teacher education as one of the major obstacles to introducing computers in education. The subcommittee indicated that progress in solving the problem has been slow and will continue to be slow. The situation today has not changed from ten years ago. It is interesting to note that this subcommittee ten years ago stated that short workshops and one term evening courses are inadequate for most teachers. Teachers need continuing assistance, assistance that must change as the needs of teachers change. Today, what little computer education is provided to teachers of senior high mathematics in Newfoundland and Labrador, it is usually a one day inservice with very little, if any follow-up.

Teachers' attitudes toward and knowledge of computers must be determined before designing preservice and inservice training programmes. This was the rationale behind a survey conducted by Stevens (1980). Information from the survey was used to design teacher inservice and preservice training dealing with computers. Participants in the study included teachers, teacher educators and student teachers for a total sample of 963. The study clearly indicated that the groups favoured teaching about computers but that 90% did not feel qualified to teach computer literacy. Eighty-four percent of the teacher educators felt that mathematics teachers should have the responsibility of teaching about computers. This attitude reflects a lack of knowledge of the computer and its capabilities on the part of these individuals. With respect to instructional uses of computers, 48% of the teachers felt that the computer could be advantageous to instruction but 43% were undecided. The anxiety level of the teachers regarding the use of computers in the classroom was higher than that of the student teachers or the teacher educators. Teachers' anxiety was especially prevalent when asked to indicate their perceived levels of expertise or to suggest how the computer could be used in instruction. In retrospect, this type of question may put even the most knowledgeable on the spot. About half of the teachers and about one quarter of the student teachers indicated that they were not interested in training pertaining to computers. Over half of the student teachers indicated that they knew how to operate computers, but only about 7% felt their training to be adequate for classroom use.

Several implications were drawn from the above study. If the integration of computers in education is to be a success, teachers need to understand that computers have the potential to assist in the teaching/learning process, and that they are neither replacements for teachers nor the solution to all educational problems. Teachers need the opportunity to acquire the appropriate computer skills, and thus require reasonable access to computer facilities. As well, they need to be encouraged by support staff who are aware of the problems as well as the potential of computer related activities.

Stevens (1982), replicated the 1980 study with a similar subgroup of Nebraska teachers, teacher educators and student teachers to determine present attitudes and the effects of previously designed staff development programmes that came into effect after the initial study. All subgroups in this study were considerably more knowledgeable about computer usage and their advantages in education (42% in 1980 as compared to 82% in 1982). Overall, the workshops, conferences and so forth appear to have provided some measure of confidence to teachers. In terms of teacher training, teachers and teacher educators in 1982 were much more interested in receiving training than those interested in 1980. They strongly agreed that the programme should include instructional applications of computers but were strongly against taking actual courses. Perhaps the word 'courses' had a negative connotation in terms of teacher workload.

Anxiety scores for the 1982 teachers were significantly lower than the scores for the 1980 teachers, and also, but not to the same extent, with the teacher educators and student teachers. The teacher educators were more at ease when talking about computers, but had strong apprehensions toward modelling instructional techniques and teaching computer technology to educators. These teacher educators' apprehensions are alarming and trigger an interesting study that could be done with teacher educators in Newfoundland and Labrador. Indeed two years, as was the case with Stevens, is at least what it will take to even see minimal changes in teacher attitude and knowledge. The mere notion of a one day inservice meeting the needs of teachers is absurd.

The student teachers were still the most conservative. Student teachers in 1982 were more anxious than those in 1980 and significantly fewer student teachers in 1982 than in 1980 believed that students' understanding about computers was important. Stevens finds this troublesome, bearing in mind that these are the teachers entering classrooms during the so called computer revolution of society. This is an important consideration in teacher education programmes. This study was conducted almost 10 years ago and so perhaps this is no longer the situation. Nonetheless, it is an interesting study.

Gressard and Lloyd (1985) found that one of the most effective ways of improving teacher attitudes toward computers is the implementation of programmes which provide opportunities for the teachers to learn about and work with computers. All subjects in this study were female teachers from elementary to high school and prior to the programme none of the teachers had received more than a week of previous experience. The programme provided instruction and experience in the areas of history, computer terminology, the use of computers and programming in BASIC. The instrument provided scores on computer anxiety, computer confidence, and computer liking. Anxiety was significantly decreased, while computer confidence and liking were increased. Results of this study strongly indicate the value of providing computer instruction and experience to all teachers of all ages where computers are being introduced into the classroom.

Wedman, Heller and Strathe (1986) assessed teachers' concerns and described the effect of an inservice effort on their concerns about educational computing. Participants in the study were all classroom teachers who voluntarily enrolled in a 'Microcomputers in Education' university course. The Stages of Concern Questionnaire was used to measure teacher attitudes toward educational computing before and after the course. The concerns profile for after the course revealed inconsistencies from the suggested developmental changes in concern as hypothesized by the Concerns Based Adoption Model. Management concerns were typically lower in intensity, the higher level concerns did increase, but the lower level concerns did not change markedly. This is inconsistent with what is suggested by the Concerns Based Adoption Model. One important implication from this study concerns those responsible for computer inservice training. Any inservice training must be preceded by a needs assessment of those individuals to whom the inservice training is to be designed. This is certainly no different for the teachers of senior high mathematics in Newfoundland and Labrador than it is for any other group of teachers.

Madsen and Sebastiani (1987) studied the effect of computer literacy instruction on teachers' knowledge of and attitudes toward microcomputers. They hypothesized that lack of familiarity with computers may be a contributing factor to teacher resistance toward computer technology. In an experimental pretest-posttest design involving 60 secondary school teachers, the control group received a 15 hour computer literacy course. The definition of computer literacy for this study demanded a fairly high degree of familiarity with the technical aspects of computer use including programming. The attitude of teachers toward computers in this study as well as their knowledge of computers was significantly improved by their participation in the inservice computer literacy course. The greatest improvement was on the anxiety items. This may be because of the attitude improvement. These results should encourage a widespread implementation of inservice computer literacy courses. One criticism with this study is the length of the computer literacy course, only fifteen hours.

In a survey of 400 teachers of mathematics and science from South Carolina, Dickey and Kherlopian (1987), found that in spite of 70% of the teachers having access to a computer, only 4% had any training in the area of computers. A primary concern was the failure of the teachers of mathematics to use the computers for demonstration. The researchers suggest that this implies that the teachers were not demonstrating the BASIC programs supplied with many mathematics textbooks and were not even using the provided spreadsheet and Logo programs. This study again indicates the necessity of teacher training. The mere presence of computers in schools will not guarantee their use.

In a survey of Florida's public school administration, Dickerson and Pritchard (1981) found that in spite of 60% of the reporting districts using computers in some way for instructional purposes barely 40% provided support or training for teachers. The researchers contend that computer literacy will be developed most effectively by using computers in conjunction with instruction but this study clearly indicates that unless the situation changes, computer literacy will not be developed at least at a fast enough rate to keep up with the technology.

Clearly, if inservice and preservice training is to be effective, it must be responsive to the developmental concerns of teachers. Only then will it be possible for us to expect teachers of senior high mathematics in Newfoundland and Labrador to use computers in the teaching and learning of mathematics.

Conclusion

The use of computers in mathematics education is perhaps no longer an issue. As Hatfield (1984) has stated:

> Throughout the world educators are exploring the potential of the computer in instruction. Indeed, during more than twenty years of innovative efforts, we have seen considerably varied computer applications in instruction. Mathematics education has been among the most extensively explored areas of instruction, and their exists a broad base of experience and materials for mathematics instructional computing. (p. 1)

Rather, the concern is how to best get teachers of mathematics to use the power of the computer in their instruction. The research done to date indicates that teacher's knowledge of computers and their applications is basic to any use of computers in education. Related to this and just as important, are the attitudes of teachers towards educational computing.

There is a strong literature base linking computer literacy with positive attitudes toward computers. Studies clearly indicate that the more experience and knowledge that a person has with computer technology, the more positive their attitudes will be toward computer technology.

The research points to various factors that may account for differences in teachers' knowledge of and attitudes toward computers. Included in these factors are: age of the teacher; sex of the teacher; and whether or not the teacher is teaching in an urban or rural community. Although the research is conflicting, it does suggest that older teachers have less knowledge of computers and as a result have more negative attitudes towards computers. With respect to sex differences in the knowledge of and attitudes toward computers, the literature base is limited. What is available is conflicting. As well, the literature suggests a connection between math anxiety and computer anxiety among females. Although urban/ rural differences in knowledge of and attitudes toward computers have not been studied a great deal in the literature, what is available does not suggest any differences.

CHAPTER III

Methodology

This study deals with assessing the knowledge and attitudes of teachers of senior high mathematics toward the use of computers in the teaching and learning of mathematics. Included in this chapter is a description of the questionnaire, the data collection process, the variables used in the study and the statistical analysis.

