COMPUTER USE IN SENIOR HIGH SCHOOL SCIENCE INSTRUCTION: A SURVEY OF SENIOR HIGH SCHOOL SCIENCE TEACHERS IN SOUTHERN ALBERTA

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ABSTRACT

This project is concerned with the ways in which senior high school science teachers use microcomputer technology in their regular science instruction programs. The focus of this study is the classroom teacher - teacher attitudes and behaviors, and some of the underlying factors connecting what teachers think and do about innovation and change, specifically concerning the applications of micro-computers to senior high school science classroom instruction and management. The intent of this project is to provide some specific information about the ways in which senior high school science teachers in southern Alberta utilize microcomputer technology in their classes; and to identify some of their attitudes about microcomputer technology in senior high school science instruction. The study itself consisted of two components: a survey of high school science teachers, and interviews with four of the survey respondents.

The survey component comprised a questionnaire to determine to what extent micro-computers are actually being used in high school science classrooms, the nature of this use, and a simple experience and attitude profile of both users and non-users.

The second facet of this study consisted of interviews with four volunteers from the survey sample, to provide a broader and deeper portrait of the situational and attitudinal environments associated with different degrees of microcomputer use in senior high school science instruction. Primarily, this project focused on determing what senior high school teachers in this region are doing with microcomputers, and what factors appear to influence or predicate these uses.

Forty-five teachers responded to the survey. The primary computer use reported by these respondents was word-

processing and grade calculation. Only very limited use of computers by students in science classes was reported. While a majority of teachers reported endorsement of the integration of computers into the high school science program, most also reported receiving little or no support from administrations for such integration. Teachers cited shortages of funds, restricted access to hardware, and lack of quality software as major hindrances to implementation of microcomputer technology in senior high school science classrooms. While the impetus for technological innovation may come from the grassroots, implementational momentum must come from the educational hierarchy.

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I. PREAMBLE

Since the advent, scant years ago, of the affordable, accessible, portable, and relatively powerful personal micro-computer, Alberta schools have collected "Apples", "P.C.'s", "Tandy's" and "Commodores" by the thousands - 21,000 by 1986 and increasing at a rate of 5,000 per year (Petruk, 1986). Some teachers (primarily the "techno-maniacs" who seem happy to adopt any new technical "toy") have attempted to make the micro-computer an integral part of practically every aspect of their teaching strategy - from lesson planning, through computer-assisted instruction and computer-managed learning, to computerization of student records. Others seem to have resisted at all costs even learning where the computers in the school are located, let alone where on the computer the "on/off" switch might be found. Many educators, I believe, have attempted to rationally consider the ways in which micro-computers might be useful in assisting them with their regular instructional tasks, and have (where possible and appropriate) attempted to utilize the special capabilities of the micro-computer to enhance and augment their programs, preparations, and methodologies. The "educational computer" will not, however, replace the classroom professional who is ultimately responsible for the instruction of his/her students. At the senior high school level in Alberta, all formal instruction in "computer literacy" has fallen (possibly by default) to the business education departments. Yet, the computer is a potentially powerful tool in the instruction, investigation, and discovery of science (Batey, 1985; Science Council of Canada, 1984), and certainly a permanent and important feature of the "real" scientific community (Ganon, 1986).

The motivation for this project has been my own questions (largely unanswered) concerning my own use and non-use of micro-computers as instructional aids in high school chemistry and physics instruction. Though somewhat of a "techno-phile" by nature, I have not made the micro-computer a prominent feature of my instructional methodology. It has certainly replaced the typewriter on my desk, and made the calculator obsolete for the computation of report card marks. There are even a few physics laboratory simulations which I have my students do on the computer in addition to or in lieu of the "real thing". In the "scientific" world, though, (especially the "hard" sciences such as chemistry, physics, engineering, biology, and medicine) the computer (micro-, mini-, or main frame) has become a standard facet of work and research. Never-the-less, students in my classes (and most others it seems) do not use spreadsheet and graphing programs for "number-crunching"; nor do they learn how to create simulations of experimental events - as they do in some high school science classes (McGuire, 1988). They do not even receive as a part of their science education formal instruction about computer applications in industry or research, regardless of official encouragements (Alberta Education 1984b, 1985; Science Council of Canada, 1984). Access to computers is often limited by simple logistics - how to get one's students, sufficient hardware and the appropriate software together at the same place and time. Certainly curricular constraints (especially in grade twelve courses which require students to write a "Diploma Examination"), forbid tangential forays into many of the avenues which could be pursued in search of "scientific literacy". What factors, however, really determine why teachers of senior high school sciences do or do not include computer education or applications in their programs?

Some studies suggest that attitudes determine what activities teachers include in their classroom practices (Madsen & Sebastiani, 1987), while others indicate that logistics is the key to acceptance or rejection of innovations (Knupfer, 1987).

As a personal project, it was intended that this study might illuminate my questions and concerns regarding micro-computer use in my own high school physics and chemistry classes. While I have attended numerous courses and seminars on topics ranging from programming to applications to hardware to electronic theory, I actually make little use of micro-computer technology in my daily teaching. I certainly use my own personal computer for word processing and make use of a grade calculation program for student marks. Micro-computers, nevertheless, have little place in my regular teaching methodolgy. While I do make some very limited use of simulations in Physics 30, the majority of my students make no use of micro-computers as a part of their science program. While I am a vocal proponent of the need to make micro-computers a standard facet of the science class, I make little use of computers as teaching/learning tools in my own classes. What are the factors which dictate this inconsistency? Is it simply "too much hassle?" Would more funding make the difference? Is it just not possible to integrate computers into the current curricula? Do the constraints imposed by Diploma Examinations override other pedagogical considerations? The motivation for this project has been my own disuse of an innovatory technology, which I believe could revolutionize science teaching and science learning at the high school level.

Many pundits have extolled the numerous educational virtues of micro-computers (Alessi & Trollip, 1985; Taylor, 1980; Baker, 1982), and certainly a significant amount of hardware and software has found its way into

Alberta's high schools (Petruk, 1986). Never-the-less, computer applications (on the whole) seem to remain primarily within the purview of business education departments, and are virtual strangers in science classrooms; regardless of imprecations from governmental agencies, educational theorists, or industry itself to integrate "science/technology/society" topics and concepts into science curricula and instruction (Baker, 1982; Ganon, 1986).

This project is concerned primarily, not with the technical aspects of computer applications in science instruction; but, with the ways in which senior high school science teachers actually use computers in their science courses, and why they use computers in these ways. Numerous quantitative studies (Petruk, 1981, 1985, 1986; Romaniuk, 1983; Hallworth & Brebner, 1980) have investigated the extent of computer use by Alberta teachers and schools in general. This project is intended to be a qualitative study of computer uses in, specifically, high school science instruction - concerned primarily with innovation and change in education, with change agents, innovators, acceptors, and resisters; rather than with interfacing, micro-processors, RAM, ROM, hardware, or software.

The focus of this project, therefore, is the classroom teacher - teacher attitudes and behaviors, and an investigation into some of the factors connecting what teachers think and do about innovation and change; specifically concerning the applications of micro-computers to high school science classroom instruction and management.

The two questions which this project attempts to address are

(1) What are senior high school science teachers in southern Alberta doing with micro-computers?

and

(2) What factors seem to be influencing these behaviors?

II. INTRODUCTION

Micro-computers have, it seems, achieved a permanent (though by no means homologous) place in Alberta's schools. Computers here, as elsewhere, are an accepted and expected facet of the educational mileau (Kloosterman, et al, 1987). Micro-computer users can be found (for example) in the business education department, doing accounting and word-processing; in the back of the elementary classroom playing language and mathematics games; in the junior high mathematics class engaging in drill and practice; in the staff-room calculating marks and writing lesson plans; and in the office doing student time-tabling, school budgeting, record-keeping, and typing (Alessi & Trollip, 1985; Petruk, 1986; Hallworth & Brebner, 1980). Computers may also be found in the senior high school science class, offering tutorial information or skills practice, analyzing or calculating results from an experiment, generating data and graphs from a spreadsheet, providing simulations of physics, chemistry or biology experiments and phenomena, or interfacing with a piece of laboratory apparatus (McGuire, 1988; Batey, 1985; Byrum, 1982).

In industry, however, micro-, mini-, and mainframe computers are an integral part of practically every technological endeavour. No research laboratory, medical facility, or engineering office seems complete without its micro-computer or mainframe terminal (Ganon, 1986). In the "real" scientific world of today the computer has become as fundamental a "tool" of research, development, and production as the slide rule was twenty years ago (McGuire, 1988). Students leaving high school science programs to enter university faculties of science, college departments of technology, or the technological work force are increasingly expected to be not only "computer literate" (Baker, 1982), but also to be able to use the computer as an industrial and technological tool for the processing, analysis, storage, and dissemination of scientific information (Science Council of Canada, 1984; Byrum, 1982).

Never-the-less, the micro-computer in the high school science class, it seems, has not had a revolutionary (or even significantly evolutionary) effect on science instruction pedagogy or methodology (Woodward & Mathinos, 1987), but rather has found its place beside the overhead projector and the video recorder - another piece of "A/V" equipment to be trundled out occasionally for a lab simulation, or to add a bit of speed or variety to the calculation of experimental data. High school programs, other than business education, in fact, appear to have one of the lowest rates of computer use amongst schools in this province (Petruk, 1986). And, while a majority of Alberta's high school teachers could certainly be considered to be "computer literate" if not "expert", there seems to be little disquiet with the limited amount of use made of micro-computer technology outside of business education instruction programs (ibid).

The micro-computer does, indeed, have capabilities and potentialities which make it specifically appealing to senior high school science instruction (Alberta Education, 1984a). Primary among such potential applications, certainly, is simulation (Alessi & Trollip, 1985). Computer simulations of phenomena from the sub-atomic to the galactic allow students to experiment with the manipulation of variables, while receiving immediate feedback - encouraging experimentation and opening the door to serendipitous discovery (Payne, et al, 1983). Simulations can recreate "real world" events and systems, allowing students to "participate" in occurences which they could never experience in the classroom (Batey, 1985). Additionally, computer "utilities" such as spreadsheets, graphing packages, and self-written "number-crunching" programs allow and encourage students to use the computer as a scientific tool in a manner similar to that of a scientist or engineer (McGuire, 1988); while computer-laboratory interface programs and technologies can make the computer as much a part of the scientific discovery process as the test-tube or stopwatch. Traditional CAI programs for tutorial, and drill and practice, certainly abound, though their quality and efficacy is routinely questioned (Striebel, 1985).

Authorities and edicts importune science teachers to both utilize computers as educational tools, and to make students aware of the increasing role that micro-technology will play in their future (Alberta Education, 1985, 1987). The traditional goals of science education and the most recent addenda emphasize the development of students' skills in experimentation, logical and critical thinking, inquiry, communication, problem analysis and hypothesis, discovery, and invention (Alberta Education, 1977, 1985; Science Council of Canada, 1984). Experts agree that computers (properly integrated with a well designed science program) can provide many opportunities for the individualization of instruction to assists students in achieving these goals (Bork, 1980; Lough, 1986). More specifically and recently, the trend toward the development of students' consciousness of science/technology/society relationships and interactions demands access to and experience with computers within the context of science education (Batey, 1985). Certainly if students are to develop personal scientific skills and attitudes, access to as many varied experiences and opportunities for experimentation and discovery as possible can not be denied them; and just as certainly computer applications in science instruction offer one (though by no means the only) avenue for such experience.

Increased implementation of computers in all aspects of the school program seems unavoidable (Alberta Education, 1987), and likely laudable (Latchman, 1987). Increased applications of micro-computer technologies in education demand, however that teachers acquire new skills and attitudes, and that they accept that both their curricula and methods may (and most probably will) be drastically altered by the nature of such technology itself (ibid). Presently, computers are not being fully integrated into school programs (Woodward & Mathinos, 1987), due not to short-comings in the technology; but due rather to the nature of schools (Molenda, 1986), and the political and practical exigencies of the change processes at work in schools (Bond & Himmler, 1985). The focus of this project, thus, is micro-computer applications in high school science instruction as an educational innovation, and the nature of educational innovation processes in this context.

Educators' acceptance of any change depends to much a greater degree upon their perception of its feasibility than upon its potentiality (ibid). Acceptance by teachers of any innovation, demands that it be seen to offer a practical solution to real classroom needs and problems (Butt & Olson, 1983). The increased use of micro-computers in the educational milieu has not had its genesis in the customary "research/development/dissemination" mode of educational innovation and implementation (Moorish, 1976). It has instead been bred and nurtured among the "grassroots" by a cadre of motivated and enthusiastic users who have demonstrated to their colleagues the potentials and practicalities of computer assisted instruction (Kloosterman, etal, 1987). The implementation of micro-computers in contexts outside the traditional business education - computer literacy domains belies administrative, "top-down" theories of implementation (Rogers, etal, 1985), revealing the efficacy of teachers as innovators when they perceive a real benefit to themselves in the context of their own classroom practices and environments (Lieberman, 1984).

Teacher attitudes toward any proposed change and its proponents, whether such change is imposed from above or introduced by a colleague; are probably the prime factors in the acceptance or rejection of such change. The use teachers make of technological innovations seems dependent upon their attitudes toward such technologies (Madsen & Sebastian, 1987), and each individual teacher's perception of how easily such changes will fit into their existing classroom stuructures and methods (Knupfer, 1987). The questions posed by this project, hence, deal not with the "nuts and bolts" of computer applications in science instruction; but with the human components which ultimately determine the true nature of such applications. Because the human component in the acceptance or rejection of innovation revolves about the realities (not theories) of classroom practice and pedagogy (Butt & Olson, 1983), this study reflects a qualitative approach, in an attempt to be descriptive of real classrooms, teachers, and methods (Walker, 1986). The project design does not purport, or intend, to be an experimental investigation of factors, variables, controls, or outcomes. This project does, however, attempt to provide a descriptive benchmark of the realities of computer usage in senior high school science instruction in southern Alberta; and includes selected case studies of classrooms where computer uses range from the "revolutionary" to the "reactionary". This study focuses on teacher attitudes, experiences, and practices. Within this context, data was collected both formally through questionnaires, and informally from discussions and interviews with selected respondents.

At the foundation of this project is a personal thesis concerning teachers of high school science themselves, and their attitudes toward technological change. Some may be "innovators": those edge-of-the-frontier, state-of-the-art, individuals who embrace new ideas and technologies; experimenting, adopting and adapting, to make innovation a fundamental facet of their programs. Others are the "implementors": a step or two behind the "innovators", these individuals are those who can see the potentials and possibilities presented by technological advancements, but who move with slightly more restraint and caution; fitting change into their programs where it seems to offer benefits, while unwilling to merely change for change sake. Still others are the "reactionaries": often unaware of the potential of technological innovation, wary of the promises of benefits to accrue from adoption of such innovations; resisting the disruption implicit in further pertubation of traditional educational processes.

III. LITERATURE REVIEW

Studies of micro-computer applications in schools are not new. Nor are studies of the uses of micro-computers in science education. In 1973, Hughes studied the uses of computer simulations of physics experiments, and their correlation with student achievement on process skills tests. As early as 1980 (Hallworth & Brebner) researchers began querying the actual and potential uses of micro-computers in Alberta classrooms. In 1981 Petruk began an annual survey of computer use throughout the province. Numerous other studies have attempted to quantify and/or qualify micro-computer uses in school classrooms (Taylor, 1980; Payne et al, 1983; Striebel, 1985; Petruk, 1986). Studies by Alberta Education (1983, 1987) have outlined issues, needs, and directions for computer applications in Alberta schools. Educational theorists continually propound the salutory effects expected to accrue from increased use (especially use by students) of computers in schools (Papert, 1980; Allessi & Trollip, 1985; Batey, 1985; Lough, 1986; McGuire, 1988).