Questionnaire Design

The survey questionnaire instrument (Appendix G) for this study was designed and validated by Touchings (1989). The instrument used was validated over all teachers, and so the fact that the sample consisted of only teachers of mathematics is not of major importance. The reliability of the instrument (see page 56) was sufficiently high that a revalidation over a pilot sample of mathematics teachers was not thought necessary. It is important to use an impartial instrument for measuring attitudes toward computers and level of computer literacy. The fact that the instrument is not specific to mathematics instruction is not of great importance. An item analysis completed on the attitude items indicated 28 items that did not positively correlate with the rest. These items were disregarded for this present study. Part B of the questionnaire was of the same format as Touchings but was changed somewhat to reflect the definition of computer literacy for this present study. The survey included three components: (a) attitudes; (b) knowledge; and (c) personal information.

Part A of the survey instrument was used to solicit teacher attitudes toward computers. A five point Likert scale was provided. It consisted of the following responses: (1) strongly agree; (2) agree; (3) no opinion; (4) disagree; and (5) strongly disagree.

Part B of the survey instrument consisted of 7 statements concerning computer use. Respondents were asked to check all statements that accurately described their computer use.

Part C of the survey instrument was used to solicit personal information that would serve as background variables. Teachers were not asked school location or size of community. This information was obtained by looking at the postmark on the outside of the returned envelope. To classify the community as being urban or rural, the definition used was that of Statistics Canada which classifies urban: "Any community, or 'Census Agglomerate' of communities whose population exceeds 5000..." (Appendix A). All other communities would be considered rural.

Data Collection/The Sample

The sample for this study consisted of, as much as was possible, the population of all teachers of senior high mathematics in Newfoundland and Labrador. The sample was obtained by first writing a letter to each superintendent (Appendix D) in the province seeking their support, cooperation and permission to administer the questionnaire to all teachers of senior high mathematics within their school board. As well, the superintendents were asked to return an attached sheet containing a list of the number of schools and the number of teachers in each school that were teaching senior high mathematics. A questionnaire was sent to each of these teachers. When this information was obtained, a letter and large envelope containing the appropriate number of questionnaires was sent to each principal (Appendix D) seeking their support for the project. The principals disseminated the surveys to each teacher in the school. Each teacher was responsible for returning the questionnaire by mail. Self addressed stamped envelopes were provided.

Reliability

Prior to the dissemination of questionnaires to the target population, the instrument was first pilot tested and then used by Touchings (1989). Reliability analysis using the Cronbach alpha revealed that the internal consistency of the 26 item Likert type scale to be .89, indicating a high degree of reliability.

Statistical Analysis

All items worded negatively will be recoded. This will be done to avoid any response set.

To determine an accurate measure of teachers' computer literacy level (research question #1), a computer literacy score, CLS, will be recorded. Respondents will be asked to check all statements that accurately describe their computer use. A summation of the items in this section will yield each respondent's computer literacy score on an interval scale. The scores on the CLS test are on an ordinal scale, and it is possible for a respondent to check more than one item. The items are not measuring the same traits, so if a respondent does check more than one item the scores of the checked items must be combined to yield a single CLS score consistent with the working definition on page 11. There are many operations which could be used to combine the scores, but since there is no a priori reason to suppose that a check of item 4 is worth twice as much as a check on item 2, or four times a check on item 1, the simpliest appropriate operation, addition, is chosen. The values are added to give a quasi-interval scale which may be treated as an interval scale for analysis purposes (Kruskal and Tanur, 1978), although it is not true that a score of, say, 8 reflects "twice as much computer literacy" as a score of 4. [During the analysis two inconsistencies necessitated modifications to this scheme. Firstly, if a respondent checked items 1, 3, and 4 but not item 2, a score of 10 was assigned since item 2 is implied by a check to items 1, 3, and 4. Secondly, items 4 and 5 were collapsed to a single item scored at 4 (see page 62).] The following will be the scores assigned to each level of computer literacy:

<u>0</u> I can recognize a computer but I would not be able to turn one on.

<u>0</u> I can turn a computer on but I would not know how to operate it.

<u>1</u> I am familiar with computer equipment (for example, everyday operation of computer, disk drive and printer).

<u>2</u> I use a computer for personal use (for example, word processing, but I am unsure as to how to integrate the computer into mathematics instruction).

<u>3</u> I can write simple computer programs.

<u>4</u> I am able to integrate computerized materials into my mathematics instruction.

<u>5</u> I am able to effectively evaluate educational software.

In terms of the attitudinal component of the study, the items in this part will be subjected to factor analysis using principal component analysis. The analysis will determine how many factors the scale is measuring. Computer attitudes will then be analyzed in terms of these factors. The factor scores of these factors will serve as dependent variables.

Research question number 3 will be analyzed by means of correlational analysis. Research questions 4, 6 and 8 will be analyzed by means of multivariate analysis of variance. Research questions 5, 7 and 9 will be analyzed by means of multivariate analysis of variance. Univariate analysis of variance will be performed only if the multivariate analysis is significant.

As well, descriptive statistics such as means, standard deviations and correlations will be presented. A correlational analysis between all variables will also be provided.

CHAPTER IV

Analysis

This chapter is a report of the data analysis of the study. Following a general description of the sample, the results from reliability analysis and factor analysis will be reported. Each research question will then be addressed separately, as well as other findings that were significant.

Description of the Sample

Of the 502 questionnaires that were disseminated, 342 were returned, 13 of which were spoiled, leaving a total of 329 respondents (65.5%). The sample consisted of 86.9% male and 13.1% female. With respect to age, 37.9% were less than 36 years, 43.7% were between 36 and 45 inclusive, and 18.3% were greater than 45. Sixty-seven percent of the sample were teaching in rural areas of the province, 33% were teaching in urban areas of the province. Fifty-eight and a half percent had completed twelve or less university mathematics credits with 62% of all respondents finishing their last university mathematics course on or before 1979. Fifty and three tenths percent of the sample had completed no computer science university credits. Thirty-two and four tenths percent had completed at least 2 computer science university credits. It was discouraging to find only 57.5% of the sample having received any inservice education in the area of computer technology. It was not surprising that 89.6% of the sample were teaching mathematics because they wanted to and not solely due to an administrative decision. Unfortunately the teaching of mathematics is looked upon as being an easy subject to teach, ie. the text provides lots of practise (although not necessarily suited to a student's needs) and tests are viewed as easy to mark because the answers are sometimes considered only right or wrong, with no thought given to the student's true understanding of the problem.

Reliability Analysis

A reliability analysis to determine the Cronbach alpha was completed on all items in section A of the questionnaire. It revealed that the internal consistency of the original 26-item Likert-type scale was .85. As item number 8 did not correlate positively with the rest, it was deleted from the study, increasing the overall reliability to .86. This indicates a high degree of reliability.

Factor Analysis

Using principal component analysis, five factors that accounted for 48.8 percent of the variance (Table 1) were revealed. The items representing each factor were then examined for the purpose of determining what attitude each factor represented (Appendix E). The Factors were named as follows:

Factor 1 - Teachers feel that computer technology has and will continue to have a major influence in the workforce.

Factor 2 - Teachers feel threatened by computers.

Factor 3 - Teachers do not feel that the school should be responsive to a technological society.

Factor 4 - Teachers believe that computer technology can contribute positively to the teaching/learning process.

Factor 5 - Teachers do not feel that they are able to use a computer effectively for instruction.

Table 1

Final Statistics on Factor Analysis

Factor	Eigenvalue	Percent Variance	Cumulative Percent
1	5.92738	23.7	23.7
2	2.41431	9.7	33.4
3	1.34972	5.4	38.8
4	1.28937	5.2	43.9
5	1.20691	4.8	48.8

For each respondent, a factor score was obtained for each factor. This was done by calculating the composite score of the product of the standardized value of each variable by its factor score coefficient. Since the five factors were correlated (Table 2), each univariate analysis of variance, using factor score as the dependent variable, was preceded by a multivariate analysis of variance to determine if the overall multivariate F was significant. If the overall multivariate F was not significant at the .05 level, no further univariate analysis of variance was performed. Since the purpose of this study was not to test any proposed model nor to make any predictions with respect to any relationships between the variables, regression analysis was not used.

Table 2

Factor Correlation Matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factor 1	1.00000				
Factor 2	.17937	1.00000			
Factor 3	.18242	.19255	1.00000		
Factor 4	.30017	.06621	.17335	1.00000	
Factor 5	-.23524	-.34126	-.17347	-.15966	1.00000

Research Questions

1. How computer literate are the teachers of senior high mathematics in Newfoundland and Labrador?

Forty-five and six tenths percent of the respondents received a score of 10, indicating a high level of computer literacy based on the definition of computer literacy for this study (Table 3). The mean computer literacy score (CLS) was 5.82 with a standard deviation of 4.25. (Upon a re-examination of CLS, it was viewed that the ability to evaluate educational software was closely related to the ability to integrate computer teaching materials in mathematics instruction. As a result these were recoded as one with a score of 4.)

Table 3

Frequency Distribution of Computer Literacy Scores

Value	Frequency	Percent
0	62	19.0
1	45	13.8
3	19	5.8
6	52	15.9
10	149	45.6
Total	327	100.0

2. What are the attitudes of teachers of senior high mathematics in Newfoundland and Labrador towards computers?

As previously stated, the factor analysis revealed 5 factors, each representing a different attitude toward computers. The factor scores for each of these factors will be used as a dependent variable and analyzed separately with respect to age, sex, size of community and background factors.

3. Is there any relationship between level of computer literacy and attitudes toward computers of teachers of senior high mathematics?

This question, analyzed by means of correlational analysis (Table 4), was posed with respect to each attitude as determined by the factor analysis. A statistically significant relationship was found to exist between computer literacy score (CLS) and Factor 5 ($r = .5059$, $p<.001$). A statistically significant relationship found to exist between CLS and Factor 3 ($r = .1633$, $p<.002$). No significant relationship was found to exist between CLS and Factor 1, between CLS and Factor 2 or between CLS and Factor 4.

4. Are there any differences between teacher sex and level of computer literacy?

The study revealed no statistically significant difference between teacher sex and level of computer literacy (CLS).

Table 4

Pearson Correlation Coeffecient

	TEXP	WORKSHOP	CLS	FS1	FS2	FS3	FS4	FS5	MATH
TEXP	1.0000 (327) P= .	-.1567 (327) P= .002	-.1317 (327) P= .009	-.0026 (324) P= .481	-.0582 (324) P= .148	-.0735 (324) P= .093	.0423 (324) P= .224	-.1355 (324) P= .007	-.0828 (316) P= .071
WORKSHOP	-.1567 (327) P= .002	1.0000 (327) P= .	-.3514 (327) P= .000	.0223 (324) P= .344	-.0083 (324) P= .441	-.0309 (324) P= .290	.0552 (324) P= .161	-.2880 (324) P= .000	-.1851 (316) P= .000
CLS	-.1317 (327) P= .009	-.3514 (327) P= .000	1.0000 (327) P= .	-.0794 (324) P= .077	-.0805 (324) P= .074	.1633 (324) P= .002	.0160 (324) P= .387	.5059 (324) P= .000	.3365 (316) P= .000
FS1	-.0026 (324) P= .481	.0223 (324) P= .344	-.0794 (324) P= .077	1.0000 (324) P= .	-.0030 (324) P= .478	.0021 (324) P= .485	-.0001 (324) P= .499	-.0085 (324) P= .440	.0618 (314) P= .138
FS2	-.0582 (324) P= .148	-.0083 (324) P= .441	-.0805 (324) P= .074	-.0030 (324) P= .478	1.0000 (324) P= .	.0065 (324) P= .454	.0051 (324) P= .464	-.0049 (324) P= .465	-.0801 (314) P= .078
FS3	-.0735 (324) P= .093	-.0309 (324) P= .290	.1633 (324) P= .002	.0021 (324) P= .485	.0065 (324) P= .454	1.0000 (324) P= .	-.0042 (324) P= .470	.0052 (324) P= .463	.0907 (314) P= .054
FS4	.0423 (324) P= .224	.0552 (324) P= .161	.0160 (324) P= .387	-.0001 (324) P= .499	.0051 (324) P= .464	-.0042 (324) P= .470	1.0000 (324) P= .	.0107 (324) P= .424	.1130 (314) P= .023
FS5	-.1355 (324) P= .007	-.2880 (324) P= .000	.5059 (324) P= .000	-.0085 (324) P= .440	-.0049 (324) P= .465	.0052 (324) P= .463	.0107 (324) P= .424	1.0000 (324) P= .	.1584 (314) P= .002
MATH	-.0828 (316) P= .071	-.1851 (316) P= .000	.3365 (316) P= .000	.0618 (314) P= .138	-.0801 (314) P= .078	.0907 (314) P= .054	.1130 (314) P= .023	.1584 (314) P= .002	1.0000 (316) P= .

(Coefficient/(Cases)/1-Tailed Sig) " . " is printed if a coefficient cannot be computed

TEXP - Teaching Experience
WORKSHOP - Attendence at Computer Workshop
CLS - Computer Literacy Score
FS1 - Factor Score 1
FS2 - Factor Score 2
FS3 - Factor Score 3
FS4 - Factor Score 4
FS5 - Factor Score 5
MATH - Number of University Mathematics Courses

5. Are there any differences between teacher sex and attitudes toward computers?

The study revealed no statistically significant differences between teacher sex and attitudes toward computers.

6. Are there any differences between teacher age and level of computer literacy?

The study did a reveal statistically significant difference between teacher age and computer literacy score (multivariate F test; $F(2, 315) = 9.63$, $P<.001$) The mean CLS for teachers older than 45 ($x = 3.70$) was found to be significantly less than that for teachers between 36 and 45 ($x = 6.23$) and teachers less than 36 ($x = 6.38$). Due to insufficient numbers in each cell with the original 5 groups on the questionnaire, age was recoded into 3 groups for the analysis.

7. Are there any differences between teacher age and attitudes toward computers?

Since the overall MANOVA was significant, univariate analysis was performed. The analysis revealed a statistically significant difference between teacher age and factor 5 ($F(92,312) = 13.74$, $P<.001$). There were no significant differences with respect to teacher age and the other four factors.

8. Are there any differences between urban/rural teachers and level of computer literacy?

With respect to level of computer literacy, teachers in urban areas of the province were found to have a statistically significantly higher level of computer literacy ($x = 6.82$)

than teachers in rural areas of the province ($x = 5.33$). The multivariate F test revealed: $F(1, 315) = 9.95$, $P<.002$.

9. Are there any differences between urban/rural teachers and attitudes toward computers?

The study revealed no statistically significant differences between urban/rural teachers and attitudes toward computers.

Interaction Effects

Using computer literacy score (CLS) and the factor scores for factor 1 through factor 5 (FS1 thru FS5) as dependent variables, there were no statistically significant interaction effects with respect to the independent variables sex, age and urban/rural (ur).

Other Findings

Statistically significant relationships were found to exist between teaching experience (TEXP) and attendance at computer workshops (WORKSHOP), between TEXP and Factor 5, and between TEXP and computer literacy score (CLS). In spite of these findings being statistically significant, each accounted for very little of the explained variance (Table 4).

Several statistically significant relationships were found to exist with respect to attendance at computer workshops (WORKSHOP). WORKSHOP was statistically significantly related to CLS, Factor 5 and the number of university mathematics courses completed (MATH). As with teaching experience, in spite of these relationships being significant, they account for very little of the explained variance (Table 4).

A statistically significant relationship was found to exist between MATH and CLS, between MATH and Factor 5 and between MATH and Factor 4. Again, these relationships account for very little of the explained variance (Table 4).

CHAPTER V

Conclusions

With respect to each research question, this chapter presents a summary of the findings of this study, as well as suggestions for future research.

Research Questions

1. How computer literate are the senior high teachers of mathematics in Newfoundland and Labrador?

In spite of the results indicating that about half (45.6%) of the teachers of senior high mathematics in Newfoundland and Labrador have high levels of computer literacy (score = 10), the results are misleading for 54.4% received a score of 6 or less which indicates that they are unable to integrate computerized teaching materials into mathematics instruction or to effectively evaluate educational software. Further, a mean score of 5.82 and a large standard deviation (sd = 4.25), suggest two extremes with respect to level of computer literacy among teachers of senior high mathematics (see Figure 3). At one extreme there are a large number of teachers with a high level of computer literacy but at the other extreme there are just as many with a low level of computer literacy.

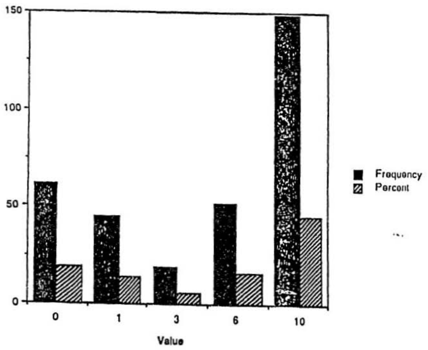


Figure 3. Histogram of Frequency Distribution of Computer Literary Scores

Considering these results, it is quite disappointing to see that 40.7% of the sample were not interested in training inservice that included information on different types of software. Even more alarming was the fact that 58.7% of the sample were not interested in inservice that included the evaluation of educational software, which was a major component for the definition of computer literacy for the purposes of this study. 34.3% were not interested in obtaining hands on experience. 73.4% were not interested in learning about computers and 70% were not interested in learning any programming. Forty-one percent were not interested in learning about classroom organization. This result is very troublesome for this skill is at the heart of instructional computing. As was discussed in Chapter II, in the section on educational change, the deviation from traditional methods of teaching is probably one of the greatest obstacles that will have to be overcome in the implementation of computer technology in mathematics education.

Of those who attended any workshops (189/329), 34.9% attended workshops sponsored by school boards, 8.8% said they attended workshops sponsored by the department of education, 22.6% said they attended workshops sponsored by the Newfoundland and Labrador Teachers' Association (NTA) Math Council, 4.3% said they attended workshops sponsored by a university, 10.1% said they attended workshops sponsored by other, for example: Newfoundland and Labrador College of

Trades and Technology, private corporations, Cabot Institute, adult education, Special Education Council (NTA), Science Council (NTA). There was a surprisingly large number of respondents who indicated that they attended workshops that were sponsored by their schools. This is very positive for it implies that in spite of the what seems to be a lack of help on the part of many other organizations, individual schools are taking some initiative in educating their teachers in computer technology. Unfortunately this also puts into question, at least for the purposes of mathematics education, whether the inservice training that is provided is planned or conducted by experts in the field of computers and mathematics education.