In the instruction of senior high school sciences, micro-computers have certainly demonstrated their potential for enrichment of the normal program of studies. Alberta Education (1984a) and the Science Council of Canada (1984) have both recognized the unique contribution that computers can make to science education; and in the scientific "workplace" the computer has become a common and useful tool for computation, information storage, data processing, and communication (Ganon, 1986; McGuire, 1988). The nature of science education, with its emphasis on experimentation (Renner, 1986), logical problem solving skills (Alberta Education, 1985), creativity (Latchman, 1987), and personal involvement in the discovery process (Lough, 1986), lends itself naturally to the adoption of micro-computer applications. Simulations of scientific phenomena can allow students to investigate the relationships between variables, encouraging experimentation and serendipitous discovery through the provision of immediate and non-threatening feedback (Payne et al, 1983). Utilities software and laboratory inter-facing apparatus allow students to use micro-computers as investigative tools in the science classroom (Batey, 1985). Some (Luehrmann, 1980) argue that the computer presents a broader intellectual dimension to science education; and Papert (1980) sees the computer as potentially revolutionizing the entire process by which students can learn to solve both real and imaginary problems.

Computer application in science education is not without its detractors, however. Latchman (1987) sees that while micro-compters may be "convivial" (encouraging use of and interaction with computer-driven activities, and offering the potential for creative involvement and access to a much larger world); their present usage in the classroom tends to be "reductionist" - emphasizing standardization and quantification, presenting knowledge in its most simplistic form, fostering passivity of learning, and increasing the depersonalization of pedagogy. Striebel (1985) more specifically identifies potential threats to good pedagogy presented by computer applications in science instruction: positing that (1) simulations offer students "procedures without reasons", forcing students to think about phenomena in precise, structured systematic ways; (2) drill and practice programs may thwart the goals of science education, promoting convergent rather than divergent thinking, and fostering absolutist rather than evolutionary discovery processes; (3) even the use of computer utilities to assist in problem solving may force students to seek solutions which fit "computer methodologies" rather than look for creative problem solving approaches. Specifically with respect to computer simulations of scientific events, Wellington (1985) warns that computer simulations foster the development of incorrect assumptions concerning such things as control of experimental variables, accuracy of data, and the difference between theory and reality.

Regardless of such caveats, the ever increasing use of computer hardware and software in science instruction is practiced (McGuire, 1988), encouraged (Alberta Education, 1984a), mandated (Alberta Education, 1987), and well documented (Petruk, 1986). Recent studies of computer uses in Alberta schools (Petruk, 1986; Peet, 1987), and elsewhere (Olson & Eaton, 1986; Kloosterman et al, 1987), indicate that while the numbers of computers appearing in schools is steadily increasing as the computer becomes an "expected" part of the school setting, computers are not being consistently integrated into curricula or methodologies. In Alberta high schools, for example, Petruk (1986) finds that while high school teachers report the highest degree of accessibility to micro-computers, they also report the lowest rate of use of computers in their classes - computers being located in only 4% of all regular high school classrooms, the majority being found in micro-computer labs under the auspices of business educaton departments. Quantitative surveys such as Petruk's annual research for Alberta Education indicate what hardware is being used (or not used) where and by whom, but tend to ignore <u>why</u> teachers do (or do not) use computers in specific educational contexts. There exists, it seems, a cadre of grass-roots, "revolutionary" computer users who tend to be the real motive energy behind computer innovatons in instructional practice (Kloosterman et al, 1987). Studies, such as Kloosterman's, indicate that the acceptance of computers as "normal" classroom instructional tools depends not (as might be expected) on the potential of the micro-computer for instructional enhancement; but is a function rather of (1) teacher attitudes (Wedman, 1986; Madsen & Sebastian, 1987), and (2) educational change processes and strategies (Bond & Himmler, 1985; Mudd & Wilson, 1987).

Teachers' attitudes toward computers in the classroom seem driven primarily by practical rather than philosophical considerations. Acceptance (or rejection) of educational innovation seems to be a function of the realities of classroom practice (Butt & Olson, 1983); and must be seen by classroom practitioners as a viable solution to a practical problem to earn mere consideration let alone acceptance. Teachers on the whole tend to be quite conservative, particularly toward technological innovations (Vemette, et al, 1986); more often simply "adding" innovations on to existing practices where they can be made to fit, and rarely restructuring their classroom practices to take advantage of the potentialities offerred by technological innovations (Wright, 1987). Innovations which are adopted by teachers are those which fit easily into existing classroom structures - teachers tending to shape implementational strategies to their own particular situations and priorities (Knupfer, 1987). Teachers making little or no use of educational computers seem primarily concerned with the practical (rather than philosophical or pedagogical) problems associated with implementation and incorporation of educational computers into their programs or classrooms. Such "problems" include lack of suitable software, lack of knowledge or training, poor access to hardware, disruption of classroom routines, time lost from other activities, poor integration with existing methods and curricula, lack of administrative support, changes in the role of the teacher, loss of classroom control, inequities in access and abilities, and lack of clear goals or objectives related to the educational use of computers (Chandra, 1984; O.E.R.D., 1986; Olson & Eaton, 1986; Wedman, 1986; Knupfer, 1987). Resisters of technological innovation often view computers as "solutions in search of problems" or "distracting gadgetry" (Hoddinott, 1989). Other research (Woodward & Mathinos, 1987) indicates that computers are not being integrated into the curriculum when teachers sense that the use of educational computers is neither applicable to nor supportive of student success on departmental achievement exams. Coupled with the logistical and practical problems of computer integration into the classroom, this leads many teachers to believe it is simply "easier to not use computers at all" (ibid). Innovators and implementors of innovation, however, report a belief that computers are beneficial to student success, are often excited about the potential applications of such technology, and commonly report satisfaction with their own skills in using such technology (Small & Haley, 1986). These users perceive higher student motivation, greater student co-operation and independence, and greater opportunities for challenge (of higher achieving students) and mastery (by lower achievers) (Becker, 1986). Additionally, implementors (and innovators) of computer use in education tend to be younger (Knupfer, 1987); have acquired previous experience with computers through formal or informal training; and express personal interest in technology and technological innovations - resulting in positive attitudes toward technological innovation generally, and computer applications in particular (Manarino-Lettett & Colton, 1985; Madsen & Sebastian, 1987).

The implementation of micro-computers and micro-computer programs in secondary school science classrooms depends greatly upon the nature of the educational change process itself. Implementation of any innovation (technological or otherwise) is a function of (a) the nature of the innovation itself, (b) the political characteristics of the school system involved, (c) the nature of the individual school and staff affected by the proposed change, and (d) external factors such as governmental support and assistance (Kelsey, 1988). Successful implementation of innovatory practices or ideas seems to hinge upon a sense of ownership of the innovation on the part of those directly involved (Woodward & Mathinos, 1987). Conversely, technological innovations such as the use of computers in the classroom are often doomed to failure because traditional school organizational modalities are inappropriate organizational structures for the effective implementation of educational technology (Molenda, 1986).

While different models for educational change can be identified (Sashkin, 1974); the very nature of educational computing and the potential uses of educational computers in science classrooms predicates a "diffusion" or "social interaction" model of implementation (Mudd & Wilson, 1987; Moorish, 1976). That is, because successful implementation of computers into the classroom depends greatly upon teachers' own experience and confidence with such technology, and the attitudes derived from their experiences (Wedman, 1986; Komoski, 1987); such changes can be successful only when all participants (change agents and implementors) share common views of both the educational needs and the potential solutions available (Butt & Olson, 1983).