The number of completed university mathematics courses was found to be positively related to level of computer literacy. Considering 58.5% of the sample had completed less than 13 university mathematics courses, this has strong implications for the need of teacher education in this area. Given the recent finding by Crocker (1989) that there are not enough teachers with university degrees in mathematics, it was interesting to find such a large proportion of respondents indicating that they were teaching mathematics because they wanted to and not solely due to an administrative decision. This implies that inadequate preparation in mathematics education, as stated in the Crocker (1989) report, is not an important factor in the desire to teach mathematics.

2. What are the attitudes of teachers of senior high mathematics in Newfoundland and Labrador toward computers?

Apart from the attitudes that will be discussed with respect to each of the remaining research questions it was felt important and relevant to the study to comment on two attitudes that were examined but were found to have no statistically significant relationships.

1. Teachers feel that computer technology has and will continue to have a major influence in the workforce.

No significant relationships were found to exist between any of the background factors examined and this attitude. This finding is encouraging as it indicates that regardless of age, sex, location of community, number of mathematics courses, teaching experience, attendance at workshops, or level of computer literacy, the impact of computers is certainly not unrecognized by teachers of senior high mathematics.

2. Teachers feel threatened by computers.

No significant relationships were found to exist between any of the background factors examined and this attitude. This result is also encouraging but it must be kept in mind that not feeling threatened by computers does not necessarily indicate positive attitudes towards computers, nor does it indicate that teachers will use computers in the teaching and learning of mathematics.

3. Is there any relationship between computer literacy and attitudes toward computers of teachers of senior high mathematics in Newfoundland and Labrador?

There was a very strong relationship found to exist between the level of computer literacy and the feeling of being able to use a computer in mathematics instruction. This supports the need of having teachers of senior high mathematics who are computer literate. More specifically, teachers with a low level of computer literacy indicated the inability to use a computer in their mathematics instruction more so than teachers with a high level of computer literacy. This result is very important for it accounts for 25.6% of the explained variance. As well, teachers with a high level of computer literacy, more so than teachers with a low level of computer literacy felt that the school should be responsive to technological change. Even though this relationship accounted for only 2.7% of the explained varia·.ce, as above, it does lend emphasis to the importance of having teachers of mathematics who are computer literate if they are to have positive attitudes towards computers.

4. Are there any differences between teacher sex and level of computer literacy?

There were no significant sex differences with respect to the level of computer literacy. Whether or not this is related to the fact that the teachers in the sample are all teachers of mathematics, and that 89% of the sample were male, would certainly make for an interesting study.

5. Are there any differences between teacher sex and attitudes toward computers?

There were no significant sex differences with respect to attitudes toward computers. It is quite interesting that this result is in contrast to that found by Touchings (1989), whose sample was also taken from the population of teachers in Newfoundland and Labrador. In spite of this, the conflicting results are possibly still a reflection of the differences in the samples between this study and the present study. The study by Touchings sampled teachers from kindergarten to Level III, within all subject areas, a definite contrast from the sample used in the present study where the sample consisted only of teachers of senior high mathematics. It is possible that these sample differences support the notion that teachers of mathematics (male or female) have positive attitudes toward computers simply because they are mathematics teachers. On the other hand, given the possible transfer of anxiety in mathematics to anxiety in computer technology for females, discussed in Chapter II, and given the male dominance of the sample, it may be that the female teachers in this present study did not suffer from mathematics anxiety in the first place and thus do not suffer from computer anxiety. Therefore, the results indicate no sex differences in attitudes toward computers simply because of the sample used.

6. Are there any differences between teacher age and level of computer literacy?

The results indicate that teachers older than 45 are able to use the computer for some personal use but would be unable to write a simple computer program, to integrate computerized teaching materials into mathematics instruction or to effectively evaluate educational software. In spite of those teachers less than 46 having a significantly higher level of computer literacy than older teachers, their mean score (x = 6.31) still indicates some lack of ability and/or knowledge with respect to the integration of computerized teaching materials into mathematics instruction and the effective evaluation of educational software.

Although older teachers had a significantly lower level of computer literacy than younger teachers, they accounted for only 18.3% of the sample. This result points to a large proportion of relatively young teachers who still have a number of years remaining to teach, and who are not very computer literate in terms of the definition for this study.

Since it is reasonable to assume that teachers with the most teaching experience are the older teachers, the following relationships may help explain the statistically significant age difference with respect to the level of computer literacy. First, it was found that teachers who had attended computer workshops had higher levels of computer literacy than those who had not attended any computer workshops. Since, teachers with the most teaching experience (older teachers) were the least likely to have attended any computer workshops, it stands to reason that they are not as computer literate as those teachers who had attended computer workshops, namely the younger teachers.

7. Are there any differences between teacher age and attitudes?

Teachers younger than 46 felt more able to use a computer in their mathematics instruction. Given the already stated relationships that were found to exist between the level of computer literacy and factor 5, and between the level of computer literacy and age, this result is certainly not surprising.

8. Are there any differences between urban/rural teachers and level of computer literacy?

Teachers living in rural areas of the province were found to have a lower level of computer literacy than those living in urban areas. Given that 67% of the sample are teaching in rural schools, this difference between level of computer literacy with respect to urban/rural teachers, will need to be addressed very soon. The result leads to the question of whether or not teachers in rural areas have the same access to computers as those teachers in urban areas. If this is the case, it is in agreement with the Newfoundland Small Schools

Study (Riggs, 1987). This 1987 study recommended that a greater use of technology be used in small schools, especially in small high schools, in the hopes of enhancing educational opportunity for students in small schools.

9. Are there any differences between urban/rural teachers and attitudes towards computers?

Interestingly enough there were no differences between urban and rural teachers and attitudes toward computers, but there was a statistically significant difference in level of computer literacy. One wonders that if there was no significant difference in the level of computer literacy, would the attitudes of those teachers in rural Newfoundland and Labrador be more positive than those teachers in urban Newfoundland and Labrador?

Teacher Comments

Although not specifically solicited from teachers, there were a large number of teachers who made comments concerning the issue of computers in education and more specifically computers in mathematics education. If anything, the comments indicate that teachers of mathematics have real concerns about the use of computers in mathematics education.

A major concern of many teachers was the lack of available software and necessary computer equipment. A very large number indicated the lack of appropriate inservice training. Further, if inservice training was provided it was usually only one day, with no follow up. Many teachers stated that this was totally inadequate.

A pessimistic attitude toward the whole issue of computers, because of the perceived lack of funding, seemed to be prevalent. This is exemplified in the following statement: "I don't want an inservice. I don't mean to be rude, but what's the sense? Our board can hardly afford paper let alone computers. So why should I be interested?" A more interesting opinion of some, was that although mathematics was a basic subject, language skills were much more basic to the development of the student and that computers could be put to better use in that area. This may be a reflection of the inadequate mathematical preparation of a large proportion of the teachers of senior high mathematics. This inadequate mathematical preparation may limit these teachers in seeing the real potential of computer technology in mathematics education.

Further Research

1. **The difference between female teachers of mathematics and female teachers attitudes toward computers.** Given that in the present study where the sample included only teachers of mathematics and where teacher sex made no statistically significant difference with respect to attitudes toward computers, it would make for an interesting study to determine whether mathematics background is the main factor

for this, given that in prior research (Touchings, 1989) statistically significant sex differences were found to exist with respect to attitudes toward computers.

2. **The effect of mathematics anxiety of female students on attitudes toward computers.** This relationship has only been hypothesized in the literature (Begle, 1979, cited in Blank & White; Munbey, 1980, cited in Blank & White). If in fact there is a real relationship, it would be worthwhile to determine if the effect could be reduced if females were introduced to computers in ways totally unrelated to mathematics. It is probably reasonable to assume that female teachers of senior high mathematics never suffered from mathematics anxiety, but the same cannot be said for female teachers in the primary and elementary grades. These female teachers will still be involved in mathematics education and will also be expected to use a computer.

3. **The difference in access to computers between urban and rural schools in Newfoundland and Labrador.** Given that there were no statistically significant differences in attitudes toward computers for teachers teaching in urban and rural schools, but the same was not found for level of computer literacy, the reason may be because of differences in access to computers. Prior research suggests that there is no difference in access to computers between urban and rural areas (Dickey & Kherlopian, 1987). This is in contrast to the Newfoundland Small Schools Study (Riggs, 1987).

Bibliography

Balistreri, J.P. (1987). What we know about change. **Technology Teacher**, 46(5), 3-5.

Barker, B. (1986). The role of the microcomputer in rural schools. **Rural Educator**, 8(1), 1-3.

Billstein, R. (1985). The role of technology in mathematics education: What's your view? **The Computing Teacher**, 12(7), 19-20.

Blank, S.S., & White, R.B. (1984). Teachers and technological innovation. **B.C. Journal of Special Education**, 8(1), 71-78.

Breman, P., & Mc Laughlen, M.W. (1987). **Federal programs supporting educational change viii: Implementing and sustaining innovations.** Milbrey Wallin Rand Corp., Santa Monica, Calif. (ERIC Reproduction Service No. ED 159 289).

Brown, I.M.J. (1985). **A study of the evolution of school library media programs and the process of educational change with implications for program implementation.** Unpublished Master's Thesis, Memorial University of Newfoundland, St. John's, Newfoundland.

Cannings, T.R., & McManus, J.F. (1987). Facilitating and monitoring a computer education program. In R.E. Bennett (Ed.), **Planning and evaluating computer education programs** (pp.145-162). Merrill Publishing Company: Columbus, Ohio.

Chambers, J.A., & Sprecher, J.W. (1980). **Computer assisted instruction: current trends and critical issues. Communications of the ACM,** 23(6), 332-342.

Cicchelli, T., & Baecher, R.E. (1987). The use of concerns theory in inservice training for computer education. **Computers and Education,** 11(2), 85-93.

Collis, B. (1987). Sex differences in the association between secondary school students' attitudes toward mathematics and toward computers. **Journal For Research In Mathematics Education,** 18(5), 394-402.

Crocker, R.K. (1989). **Towards an achieving society: Final report.** Task Force on Mathematics and Science Education. St. John's, Newfoundland.

Crocker, R.K. (1989). **Towards an achieving society: Summary report.** Task Force on Mathematics and Science Education. St. John's, Newfoundland.

Day, R.P. (1987). The emergence of computer technology in school mathematics: A comparison of recommendations. **Journal of Computers in Mathematics and Science Teaching,** 6(4), 14-16.

Dickerson, L., & Pritchard, W.H. Jr. (1981). Microcomputers and education: Planning for the coming revolution in the classroom. **Educational Technology**, 21(1), 7-12.

Dickey, E., & Kherlopian, R. (1987). A survey of teachers of mathematics, science and computers on the use of computers in grades 5-9 classrooms. **Educational Technology**, 27(6), 10-14.

Fey, J., & Heid, M. K. (1984). Imperatives and possibilities for new curricula in secondary school mathematics. **Computers In Mathematics Education: 1984 Yearbook**, Reston, VA: NCTM. 20-29.

Finn, S. (1896). Innovation and change: Technological innovation, diffusion, and resistance: A historical perspective. **Journal of Library Administration**, 7(1), 83-108.

Fitting, M. (1983). Using computers in teaching mathematics. **The Agenda In Action: 1983 Yearbook**, Reston, VA: NCTM 143-153.

Ford, J.D. (1983-1984). Four educational concerns in using microcomputers. **The Teacher Educator**, 19(3), 16-19.

Fresko, B., & Ben-Chaim, D. (1986). Experience, education and the inservice needs of mathematics teachers. **Teaching and Teacher Education**, 2(3), 245-249.

Fullan, M. (1982). **The meaning of educational change.** Toronto. OISE Press/The Ontario Institute for Studies in Education.

Gibb, J.R. (1978). **Trust: A new view of personal and organizational development.** Los Angeles, CA: Guild of Tutors Press.

Glass, E.M. (1984). Computers: Challenge and opportunity. **Computers In Mathematics Education: 1984 Yearbook,** Reaton, VA: NCTM.

Goodlad, J.I. (1979). What schools are for. **Phi Delta Kappa Educational Foundation**, Bloomington. (ERIC Reproduction service No. ED 178 400).

Gressard, C., & Lloyd, B.H. (1984). **An investigation of the effects of math anxiety and sex on computer attitudes.** Paper Presented at the American Educational Research Association, New Orleans, Louisanna.

Gressard, C., & Lloyd, B.H. (1985). Age and staff development experience with computers as factors affecting teacher attitudes toward computers. **School Science and Mathematics,** 85(3), 203-209.

Hall, G.E., Wallace, R.C, & Dossett. (1973). **A developmental conceptualization of the adoption process within educational institutions.** (R & D). Austin: Research and Development Centre for Teacher Education, The University of Texas at Austin. (ERIC Reproduction Service No. ED 095 126).

Hall, G.E., & Loucks, S. (1979). Teacher concerns as a basis for facilitating and personalizing staff development. In A. Lieberman & L. Miller (Eds.), **Staff development: New**

demands, new realities, new perspectives (pp. 36-53). Teacher College, Columbia University: New York and London.

Harmon, G.D. (1986). Teachers' attitudes toward micro-computers as a teaching tool. **Journal of Education for Business**, 61(8), 341-344.

Harper, D., & Kok, Peter. T.H. (1988). Factors affecting secondary preservice teachers computer knowledge. **Computers And Education**, 12(4), 501-505.

Hatfield, L.L. (1984). Toward comprehensive instructional computing in mathematics. **Computers In Mathematics Education: 1984 Yearbook**, Reston, VA: NCTM.

Hattie, J., & Fitzgerald, D. (1987). Sex differences in attitude achievement and use of computers. **Australian Journal of Education**, 31(1), 3-26.

Havelock, R.G. (1973). **The change agents guide to innovation in education.** Englewood Cliffs, New Jersey: Educational Technology Publications, Inc.

Haynes, C., & Blomstedt, R. (1986). **The principal and educational change.** Paper presented at the Conference on Teacher Education. Dallas, TX. (ERIC Document Reproduction No. ED 280 144).

Inskeep, J.E. (1987). Computer literacy: What it is and why we need it. **Curriculum Review**, 21(2), 138-141.

Jay, T.B. (1986). Computerphobia: What to do about it? In D.O. Harper & J.H. Stewart (Eds.), **RUN: Computer education** (pp. 94-95). Brooks/Cole Publishing Company: Monterey, California.

Jones, P.E., & Wall, R.E. (1985). **Computer experience and computer anxiety: Two pilot studies.** Towson State University, Towson, Maryland. (ERIC Reproduction Service No. ED 275 315).

Kinmel, H. (1987). Training teachers to incorporate computers into the school curriculum. In R.E. Bennett (Ed.), **Planning and evaluating computer education programs** (pp.145-162). Merrill Publishing Company: Columbus, Ohio.

Kruskal, W.H., & Tanur, J.M. (Eds). (1978). **International Encyclopedia of Statistics**, Volume 2. New York: The Free Press.

La Porte, J.E. (1986). The teacher's role in curriculum change. **Vocational Education Journal**, 61(5), 25-26.

Leithwood, K.A., & Montgomery, D.J. (1980). **Assumptions and uses of a procedure for assessing program implementation.** Paper presented at the annual meeting of the American Research Association, Boston.

Licthman, D. (1979). Survey of educators attitudes toward computers. **Creative Computing**, 5(1), 48-50.

Lockheed, M.E., Hunter, B., Anderson, R.E., Beazley, R.M., & Esty, E.T. (1983). **Computer literacy: Definition and**

survey items for assessment in schools. Washington, D.C. National Center for Educational Statistics, (ERIC Reproduction Service No. ED 238 895).

Lockheed, M.E., & Frakt, S.B. (1984). Sex equity: Increasing girls use of computers. **The Computing Teacher,** 11(8), 16-18.

Loucks, S.F., & Hall, G.E. (1979). Assisting and facilitating the implementation of innovations: A new approach. **Educational Technology,** 17, 18-21.

Madsen, J.M., & Sebastiani, L.E. (1987). The effect of computer literacy on teachers knowledge of and attitudes toward microcomputers. **Journal of Computer Based Instruction,** 14(2), 68-72.

Manarino-Lettett, P., & Cotton, B. (1985). **Attitudes of teachers towards the use of use of computers in schools.** Fayetteville State University, Fayetteville, N.C. (ERIC Reproduction Service No. ED 280 455).

Miller, J.P., & Seller, W. (1985). **Curriculum: Perspectives and practises.** Longman Inc., White Plains, NY.

Moersch, C., & Klein, M. (1988). **The potential utilization of microelectronic technology in accomplishing the major goal of schooling.** Unpublished paper presented at AERA, New Orleans.

Morrish, I. (1976). **Aspects of educational change.** New York: John Wiley & Sons Inc.

Moore, P. (1987). Teachers and computers: A joint venture. **Journal of Curriculum Studies**, 19(2), 187-190.

Moursund, D. (1979). Microcomputers will not solve the computers in education problem. **AEDS Journal**, 13(1), 31-40.

National Council of Teachers of Mathematics. (1984). **The impact of computing technology on school mathematics**, Reston, VA. (ERIC Document Reproduction Service No. ED 259 898).

Newton, B. (1987). The incorporation of microcomputer technology into school mathematics. **The Australian Mathematics Teacher**, 43(1), 22-25.

Norton, P. (1985). An agenda for technology and education: Eight imperatives. **Educational Technology**, 25(1), 15-20.

Orlich, D.C. (1983). Some considerations for effective inservice education. **The Clearing House**, 56, 197-202.