With respect to computers in the classroom, successful implementation depends largely upon teachers' perceptions of the "feasibility" of such change rather than simply the "potential benefit" to be derived (Bond & Himmler, 1985). Many, thus, adopt a "wait and see" attitude, regardless of hierarchical pressure, adopting such innovatory practices only once they are convinced of the applicability to their own usual work patterns, and have gained a belief and confidence in the needs for and potentials of computer use in their own classrooms (Wright, 1987). Never-the-less, some posit, micro-computers differ in context and content from other educational innovations because of the societal impact component of such use in the educational milieu (Bond & Himmler, 1985). Additionally, these researchers argue that implementation of micro-computers and computing programs into regular classrooms changes the originally intended nature of the innovation itself, as teachers adapt such technologies to their own intentions and contexts (ibid). Successful and accepted implementation of micro-computers into regular classrooms, demands integration with the entire educational philosophy and program (Murphy, 1981); and the realization that educational technological innovations can never be a panacea for education ills - that educational computers can only be one component of good curriculum, not a replacement of it (Komoski, 1987).

Rogers, et al (1985) and Wedman (1986) identify some key implementational components and concerns related to the educational use of micro-computers in the classroom. The implementation of any innovation, whether initiated from the "top" or the "grassroots" level, begins with the perception by the stakeholders of a "need to do something" (Zais, 1976). A needs assessment subsequently leads to a master plan and a logistical analysis of the practical means for successful implementation. Innovators and early adoptors (Mudd & Wilson, 1987) can serve as models by which others can evaluate the innovation for themselves. Successful adoption of any innovation depends upon the perception by the majority that the innovation meets their own specific criteria for positive change (Chandra, 1984). Adoption by a majority follows from awareness and interest to evaluation, personal trial, and acceptance (Mudd & Wilson, 1987). Various uses and users elict different concerns with acceptance or adoption of any innovation dependent upon each unique perspective and context (Wedman, 1986). The innovatory process, as it applies to the introduction and acceptance of micro-computers and micro-computer programs by classroom teachers appears to be bound closely to the specific idealogical and contextual environments of each practitioner (Chandra, 1984; Lieberman & Miller, 1984). Some seem to embrace and promote innovation whole-heartedly; others evaluate, analyze, and synthesize innovatory concepts and practices in a much more conservative fashion; and still others seem to resist change at all costs, displaying at best indifference, at worst antagonism.

IV. PROJECT DESIGN

The intent of this project is not to provide a comprehensive analysis of computer use in senior high schools in Alberta. It is intended to provide some specific information about what senior high school science teachers in southern Alberta do with micro-computers in their classrooms. As the purpose of this project is to relate "why's" and "what's" concerning the use of micro-computers in high school science instruction, care has been taken to limit the nature and extent of both the survey used and the interviews conducted. Many very extensive and comprehensive surveys of computer use in schools have been conducted by others (Becker, 1986; O.E.R.D., 1986; Petruk, 1986; Knopfer, 1987; Peet, 1987) - surveys which attempt to exhaustively reveal facets of the "computer use question"; from hardware, to software, to attitudes, to access, to equity. This project proposed to obtain a close look at the "real" (Walker, 1986) high school science classrooms in southern Alberta. It attempted (within a qualitative framework) to discover what use is being made of computers in these classes, and to uncover some of the reasons (Olson, 1984; Olson & Eaton, 1986) for the kinds of micro-computer applications adopted or rejected by science teachers. From a review of current literature in this area, it seems apparent that the classroom use of micro-computers and micro-computer programs in the high school sciences is a function of a number of factors. These may include the age, experience, and training of the classroom teacher; the availability of micro-computer hardware and software; the demands and constraints of high school science curricula; and the teacher's attitudes toward technological innovation in general, and micro-computer technology in particular. Additionally, among the "users" and "non-users" it is expected that the nature of the innovatory process itself impacts upon each individual's response to a proposed or potential innovation in educational technology (Cornbleth, 1988). The two facets of this project, thus, are a limited survey of the kinds of use high school science teachers are making of micro-computer technology in their classrooms; and, a survey of the contexts (attitudinal and practical) in which this use occurs.

The study itself consisted of two components. The first comprised a paper-and-pencil survey questionnaire of senior high school science teachers in southern Alberta to determine to what extent micro-computers are actually being used in high school science classrooms, the nature of this use (if any), and a simple profile of both users and non-users. This data reveals the nature of the adoption/rejection of micro-computer applications (Mudd & Wilson, 1987), and the types of attitudes expressed by both users and non-users (Manarino-Lettett & Colton, 1985). There exist, it can be argued, three broad categories into which the users and non-users may be classified: "innovators", who embrace and promote micro-computer technology, convinced of the potentials, and undeterred by the problems (Kloosterman, etal, 1987); "implementors", who, having seen what the innovators are doing, can evaluate and analyze the potentials and problems in terms of their own situations and priorities, and make use of micro-computer technology in a limited fashion, where it fits into the existing classroom structures (Knufper, 1987); and, "reactionaries", who are deterred by the numerous problems and disruptions, and (unconvinced of the potentials associated with incorporating micro-computers into their classroom programs) perceive the technology to be more detrimental than beneficial to the educational program (Olson, 1986).

The second component of this project consisted of interviews with a few selected volunteers from the survey sample who seem to typify the categories of users and non-users. The interview technique used (directed but open-ended) was intended to provide a broader and deeper portrait of the situational and attitudinal environments associated with different degrees of micro-computer use or non-use in the senior high school science classroom. The direction for these interviews was toward elucidation of the reasons for the extent of use or disuse, in terms of the participants attitudes toward, and experiences with, micro-computers in science instruction (Olson & Eaton, 1986). While the survey attempted to provide an overview sketch of the "what's" and "whys" of micro-computer use (Peet, 1987); the interviews with selected participants was intended to provide a contextual framework within which this data may be more realistically viewed (Walker, 1986). Relationships between attitudes, experiences, change processes, and classroom realities can be drawn from comparisons and analyses of both survey and interview data. Additionally, the results of interviews with innovators, implementors, and resisters, may indicate possible conclusions concerning the nature of the innovatory process itself - as it exisits and operates in science classrooms in southern Alberta.

The sample chosen for the survey consisted of teachers of senior high school sciences (ie. Science 14/24, Biology 10/20/30, Chemistry 10/20/30, and Physics 10/20/30) teaching at senior high schools within the Lethbridge region - ie. within approximately a 100 km radius of Lethbridge (Alberta Education, 1989). This choice of sample was predicated by (1) the focus of this project, which is senior high school science instruction, and (2) the necessity to limit the data collected to a manageable size, and the travel required (for interviews) to a reasonable distance. As well, since school systems in the large urban centres of Calgary and Edmonton often have in place well defined and co-ordinated innovatory and implementational strategies and tactics, it was deemed important to limit the data collected to schools and systems where change often occurs in a more "reflexive" (Olson, 1985) context.

The survey, in order to increase the probability of completion and return, was limited to as few questions as possible which could still give an accurate overview of the extent and nature of computer use by the teachers surveyed, and give some general impressions about the profiles of the highly active users, the moderately active users, and the non-users. Because teachers are often innundated with surveys and questionnaires of all types and of various origins, maximum response rate was encouraged by limiting this survey to a few specific key questions which, hopefully, provide an adequate "benchmark" indication of the real situations and attitudes prevalent among as many respondents as possible. While others (Petruk, 1986; Peet, 1987) attempt to quantify precisely the access to hardware and software, the nature and extent of use, and the computer expertise of teachers through out the province and across the grades; this survey seeks to provide a portrait computer use in senior high school classes in the southern Alberta region. Additionally, where recent qualitative research (Olson & Eaton, 1986) focuses on the perceptions and attitudes of elementary and junior high school teachers toward micro-computer uses, this survey is concerned soley with how micro-computers come to be used in senior high school science instruction in southern Alberta schools.