Podemski, R.S. (1981). Computer technology and teacher education. **Journal of Teacher Education**, 32, 29-33.

Rawitsch, D.G. (1981). Teaching educators about computers: A different ball game. **Computing Teacher**, 9(4), 27-32.

Reed, W.M. (1986). Teachers' attitudes towards educational computing: Instructional uses, misuses and needed improvements. **Computers In The Schools**, 3(2), 73-80.

Sanders, J.S. (1984). The computer: Male/female or androgynous? **The Computing Teacher**, 11(8), 31-34.

Stevens, D.J. (1980). How educators perceive computers in the classroom. **AEDS Journal**, 13(3), 221-232.

Stevens, D.J. (1982). Educators perceptions of computers in education 1979 and 1981. **AEDS Journal**, 16(1), 1-15.

Stiegelbauer, S.M., Muscella, D., & Rutherford, W.L. (1986). The facilitation of change in elementary and secondary schools - similarities, differences and interactions about the process. **Symposium Presented at the Annual Meeting of the American Educational Research Association.** Research and Development Center for Teacher Education. The University of Texas at Austin. (ERIC Reproduction Service No. ED 276 102).

Superintendent of Documents. (1989). **Power On: New Tools for Teaching and Learning** (Publication No. 20402-9325). Washington, D.C: U.S. Government Printing Office.

Touchings, D. (1989). **Teachers' attitudes toward computers.** Unpublished Master's Thesis, Memorial University of Newfoundland, St. John's, Newfoundland.

Wedman, J. & Heller, M. (1984). Concerns of teachers about educational computing. **AEDS Journal**, 18(1), 31-40.

Wedman, J., Heller, M., & Strathe, M.I. (1986). Changes in teachers concerns about educational computing. **Computers In The Schools**, 3(2), 63-70.

Winkle, L.W., & Mathews, W.M. (1982). Computer equity comes of age. **Phi Delta Kappan**, 63, (5), 314-315.

Woodrow, J.E. (1987). Educator's attitudes and predispositions towards computers. **Journal of Computers in Mathematics and Science Teaching**, 6(3), 27-37.

Appendix A

List of communities and census agglomerates with a population of 5,000 or more

Census Agglomerate	Community	Population	Region
St. John's CMA	St. John's	83,770	1
	Mount Pearl	11,543	1
	Metro Area	24,485	1
	Wedgewood Park	1,226	1
	Hogan's Pond	129	1
	Lawrence Pond	46	1
	Paradise	2,861	1
	Goulds	4,242	1
	Petty Hr/Maddox Cv	853	1
	Torbay	3,394	1
	Flatrock	808	1
	Pouch Cove	1,522	1
	Conception Bay S.	10,856	1
	St. Thomas	448	1
	Portugal Cove	2,361	1
	St. Phillips	1,365	1
	Foxtrap	2,292	1
	Seal Cove	497	1
		154,820	
Carbonear CMA	Carbonear	5,335	1
	Harbour Grace	2,988	1
	Victoria	1,870	1
	Bryant's Cove	380	1
	Salmon Cove	768	1
		12,983	

Census Agglomerate	Community	Population	Region
Corner Brook CMA	Corner Brook	24,339	4
	Gillams	488	4
	Hughes Brook	128	4
	Irishtown	742	4
	Meadows	656	4
	Pasadena	2,685	4
	South Brook	477	4
	Steady Brook	377	4
	Summerside	848	4
		32,269	
Grand Falls	Grand Falls	8,765	3
	Windsor	5,747	3
		14,512	
Labrador City	Labrador City	11,538	5
	Wabush	3,155	5
		14,512	
Bay Roberts	Bay Roberts	4,512	1
	Spaniard's Bay	2,125	1
		6,637	
Marystown		6,299	2
Gander		10,404	3
Stephenville		8,876	4
Channel-Port aux Basques		5,988	2
Happy Valley-Goose Bay		7,103	5

Appendix B

Senior High Mathematics in Newfoundland and Labrador

The mathematics programme in Newfoundland and Labrador senior high schools are designed to provide all students with a sound background in basic mathematical skills necessary for them to have in order to function in contemporary society, and for use in the future. The concept of a tri-level syllabus is to provide students with programs and resources varying in degrees of practicality and abstraction, and flexible enough to allow individual capabilities and needs to be accommodated.

The academic courses are the ones which the majority of students should study. The advanced courses are designed for students with considerable interest and ability in mathematics. The practical courses are designed for students who have had minimal success with mathematics, and who expect to pursue careers in which practical mathematics rather than abstract mathematics is needed. It is anticipated that 15-25 percent will be enrolled in advanced courses, 15-25 percent will be enrolled in practical courses and 50-70 percent will be enrolled in the academic courses.

As they relate to the aims of education for Newfoundland and Labrador, the general objectives of mathematics education are the same for all students whether they are enrolled in the practical, the academic, or the advanced courses. Although the objectives are the same, the expectations for students in the various levels are different. For example, an objective relevant to all students is to provide opportunities for the development of pupils' ability to think critically. However, the expectations for critical thinking differ at each of the three levels.

Appendix C

The Concerns Based Adoption Model

The Concerns Based Adoption Model (CBAM) (Hall, Wallace, & Dossett, 1973) developed from empirical evidence, depicts innovation adoption in educational institutions as a developmental process in which the users demonstrate successively higher qualities of use of the innovation. It also depicts a process capable of being facilitated by trained adoption agents. The model describes the types of interactions that are necessary to facilitate change from the point of view of the facilitator and those who will be effected by the change. The model has the following basic assumptions (cited in Stiegelbayer et al, 1986):

1. Change is a process not an event.

2. The needs of the individual are the primary focus of actions.

3. Change is a highly personal experience and thus everyone reacts differently.

4. There are identifiable stages and levels of the change process as experienced by the individuals.

5. Change is best understood when it is presented in operation as it would appear when fully in use.

6. Change is best facilitated when actions are based on the diagnosed needs of individuals.

The model assumes the existence of two primary systems: a user system and a resource system. There is also the establishment of a temporary third system, a collaborative adoption system. The model presents a conceptual framework for a multi-stage decision process that involves these three systems.

In the beginning the resource system is the senior partner in the collaborative system. This seniority is based on the fact that the resource system has more knowledge about the innovation than the user. Since the purpose of collaboration is to transfer power, knowledge, and skills to the user system, this seniority is hopefully short lived. With respect to the user systems, the adopters of the innovation, the model assumes that the systems have full knowledge of the resources available to them, that they are aware of their own needs and that they have reached a decision to adopt some specific innovation. The adoption process is facilitated by the collaborative system, a joint activity of resource and user systems. Collaboration is realized as both systems engage in an analysis of needs, an identification of concerns, and an analysis of the current use of the innovation. Readiness of the user system personnel is determined a) by stages of concern; and b) by their level of effective use of the innovation.

1. **Stages of Concern (SoC) About The Innovation** (Hall, Wallace and Dossett, 1973, p. 36)

0 Unaware: No indication of awareness that the innovation exists. There may be interests in similar innovations or a complete absence of awareness or interest in the area.

1 Awareness: Indicates a general awareness of the innovation. The potential adopter is likely to inquire about obvious characteristics of the innovation and of himself in relation to it in various non-specific ways (e.g., expressions of general feeling toward innovation, limited evaluation, passive, passing interests in it) and may include expressions of concern about possible personal conflict or threats toward self and personal status quo.

2 Exploration: Indicates exploration of the roles played by the individual user and of the demands placed upon him; also includes exploration of the role in relation to the reward structure of the organization and exploration of potential conflicts with existing structures and personal commitment that have financial or status implications.

3 Early Trial: Indicates user's exploration of his performance and manipulation of materials and time.

4 **Limited Impact**: Indicates user's exploration of impact of innovation on clients in his immediate sphere of influence.

5 **Maximum Benefit**: Indicates user's exploration of the total impact of the innovation in an institutional context on learners and users.

6 **Renewal**: Indicates user's exploration of new or better ways to reach the same goals or new goals.

2. **Levels of Use (LoU) of The Innovation** (Hall, Wallace and Dossett, 1973, p. 32)

0 **No Use**: State in which the user does not know that the innovation exists.

1 **Orientation**: State in which the user is acquiring information about the innovation, its value orientation, its demands upon him, and the user system.

2 **Initial Training**: An action stage in which the user is being trained in the logistics and use of the innovation.

3 **Mechanical**: A stage of innovation implementation where users are engaged in pilot use of the innovation. The user is engaged in a step-wise attempt to master the tasks required by the innovation, often resulting in disjointed and superficial use.

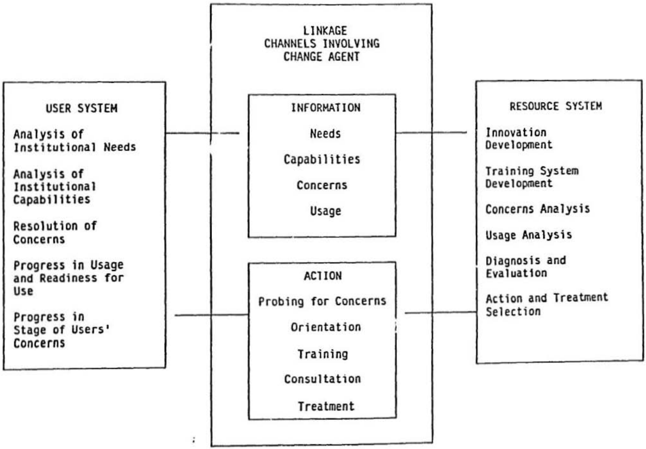
4 **Independent**: A stage of innovation usage where the user handles the innovation well as an individual

with quality impact on learners in his immediate sphere of influence, yet fails to integrate his work with the total system's effort.

5 <u>Integrated</u>: Stage in which the user is actively seeking ways to combine his efforts in using the innovation with colleagues to achieve a collective impact on all learners within an institution.

6 <u>Renewing</u>: The stage of use of an innovation in which the user re-evaluates the quality of use of the innovation, seeks new alternatives to achieve impact on learners, examines new developments in the field, and identifies new goals for himself and the institution.

(The diagram on the following page was taken from Hall, Wallace and Dossett, 1973, p. 39)



Conceptual Structure and Functional Process
Organization of CBAM Components

Appendix D

Correspondence

Letter to School Boards

Dear Sir:

I am a graduate student of Curriculum and Instruction at Memorial University, and am currently doing my thesis work in the area of computers in mathematics education.

The purpose of this study is to determine the awareness of teachers of senior high mathematics in Newfoundland and Labrador concerning computer technology and the use of computers in mathematics instruction and to assess their attitudes towards the future use of computer technology in mathematics teaching and learning.

The instrument to be used will be a questionnaire that is chiefly attitudinal in nature. It is designed to be administered to teachers of mathematics in levels I, II and III. The projected date on which the questionnaires are to be sent to teachers is February 1989.

I am writing this letter to request the assistance of your school board in carrying out this study. Enclosed is a form which will indicate whether or not I have permission to administer the questionnaire to teachers of senior high mathematics within your school board. I also need to know the number of teachers and in what schools they teach. I would appreciate it if you could ask your mathematics program co-ordinators to complete this form. Should you have any questions related to this study, please feel free to contact me at 368-2012 (after 4:30 P.M.) or 368-2123 (school).

I thank you for your consideration.

Sincerely,

Susan M. Pope

Superintendent____

School Board____

Address____

This school board **does/does not** permit the aforementioned questionnaire to be administered to teachers of senior high mathematics within this school board.

Name of School	**Number of Teachers**

<u>Letter to Principals</u>

Dear Principal:

I am a graduate student of Curriculum and Instruction at Memorial University, and am currently doing my thesis work in the area of computers in mathematics education.

Enclosed are teacher questionnaires, which have been approved for use by your superintendent. The questionnaires are to be distributed to teachers of senior high mathematics in your school. Each respondent has been provided with a self addressed stamped envelope in which the questionnaire is to be returned. Your assistance with this project will be greatly appreciated.

Sincerely,

Susan M. Pope

Letter to Teachers

Dear Fellow Teacher:

My name is Susan Pope and I am a graduate student of Curriculum and Instruction at Memorial University, currently doing my thesis work in the area of computers in mathematics education. The purpose of this letter is to request your assistance with this research.

The purpose of this study is to determine the awareness of teachers of senior high mathematics in Newfoundland and Labrador concerning computer technology and the use of computers in mathematics instruction and, as well, to assess their attitudes towards the future use of computer technology in mathematics teaching and learning. I would greatly appreciate it if you would take ten minutes from your already busy schedule and complete the attached questionnaire, which has been approved for use by your superintendent. All results are confidential and anonymity is protected.

When you have completed the questionnaire please return it in the envelope provided. Your assistance with this project will be greatly appreciated.

Sincerely,

Susan M. Pope

Letter from Wilbert Boone

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
DEPARTMENT OF EDUCATION

P. O. BOX 4750
ST. JOHN'S, NFLD.
A1C 5T7

Re: An Assessment of Teacher Knowledge and Attitudes Towards the Use of Computers in Senior High Mathematics Instruction

Conducted by

Susan Pope, Graduate Student, M.U.N.

As Education Consultant responsible for Mathematics, I support the research by Ms. Susan Pope related to teacher knowledge and attitudes towards the use of computers in senior high mathematics instruction. I encourage you to complete the instrument being forwarded to you by Ms. Pope.

The information collected will provide a provincial scope on the level of computer literacy and attitudes of senior high mathematics teachers toward the use of computers for instructional purposes.

Wilbert Boone

Wilbert Boone
Education Consultant - Mathematics

Appendix E

Statements Related To Each Factor Studied

Factor 1: Teachers feel that computer technology has and will continue to have a major influence in the workforce.

6. Computer literacy is important if an individual is to succeed in today's world.

15. The ability to use computers is as basic and necessary to a person's formal education as reading writing and arithmetic.

16. All teachers should be computer literate,i.e aware of the basic operation of the computer.

17. Over the next decade, sweeping economic and technological transformations will alter the jobs people do and the ways in which they do them.

19. Computers will be important for Canadians in their future work and jobs.

Factor 2: Teachers feel threatened by computer technology

5. Computers in the classroom are a threat to teacher job security.

10. Extensive use of computers imposes too much of a workload on teachers.

11. The introduction of computers will mean fewer chances for promotion in my job.

13. Computers are extremely frustrating machines.

14. Computers concentrate too much power in the hands of experts.

21. Computers dehumanize society by treating everyone like a number

Factor 3: Teachers do not believe that the school should be responsive to a technological society.

2. Computers will improve our society

3. As jobs become increasingly oriented toward the use of information, society demands and rewards individuals who know how to use computers.

4. It is up to educators to see that the next generation become adept in the use of modern technology.

6. Computer literacy is important if an individual is to succeed in today's world.

Factor 4: Teachers believe that computer technology can contribute positively to the teaching learning process.

2. Computers will improve our society.

7. If there was a computer terminal in my classroom, it would help me to be a better teacher.

9. Computers have raised the quality of life in my province.

18. Computers can bring out human creativity and self expression.

22. Computer assisted instruction will help students become more responsible people.

26. The computer will solve many problems in education.

Factor 5: Teachers do not feel that they can effectively use a computer for instruction

1. I would feel comfortable working with a computer.

20. Computers are a tool, just like a hammer or a saw.

23. Computers are mainly for people who are good at math and science.

24. The computer can be a great resource for the teaching of problem solving skills.

25. The ability to use a computer effectively requires good programming skills.

Appendix F

Table 1

Zero Order Correlation Matrix

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q9	Q10	Q11	Q12	Q13
Q1	1.00000											
Q2	.27172	1.00000										
Q3	.26946	.35396	1.00000									
Q4	.19157	.27931	.50196	1.00000								
Q5	.10367	.11710	.15438	.20328	1.00000							
Q6	.24571	.26738	.39819	.45245	.05479	1.00000						
Q7	.35693	.28424	.30232	.30778	.14115	.42460	1.00000					
Q9	.04397	.34693	.24070	.17209	.13466	.26431	.33083	1.00000				
Q10	.18501	.13411	.14114	.22452	.23259	.03291	.11209	.06017	1.00000			
Q11	.24270	.24035	.26866	.25774	.31019	.14020	.14851	-.03234	.25945	1.00000		
Q12	.14633	.13957	.16156	.24132	.21134	.20247	.15206	.05896	.16619	.20402	1.00000	
Q13	.16245	.05600	.12196	.19589	.25607	.06609	.14966	-.00629	.27408	.27909	.18522	1.00000
Q14	.21913	.17842	.15270	.15599	.23214	.13370	.27746	.13111	.24005	.31173	.16538	.39416
Q15	.18085	.20888	.26086	.29977	.14380	.44877	.33403	.17851	.10904	.11382	.13444	.10835
Q16	.21726	.14107	.28215	.34500	.04914	.45896	.39579	.19836	.11482	.01649	.21666	.03963
Q17	.05509	.12478	.18594	.16890	.03479	.31454	.30844	.13848	.03457	.03390	.16070	.02270
Q18	.25530	.29474	.25448	.20770	.13918	.27457	.31257	.24435	.09783	.14995	.15706	.11608
Q19	.24132	.22305	.29040	.24885	.12917	.34828	.37106	.22512	.17524	.16022	.20899	.16055
Q20	.23599	.17796	.18130	.08557	.22049	.08908	.19533	.02632	.21187	.20865	.15662	.14386
Q21	.22933	.19359	.19650	.14635	.23941	.05239	.16685	-.01509	.22304	.20574	.14857	.27743
Q22	.14198	.22436	.16716	.15150	.09928	.22584	.36985	.30733	.08383	-.01757	.10578	.04404
Q23	.22997	.07874	.18559	.15672	.15500	.14780	.21273	.01588	.19891	.20901	.12578	.22363
Q24	.23049	.25305	.23278	.19390	.11596	.24285	.36931	.17432	.09533	.16212	.26352	.09104
Q25	.41450	.21608	.13186	.13603	.24305	.12391	.23525	-.02613	.19018	.28650	.17312	.19234
Q26	.07171	.23578	.22320	.23938	.09866	.28189	.38772	.34884	.07180	.02432	.08771	.06129