The survey, thus, was intended (within the limitations imposed) to examine three main facets of computer users and uses: (1) an educational and experiential profile of computer users and non-users (Wedman, 1986; Madsen & Sebastian, 1987); (2) a brief inventory of the nature and extent of computer use in high school science classrooms (Baker, 1982; Byrum, 1982; Streibel, 1985; Batey, 1985; Alessi & Trollip, 1985); and, (3) a report of teachers' attitudes about specific benefits and/or problems associated with computer use in high school science classrooms (Chandra, 1984; Molenda, 1986; Small & Haley, 1986; Komoski, 1987; Woodward & Mathinos, 1987). The first section of the questionnaire consisted of "check off" or "fill-in-the-blank" questions designed to simply identify the educational and experiential background of the respondent, the nature of the respondent's teaching assignment, and the access each respondent has to hardware and software. Secondly, respondents were asked to indicate the nature and extent of their computer use on a five-category scale of degree of use or application, with the option of providing additional germane information. The last section of the questionnaire, dealing with attitudes, consisted of a five point Likert scale indicating degree of agreement or disagreement with stated attitudes toward computer use in the classroom. Finally, respondents were given the opportunity to identify themselves (if they wished) in order to participate in the interview portion of this project.

Results of these surveys may be analyzed to determine (1) some key trends in computer use in senior high school science classrooms; (2) relationships between teacher profiles, the nature of their use of computers, and their attitudes toward computer applications in their classrooms; and, (3) some prevalent attitudes concerning computer use in high school science classrooms. Additionally the data may be analyzed to identify teachers who typify different attitudes toward computer applications in science instruction.

Interviews were held with a few selected volunteer respondents in order to investigate in greater depth the nature of teacher attitudes toward computer applications in science instruction, and the nature of the innovatory process as related specifically to such applications. These interviews, directed but open-ended, focused on perceived trends in computer uses and attitudes and on concerns relative to implementation of micro-computer technology in science classrooms (Manarino-Lettett & Colton, 1985; Kloosterman, etal, 1987). In addition, interview data may be used to broaden the understanding of the manner in which teacher experiences are related to attitudes and behaviors;

and the way in which the innovatory process operates in local schools. Interview data, thus collected, provided a framework within which to further analyze the survey data in terms of the expressions and opinions of the respondents. From the idealogical interaction and sysnthesis of these two complementary sources, conclusions may be drawn concerning the relationships between attitudes, innovations, and actions; and the nature of technological "innovators, implementors, and reactionaries".

As surveys of and interviews with teachers in local school jurisdictions falls under the purview of the "Human Subjects Research Committee", specific design of both the survey instrument and the interview procedures included consideration of the demands for approval by that committee. Once the survey instrument and interview format were finalized, approval of the H.S.R.C. was obtained prior to formal contact with specific jusidictions, schools, or teachers.

V. SURVEY DESIGN

Numerous studies, as noted previously, have been conducted concerning the use of computers in classrooms, and teachers' opinions about micro-computers in the classroom. No one study or instrument, however, seems to address the unique objectives of this project. A number of previous studies (Kloosterman, etal, 1987; Olson & Eaton, 1986; Peet, 1987; Manarino-Lettett & Colton, 1985), never-the-less, provide a rich source of key concepts for investigation, and give a foundation to the design of this specific study. From these sources, and from numerous informal discussions with collegues teaching science at the senior high school level in this locale, the specific survey instrument used, and the interview procedures followed have been derived. While these sources provide the bases for the scheme of this study, the specific organization and questions are designed and intended to meet the specific demands of the project objectives.

The purpose of the survey portion of this project is to provide an overview of the nature of computer use in senior high school science classes in southern Alberta, and to elicit opinions from senior high school science teachers about (a) the validity of computer use in high school science, (b) the support for teachers who choose to implement computers in their high school science instructional programs, and (c) the effect computer use has on classroom practice and routine. To this end the instrument developed has four components:

1 - a "teacher profile" which identifies some key characteristics of senior high school science teachers from the sample selected, generally, and specifically related to computer knowledge and experience;

2 - an "equipment profile" which identifies the nature and amount of computer equipment available to the sample high school science teachers for use in classroom instruction;

3 - a "computer use profile" which identifies the specific ways in which the sample teachers do and do not use computers in the preparation and delivery of their high school science programs; and

4 - a "teacher opinion profile" which attempts to qualify teacher opinions about the validity and efficacy of computer implementation and application in senior high science classrooms.

A first-draft survey instrument, built from these considerations was "field-tested" by three or four colleagues who were willing to lend their time to this project. From their responses and comments the instrument was "cleaned-up" and "fine-tuned" before submission to the Human Subjects Research Committee for approval. The validation stage of development was, of necessity, limited to this informal procedure. Because of the limited sample of interest of this study, any extensive field-testing among local science teachers would, obviously, preclude from the actual study the very individuals who I wished to survey. This limited "field-test" confirmed that the instrument design adequately addressed the needs and objectives of this study.

With the data available from this instrument it was possible to identify some key characteristics of users and non-users in terms of teaching assignments, experience and training, access to computer hardware and software, and use made of computer equipment and programs in high school science instruction. The opinion profile reflected the stated opinions of the sample group in three broad categories: (a) the applicability of computer use to the goals and objectives of science instruction, (b) the implementational processes and support services which promote the integration of computer applications into high school science programs, and (c) the effect such applications are perceived to have on classroom practices and routines. By relating the responses to this "opinionaire" to the "reality" information collected in the first three sections of the survey, relationships between teacher opinions and actions may be identified. Additionally these relationships may provide important identifying characteristics of the three user groups under study - the "innovators", "implementators", and "reactionaries". From these identifications, contacts for the purpose of further interviews were made.

The specifics of the questionnaire construction are detailed below:

Part A - Teacher Profile

Questions 1 - 3 are intended merely to identify the teaching assignment, education, and experience of the respondent. Questions 4 - 8 attempt to identify, specifically, the background of each respondent relative to the use and application of computers in education.

Part B - Classroom Equipment Profile

As the use made of any technology by teachers is highly dependent upon their access to it, this section attempts to identify the nature and extent of access which the respondents have to specific types of hardware, and the availability of software for classroom use.

Part C - Computer Use Profile

Based upon the uses commonly made of computers in high school science instruction (Byrum, 1982; Wells & Bitter, 1982; Alessi & Trollip, 1985; Batey, 1985), these questions ask the respondents to indicate the extent to which they and their students make use of computer technology in high school science programs.

Part D - Teacher Opinion Profile

These questions, based largely upon identified attitudes of teachers toward computers in education (Streibel, 1985; Becker, 1986; Olson & Eaton, 1986; Molenda, 1986; Small & Haley, 1986; Knupfer, 1987), fall into three broad categories of interest: (a) the applicability of computer programs and technology to the goals and objectives of senior high school science instruction, (b) the nature of the implementational and support processes related to the use of computers in high school science instruction, and (c) the effect that the use of computers in high school science instruction has upon classroom practices and methods. Since these divisions of concern are somewhat arbitrary, some questions, obviously, address more than one concern. In terms of these three broad categories, the questions can be identified as follows:

category	questions
a	1, 2, 4, 6, 7, 8, 9, 10, 13, 14, 16, 20, 22, 26, 27
b	3, 11, 12, 15, 18, 21, 23, 24, 29, 30
c	2, 3, 5, 7, 9, 13, 16, 17, 19, 24, 25, 28

The sample for this survey was selected from recognized schools which offer a senior high school program as identified by Alberta Education in the current "List of Operating Schools in Alberta " (1989). Additionally, as described, the sample selection was restricted to those schools which lie in the Lethbridge region of southern Alberta, that is within a distance of approximately 100 km from Lethbridge. Schools deleted from the sample were those which operate under special circumstances; such as special education facilities, private religious schools, home schools, Hutterian Brethren schools, and native band schools. These schools were eliminated from this study to avoid occlusion of survey results by other factors not identified by, or germane to, this particular study. Within these parameters, the sample selected for this survey consisted of teachers of senior high school science at the identified schools.

At this stage, approval was received from the Human Subjects Research Committee for the survey of teachers of senior high school science in "Zone Six". Additionally, approval was granted to contact selected volunteers from the survey sample for follow-up interviews. Contact was then made with district superintendents to obtain access to the identified schools, and principals were contacted and asked to distribute surveys to those staff members who teach any senior high school science subjects. Each survey included a covering letter explaining the purpose of the survey, and asking respondents to include identifying information if they were willing to be contacted for a further interview. The districts and schools thus identified include the following:

district	school	# staff
County of Forty Mile #8	Foremost School	(19)
	Senator Gershaw School	(16)
County of Lethbridge #26	Coalhurst High School	(16)
	Kate Andrews High School	(25)
	Noble Central School	(11)
	Picture Butte High School	(23)
County of Vulcan #2	County Central High School	(18)
	Lomond School	(8)
County of Warner #5	Erle Rivers High School	(12)
	Raymond High School	(14)
	Warner School	(14)
Cardston School Div. #2	Cardston Sr High School	(28)
	Magrath School	(38)
Crowsnest Pass Schl.Div.#63	Crowsnest Cons. High School	(24)
Pincher Creek Schl.Div.#29	Livingstone School	(20)

	Matthew Halton Comm. School	(30)
Taber School Div. #6	Chamberlain School	(13)
	Vauxhall Jr-Sr High School	(16)
	W.R. Myers High School	(20)
Willow Creek Schl.Div.#28	F.P. Walshe School	(27)
	J.T. Foster School	(21)
	Willow Creek Comp. High School	(28)
Lethbridge Schl.Dist.#51	Lethbridge Collegiate Institute	(68)
	Winston Churchill High School	(36)
Stirling Schl.Dist.#647	Stirling School	(17)
Bow Island RCSS Dist. #82	St. Michaels School	(12)
Lethbridge RCSS Dist. #9	Catholic Central High School	(36)
Pincher Creek RCSSDist.#18	St. Michael's Secondary School	(28)
Taber RCSS Dist. #54	St. Mary's RCS School	(17)

Based upon the total staff at each school, it was estimated that approximately 65 - 70 teachers comprised the survey sample - ie. senior high school science instructors.

Following the initial receipt of survey responses (about forty), a follow-up letter was sent to each school requesting that teachers return questionnaires before the end of the school term, if they had not yet done so. A total of forty-five surveys were eventually returned. The survey results and written comments could then be tabulated for analysis.

VI. INTERVIEW DESIGN

From an analysis of the survey results, characteristics of computer users and non-users, and user and non-user environments, may be identified. From among the respondents willing to be interviewed selection of appropriate individuals was made to provide further information concerning the reasons for using or not using computers in specific ways in science classrooms. The purpose of these interviews was to provide a depth and perspective not available from survey data. The results obtained from interviews conducted with high users ("innovators"), medium users ("implementors"), and non-users ("reactionaries") may provide insight into why teachers use computers in specific ways for science instruction. Further, these interviews may reveal crucial facets of the innovatory process as it operates in high school science classes. The interview data was not intended to open new ground, but rather to fill in the details and depth of data obtained from the surveys. The interview data, thus focused upon a few critical concepts identified as germane to the acceptance of rejection of classroom computer integration (Manarino-Lettett & Colton, 1985; Molenda, 1986; Small & Haley, 1986; Knupfer, 1987; Woodward & Mathinos, 1987).

The benefit of the interview technique, however, lies in its flexibility and open-endedness; providing a wholistic view of classroom realities in their contextual environment (Walker, 1986). While the interview was directed, and based primarily upon the survey results, it allowed the interviewer to follow threads which may not appear to be related, but which may in fact provide the basis for particular beliefs or actions. Additionally, the interview technique allowed each respondent to elucidate his/her responses, and hopefully, avoid obfuscation due to misunderstanding of intents. The interview "framework" was based upon the emphases of this project: i.e. what computer resources teachers have access to, how they utilize these resources, why they utilize computer resources in the ways they do, how they see the innovatory and implementational process operating with respect to computer applications in science education, and what they believe about the use of computers in science instruction (Olson, 1984; Olson & Eaton, 1986; Peet, 1987). Specifically the interviews sought to clarify the survey response data and analysis, as follows:

Part A - clarification of training and experience in the field of computer applications
- description of self-rating of computer skills

Part B - explanation of hardware and software access
- elucidation of particular problems with solutions to hardware and software access needs
- explanation of "ideal" requirements and reasons for these

Part C - reasons why certain applications are or are not being utilized
- benefits or detriments associated with specific applications

Part D - elucidation of opinions concerning computer uses

- identification of beliefs about the validity of computer applications in senior high sciences
- descriptions of support provided for innovation and implementation related to computer use in the classroom
- description of innovatory processes and agents related to classroom computer use

The results of these interviews must be viewed in an ethnographic rather than statistical fashion, providing, hopefully, a "portrait" rather than a "photograph" of the classroom realities concerning computer applications in high school science instruction.

Of the forty-five respondents who returned questionaires, fourteen volunteered to be interviewed if need be. As the purpose of the interview data was to provide a perspective on the survey results, four interviewees (from different schools and jurisdictions) were initially selected as representing a spectrum of "user types" - from non-user to high-user of computers in science instruction. From these four interviews and the written comments on the returned surveys, a commonality of response seemed to appear. It was felt, thus, that little additional information would be derived from pursuing the interviews beyond the four "representatives" obtained. The anonymity of the interviewees and all other respondents was ensured and maintained throughout the course of the project.

VII. DESCRIPTION OF DATA

It is germane to any interpretation of the results of this study to refer to my original objective in initiating this project. My purpose in conducting a survey of and interviews with my contemporaries and colleagues was to attempt to answer specific questions which I have concerning my own use of computers in senior high school science instruction. It is hoped that by questioning members of the identified sample, answers to these concerns may be elucidated. The data collected, thus, provides not a minute or statistical examination of the topic of interest; but rather a broad portrait of actual practices, beliefs, concerns, problems, and solutions surrounding real situations in real classrooms. I am looking not for statisitical cause and effect, nor to prove a particular hypothesis. My sole aim in the interpretation of these results is to paint a picture of the events which actually occur in real high school science classrooms, and to identify some of the factors which may be influencing those events.

Survey Results:

From the sixty-five to seventy predicted possible respondents, forty-five surveys were received (a return rate of 64% - 69%). See Appendix 5 for detailed and tallied results from all the surveys reveived. The subject assignments reported represent a fairly

Table 1

Demographic Descriptors:

(a) que #:

	A:2(a)	A:2(b)	A:3	A:4(a)	A:4(b)	B:1	B:2	B:3
	years teaching:		years	comp courses:		comp access:		
	total	sr sci	univ	univ	tech	class	port	avail
total:				23	6	10	23	38
percent:				51	13	22	51	84
average:	16	12	5	2	1	2	3	22

(b) que #:

	A:1				A:5	A:6	A:7(a)	7(b)	7(c)	7(d)
	subjects taught:					comp	comp courses taught:			
	Sci	Bio	Chem	Phys	wkshp	home	stdnt	tchr	conf	p-sec
total:	14	24	26	20	37	24	18	7	1	2
percent:					82	53	40	16	2	4

equitable distribution between biology, chemistry, and physics specializations; with slightly fewer general science assignments reported. This probably reflects a reasonable representation of the average high school science teaching assignment. Reported years of teaching experience range from one to thirty, the average being sixteen; while reported experience teaching high school sciences averages twelve, with a range from one to twenty-nine years. Reported years of university training range from four to seven, with an average of five. One respondent answered neither question A:2 (teaching experience) nor question A:3 (years of university training).