Table 1

Zero Order Correlation Matrix (continued)

	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25
Q14	1.00000											
Q15	.17184	1.00000										
Q16	.12559	.52899	1.00000									
Q17	.11619	.34835	.29831	1.00000								
Q18	.13856	.32179	.30788	.24327	1.00000							
Q19	.14369	.31087	.31566	.34031	.35669	1.00000						
Q20	.15562	.20913	.20729	.16466	.17087	.36727	1.00000					
Q21	.35918	.15385	.17591	.01416	.23124	.12946	.16031	1.00000				
Q22	.10193	.21087	.26445	.15646	.30814	.17192	.14045	.11287	1.00000			
Q23	.37105	.13926	.18592	.02257	.21517	.16210	.20131	.25837	.05088	1.00000		
Q24	.20991	.23264	.22456	.19240	.41602	.35027	.30359	.18063	.29253	.29363	1.00000	
Q25	.27091	.06364	.14351	-.02555	.19134	.15526	.26996	.16509	.07735	.43022	.32186	1.00000
Q26	.10636	.29736	.33769	.22193	.26907	.25441	.09850	.07974	.41085	.13570	.24291	-.03501

	Q26
Q26	1.00000

Determinant = .0013749

Table 2

The Rotated Factor Matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q1	.06592	.08041	.61532	.02963	.33563
Q2	-.06610	.06435	.25862	.43658	.53466
Q3	.22849	.12586	.11906	.15940	.68896
Q4	.33414	.23831	-.03967	.06751	.68088
Q5	-.00076	.59777	.04073	.11618	.11515
Q6	.55935	-.05437	.09390	.1676[illegible]	.50930
Q7	.37664	.11046	.30902	.4624[illegible]	.20672
Q9	.04109	.01804	-.09486	.71877	.24088
Q10	.05843	.56660	.07583	.00782	.11284
Q11	-.03633	.47995	.24256	-.14033	.42471
Q12	.30230	.30794	.13760	-.04601	.15476
Q13	.07752	.70649	.03478	-.03038	.01545
Q14	.06052	.63643	.21669	.14369	.01370
Q15	.63805	.12160	.05069	.15395	.15372
Q16	.69655	.02873	.13598	.17450	.15023
Q17	.67617	.00145	-.00908	.11285	-.01218
Q18	.30125	.08000	.37787	.41240	.08392
Q19	.53113	.11065	.30767	.17591	.11092
Q20	.29215	.21453	.48116	.00523	-.08035
Q21	.04919	.54690	.20659	.10975	.01129
Q22	.15598	.05394	.12337	.70166	-.04182
Q23	.09625	.34621	.52283	.01240	-.01344
Q24	.25061	.07951	.58[illegible]85	.33488	.00544
Q25	-.06941	.20628	.74969	-.06304	.15179
Q26	.31603	.1008[illegible]	-.06011	.65089	.05276

Table 3

Factor Score Coefficient Matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q1	-.10611	-.19641	.15618	-.08603	-.36358
Q2	-.30550	-.09808	.30807	.21866	-.10301
Q3	-.05029	-.07002	.42250	-.05024	.03772
Q4	.06147	.03842	.41504	-.13409	.18649
Q5	-.07767	.33365	-.01619	.07439	.16887
Q6	.19665	-.15011	.26126	-.11573	.03589
Q7	.01901	-.04422	-.02302	.15282	-.07877
Q9	-.22454	.04612	.07647	.43669	.14267
Q10	-.01077	.29579	-.01143	-.01593	.13532
Q11	-.10165	.13507	.25072	-.14105	-.01131
Q12	.15046	.10452	.01625	-.13467	.04617
Q13	.03212	.40490	-.09581	-.02714	.20012
Q14	-.05071	.31893	-.13017	.07578	.06622
Q15	.34850	.02154	-.04113	-.10746	.11594
Q16	.34050	.05865	-.04494	-.10490	.03240
Q17	.39468	-.00718	-.13389	-.10890	.10630
Q18	.00207	-.06470	-.09843	.14994	-.15536
Q19	.22050	-.05124	-.07763	-.06487	-.08362
Q20	.13356	-.01547	-.18972	-.09785	-.22537
Q21	-.04358	.26705	-.11202	.05541	.04164
Q22	-.12167	.04170	-.17886	.41356	.00465
Q23	-.01280	.04852	-.13168	-.04768	-.23608
Q24	-.01598	-.12434	-.15835	.10699	-.31316
Q25	-.14868	-.12466	.02286	-.09350	-.45173
Q26	-.00247	.10292	.11311	.34007	.16632

Appendix G

The Instrument

Part A

The following statements give some opinions that some people have about computers. Please indicate your opinion about these statements by circling the appropriate answers which correspond with the following headings:

SA - Strongly Agree
A - Agree
NO - No Opinion
D - Disagree
SD - Strongly Disagree

1. I would feel comfortable working with a computer. SA A NO D SD

2. Computers will improve our society. SA A NO D SD

3. As jobs become increasingly oriented toward the use of information, society demands and rewards individuals who know how to use computers. SA A NO D SD

4. It is up to educators to see that the next generation become adept to the use of modern technology. SA A NO D SD

5. Computers in the classroom are a threat to teacher job security. SA A NO D SD

6. Computer literacy is important if an individual is to succeed in today's world. SA A NO D SD

7. If there was a computer terminal in my classroom it would help me to be a better teacher. SA A NO D SD

8. Computers have an unemotional view of life. SA A NO D SD

9. Computers have raised the quality of life in my province. SA A NO D SD

10. Extensive use of computers imposes too much of a workload on teachers. SA A NO D SD

11. The introduction of computers will mean fewer chances for promotion in my job. SA A NO D SD

12. The school has no responsibility to educate students in the use of computers. SA A NO D SD

13. Computers are extremely frustrating machines. SA A NO D SD

14. Computers concentrate too much power in the hands of experts. SA A NO D SD

15. The ability to use computers is as basic and necessary to a person's formal education as reading, writing and arithmetic. SA A NO D SD

16. All teachers should be computer literate, i.e. aware of the basic operation of the computer. SA A NO D SD

17. Over the next decade, sweeping economic and technological transformations will alter the jobs people do and the ways in which they do them. SA A NO D SD

18. Computer use can bring out human creativity and self-expression. SA A NO D SD

19. Computers will be important for Canadians in their future works and jobs. SA A NO D SD

20. Computers are a tool, just like a hammer or a saw. SA A NO D SD

21. Computers dehumanize society by treating everyone like a number. SA A NO D SD

22. Computer assisted instruction will help students become more responsible people. SA A NO D SD

23. Computers are mainly for people who are good at math and science. SA A NO D SD

24. The computer can be a great resource for the teaching of problem-solving skills. SA A NO D SD

25. The ability to use a computer effectively requires good programming skills. SA A NO D SD

26. The computer will solve many problems in education. SA A NO D SD

<u>Part B</u>

Check all statements that accurately describe your computer use.

_____ I can recognize a computer but I would not be able to turn one on.

_____ I can turn a computer on, but I would not know how to operate one.

_____ I am familiar with computer equipment, i.e. every-day operation of computer, disk drive and printer.

_____ I use a computer for personal use, i.e. word processing, but I am unsure as to how to integrate the computer into mathematics instruction.

_____ I can write simple computer programs.

_____ I am able to integrate computerized teaching materials into my mathematics instruction.

_____ I am able to evaluate effectively educational software.

Part C

Although you are not asked to identify yourself, your co-operation in providing the following information would be most appreciated. It is essential to the study being carried out. Thank you.

1. Please indicate your sex.

   (1) Male (2) Female

2. In which age group do you fall?

   (1) less than or equal to 25 (2) 26 - 35
   (3) 36 - 45 (4) 46 - 55
   (5) greater than 55

3. Indicate the grade level(s) with which you are currently teaching mathematics.

   (1) Level I (2) Level II (3) Level III

4. Please indicate your number of years of teaching experience (up to and including 1988-1989).

   (1) less than or equal to 5 (2) 6 - 10
   (3) 11 - 15 (4) 16 or more

5. Please indicate your number of mathematics university credits (1 credit per 12 weeks of instruction). _____

6. Please indicate the year that you last completed a mathematics course at the university level. _____

7. Please indicate your number of Computer Science university credits (1 credit per 12 weeks of instruction). _____

8. Please indicate the reason(s) you are teaching mathematics.

   (1) I want to
   (2) Administrative decision

9. Please indicate whether or not you have attended any workshops concerning computers.

   (1) Yes (2) No

10. If yes, please indicate who they were sponsored by.

    (1) School Board
    (2) Department of Education
    (3) Math Council (NTA)
    (4) University
    (5) Other ______________________________

11. Check below what you would like an inservice to include.

    (1) different types of courseware
    (2) hands on experience
    (3) different types of computers
    (4) inservice in programming
    (5) evaluation of courseware
    (6) classroom organization