In terms of computer-specific training; fifty-one percent of respondents report having taken at least one university level course in computing or computer applications. These twenty-three respondents report an average of two such courses. Only six respondents (13%) report having any technical school training (an average of one course) in computing. Eighty-two percent (37) of the respondents report, however, having attended at least one workshop on computer applications, and two respondents indicate attending more than ten such sessions. It is germane to note, never-the-less, that two needs clearly identified by most repondents in section "D" of the survey are for better teacher-training in the use of computers in science teaching, and more access to workshops dealing with this topic. Twenty-four respondents (53%) report having their own computer at home. Slightly less than half (44%) of the respondents have actually taught courses in computing or computer applications at some level.

While only ten respondents (22%) report having a computer permanently in their classroom, fifty-one percent have access to an average of three computers which can be moved into their classes; and eighty-four percent (38 respondents) have an average of twenty-two computers available to them somewhere in their schools. One respondent reported having no idea of the number of portable computers available, while another indicated that "many" were available at some other location in the school. Eighty-two percent report access to a printer or printers, and twenty-nine percent report access to a modem. Only nine percent (4 respondents) report, however, access to computer-laboratory interface devices.

Table 2

Access Tallies:

que #								
4			5				6(a)	6(b)
peripheral devices:			external access:				program source	
prntr	mdm	lab	m/m	mail	info	dbse	own	schl
total:								
37	13	4	9	15	15	7	11	23
percent:								
82	29	9	20	33	33	16	24	51
						average:	3	7

Some respondents appear to be confused about the nature of specific peripheral devices and accesses. While only twenty-nine responses report access to a modem, thirty-three percent report access to electronic mail and information network services! (Perhaps due to information from Alberta Education, teachers have become aware of the "ASPEN" network, regardless of their own personal computer "awarness"?) Two respondents indicate that they have no idea what computer peripherals or external accesses were available to them. Eleven respondents (24%) report using their own programs at school, and twenty-three respondents report access to an average of seven programs owned by the school/district. Five respondents indicated having no idea about the availability of school/district-owned programs; while two respondents reported using their own programs only, with no availability of school-owned programs.

Respondents were asked to rate their own assessment of their expertise in four areas of computer skill: knowledge of computer operations, programming, evaluation of educational software, and computer applications in science instruction.

ie.

8. Please rate your <u>own</u> computer background on the following scale:

	poor				excellent
(a) knowledge of how computers operate	0	1	2	3	4
(b) ability to write own programs	0	1	2	3	4

(c) ability to evaluate educational software	0	1	2	3	4
(d) knowledge of educational computer applications	0	1	2	3	4

Overall, respondents score themselves lowest in programming skills and highest in ability to evaluate software. Considerably more respondents rate their overall skill as "poor" than as "excellent"; though a majority (56%) rate themselves overall in the "average to above average" categories. Seventy-three percent rate themselve "average to above average" with respect to knowledge of educational computer applications.

Table 3

Knowledge Evaluation:

que #	response tally poor 0	1	2	3	excellent 4	average response
8(a)	6.00	10.00	16.00	8.00	5.00	1.91
8(b)	17.00	10.00	8.00	6.00	4.00	1.33
8(c)	9.00	4.00	13.00	17.00	2.00	1.98
8(d)	6.00	5.00	22.00	11.00	1.00	1.91
avg.total	9.50	7.25	14.75	10.50	3.00	1.78

percentage response

que #	0 (poor)	1	2	3	4 (excellent)	CUMULATIVE AVERAGE
8(a)	13.33	22.22	35.56	17.78	11.11	mean = 1.78
8(b)	37.78	22.22	17.78	13.33	8.89	s.d. = 0.97
8(c)	20.00	8.89	28.89	37.78	4.44	mode = 2.00
8(d)	13.33	11.11	48.89	24.44	2.22	median = 2.00
average:	21.11	16.11	32.78	23.33	6.67	

One critical purpose of the survey was to determine to what extent, and in what ways teachers actually make use of micro-computers in their regular preparation and instructional routines. Questions in section "C-I" of the survey deal with teacher use, while questions in section "C-II" survey student use.

ie.

Part C - Computer Use Profile: Please answer the following questions concerning how you and your students use microcomputers in your senior high science program.

For each of the computer applications described, please indicate the extent to which you or your students make use of this application in your senior high science courses.

I. Teacher use of computers for senior high science instruction:

1. Teacher uses computer for lesson-planning, preparation of tests, preparation of student handouts, etc.

2. Teacher uses "electronic mail" or network to comunicate with other science teachers, or to access science related information from other sources.

3. Teacher uses a computer data base to keep an inventory of science equipment, supplies, references, audio-visual materials, etc.

4. Teacher uses a marks management program or spreadsheet to maintain student achievement and/or attendance records

5. Teacher uses computer simulations to demonstrate experiments, environments, or phenomena.

6. Teacher uses computer-laboratory interface device(s) to control experiments, and/or to collect data during a classroom demonstration.

7. Teacher demonstrates use of computer to record data and/or carry out calculations related to experiments or problems.

8. Teacher writes computer programs for use by self or students as part of a science lesson.

II. Student use of computers during senior high science instruction:

1. Students are required to use a computer to complete written assignments.

2. Students use a data base (on disk, or accessible via modem/terminal) to locate information related specifically to their science lesson.

3. Students use computer simulations of experiments, environments, or phenomena as part of a science lesson.

4. Students use scientific computer "game" programs as part of a science lesson.

5. Students use computer "drill & practice" programs as part of a science lesson.

6. Students use computer "tutorial" programs on new or review information as part of a science lesson.

7. Students use computer-laboratory interface device(s) to control experiments and/or to collect data during an experiment.

8. Students use computers to record data and/or carry out calculations related to experiments or assigned problems.

9. Students write own computer programs to solve specific questions related to experiments or assigned problems.

While only eight respondents (18%) report being total "non-users" (ie. in terms of teacher use or student use), the average majority of responses in both categories with respect to various applications is "never" (teacher use - 68%, and student use - 80%). The most commonly reported application of micro-computer technology is the use of spreadsheets or marks management programs to process student grades. Sixty-four percent of respondents report "regular" or "frequent" use of such programs. Additionally, teachers who use micro-computers at all make extensive use of word processing capabilities for the preparation of lessons, assignments, or tests: fifty-three percent making "frequent" or "regular" use of such programs, and an additional eleven percent using word processing programs at least "occasionally". A few individuals report "occasional" to "frequent" use of data bases (22%) and simulations (16%); while little teacher use of electronic mail, laboratory interfacing, calculation capabilities, or programming is reported. Very little student use of microcomputer technology in science education is reported. Only a few teachers (9%) report any "frequent" or "regular" student use - and that only of the use of word processing capabilities to complete written assignments. "Occasional" use of such things as simulations, tutorials, and drill/practice programs is reported by only about five percent of respondents. The average student use response is "never" for eighty percent of respondents, and "rarely" for an additional sixteen percent. One respondent reported "occasionally" using laboratory interface peripherals, though ninety percent of respondents report "never" using such devices. As well, students are practically never asked to write their own programs as a part of their science instruction, and seldom use computer programs to carry out calculations or to analyze experimental data.

Table 4

Part C: "Computer Use" - tally

que #	nevr 0	rare 1	occn 2	freq 3	regy 4	average
I - 1	11.00	5.00	5.00	8.00	16.00	2.29
I - 2	37.00	6.00	1.00	1.00	0.00	.24
I - 3	34.00	1.00	8.00	2.00	0.00	.51
I - 4	14.00	2.00	0.00	3.00	26.00	2.56
I - 5	30.00	8.00	7.00	0.00	0.00	.49
I - 6	39.00	2.00	4.00	0.00	0.00	.22
I - 7	38.00	4.00	3.00	0.00	0.00	.22
I - 8	40.00	3.00	1.00	1.00	0.00	.18
II - 1	30.00	7.00	4.00	3.00	1.00	.62
II - 2	37.00	6.00	2.00	0.00	0.00	.22
II - 3	33.00	9.00	3.00	0.00	0.00	.33
II - 4	36.00	9.00	0.00	0.00	0.00	.20
II - 5	32.00	10.00	3.00	0.00	0.00	.36
II - 6	34.00	9.00	2.00	0.00	0.00	.29
II - 7	41.00	3.00	1.00	0.00	0.00	.11
II - 8	38.00	7.00	0.00	0.00	0.00	.16
II - 9	42.00	3.00	0.00	0.00	0.00	.07
CI: total	30.38	3.88	3.62	1.88	5.25	.84
CII:total	35.89	7.00	1.67	.33	.11	.26
C: total	33.29	5.53	2.59	1.06	2.53	.53

Part C: "Computer Use" - percentage

que #	nevr 0	rare 1	occn 2	freq 3	regy 4
I - 1	24.44	11.11	11.11	17.78	35.56
I - 2	82.22	13.33	2.22	2.22	0.00
I - 3	75.56	2.22	17.78	4.44	0.00
I - 4	31.11	4.44	0.00	6.67	57.78
I - 5	66.67	17.78	15.56	0.00	0.00
I - 6	86.67	4.44	8.89	0.00	0.00
I - 7	84.44	8.89	6.67	0.00	0.00
I - 8	88.89	6.67	2.22	2.22	0.00
II - 1	66.67	15.56	8.89	6.67	2.22
II - 2	82.22	13.33	4.44	0.00	0.00
II - 3	73.33	20.00	6.67	0.00	0.00
II - 4	80.00	20.00	0.00	0.00	0.00
II - 5	71.11	22.22	6.67	0.00	0.00
II - 6	75.56	20.00	4.44	0.00	0.00
II - 7	91.11	6.67	2.22	0.00	0.00
II - 8	84.44	15.56	0.00	0.00	0.00
II - 9	93.33	6.67	0.00	0.00	0.00
CI: total	67.50	8.61	8.06	4.17	11.67
CII: total	79.75	15.56	3.70	.74	.25
C: total	73.99	12.29	5.75	2.35	5.62

SECTION C
CUMULATIVE
AVERAGE

mean = 0.53
s.d. = 0.41
mode = 0.00
median = 0.47

Section "D" of the survey dealt with teacher attitudes toward computer uses in senior high school science instruction, the provision of assistance to teachers who wish to use computers in their programs, and the relevance of computer use to the high school science program and objectives. Since each question consisted of a statement and a five-point Likert-type response, a method was needed whereby responses could be "quantified" for interpretation. Each response ("strongly agree", "agree", "no opinion", "disagree", and "strongly disagree") was assigned a number indicative of its "positive" or "negative" value with respect to the topic of the question - "positive" values indicating a favorable attitudinal response, and "negative" values indicating an unfavorable response. "No opinion" responses are assigned a value of zero. Thus a question which makes a favorable statement concerning computer applications is awarded values of -2 (SD), -1 (D), 0 (N), +1 (A), and +2 (SA). A question posing an unfavorable statement is awarded values of +2 (SD), +1 (D), 0 N), -1 (A), and -2 (SA). (See Appendix 5.) It is germane to note (if obvious), that these "values" did not appear on the surveys completed by respondents, but were added to assist in compilation, calculation, and analysis of results once all surveys had been returned. Additionally, the questions in section "D" represent teacher attitudes vis-a-vis three categories of concern: (a) the applicability of computer technology to senior high school science instruction, (b) the support provided to teachers using such technology, and (c) the impact of computer use on classroom methodologies; and have been tallied (and analyzed) both overall, and in each of these three categories.

Over the average of thirty questions, attitudes are more positive toward computer use in high school sciences (45% at +1 or +2) than negative (24% at -1 or -2). The sub-section displaying the greatest average number of favorable responses (59%) and fewest number of unfavorable responses (9%), reflects positive attitudes toward the applicability and relevance of computer technologies to senior high school science instruction. Questions related to the impact of computer technologies on classroom instruction reflect, as well, generally favorable attitudes - drawing, overall, a fifty-one percent positive response and only twenty-four percent negative responses. The area of greatest discontent, appears to be the perceived support offered to teachers who attempt to utilize micro-computer technology in their science classes. For example, eighty-two percent of respondents indicate a need for better teacher training in the use of micro-computers in science instruction, while eighty-nine percent express the need for more workshops on this subject. As well, only one respondent reports sufficient organizational support for teachers wishing to use computers; while only two indicate feeling that school districts encourage teachers to integrate computers into their instructional programs. Conversely forty-seven percent of respondents report that colleagues encourage the use of classrooom microcomputers; only three respondents (7%) indicating that this is not the case. In eight areas, a significant number of respondents indicate a "no opinion" response; on questions dealing with the pedagogical impact of classroom micro-computers, with the suitability of available software, and on the role of teachers as agents of innovational change. On the overall average a thirty-one percent "no opinion" is reported.

Table 5

PART D: "Attitudes" - tally

que #	-2.00	-1.00	0.00	1.00	2.00	average
1	0.00	2.00	7.00	29.00	7.00	.91
2	2.00	9.00	12.00	19.00	3.00	.27
3	0.00	8.00	13.00	19.00	5.00	.47
4	0.00	1.00	12.00	23.00	9.00	.89
5	0.00	2.00	10.00	29.00	4.00	.78
6	1.00	2.00	14.00	21.00	7.00	.69
7	2.00	8.00	22.00	12.00	1.00	.04
8	0.00	4.00	15.00	24.00	2.00	.53
9	0.00	1.00	19.00	22.00	3.00	.60
10	1.00	2.00	16.00	25.00	1.00	.51
11	13.00	19.00	11.00	2.00	0.00	-.96
12	9.00	11.00	22.00	3.00	0.00	-.58
13	2.00	5.00	5.00	30.00	3.00	.60
14	0.00	2.00	15.00	28.00	0.00	.58
15	22.00	15.00	4.00	4.00	0.00	-1.22
16	0.00	4.00	10.00	25.00	6.00	.73
17	4.00	11.00	17.00	12.00	1.00	-.11
18	12.00	21.00	11.00	1.00	0.00	-.98
19	1.00	4.00	17.00	20.00	3.00	.44
20	0.00	1.00	18.00	21.00	5.00	.67
21	1.00	2.00	21.00	21.00	0.00	.38
22	0.00	3.00	25.00	15.00	2.00	.36
23	11.00	29.00	5.00	0.00	0.00	-1.13
24	9.00	26.00	2.00	8.00	0.00	-.80
25	0.00	10.00	18.00	15.00	2.00	.20
26	0.00	5.00	10.00	27.00	3.00	.62
27	0.00	5.00	16.00	22.00	2.00	.47
28	0.00	1.00	13.00	24.00	7.00	.82
29	2.00	12.00	27.00	4.00	0.00	-.27
30	2.00	6.00	17.00	18.00	2.00	.27
Avg.total	3.13	7.70	14.13	17.43	2.60	.19

PART D: "Attitudes" - percentage

que #	-2.00	-1.00	0.00	1.00	2.00
1	0.00	4.44	15.56	64.44	15.56
2	4.44	20.00	26.67	42.22	6.67
3	0.00	17.78	28.89	42.22	11.11
4	0.00	2.22	26.67	51.11	20.00
5	0.00	4.44	22.22	64.44	8.89
6	2.22	4.44	31.11	46.67	15.56
7	4.44	17.78	48.89	26.67	2.22
8	0.00	8.89	33.33	53.33	4.44
9	0.00	2.22	42.22	48.89	6.67
10	2.22	4.44	35.56	55.56	2.22
11	28.89	42.22	24.44	4.44	0.00
12	20.00	24.44	48.89	6.67	0.00
13	4.44	11.11	11.11	66.67	6.67
14	0.00	4.44	33.33	62.22	0.00
15	48.89	33.33	8.89	8.89	0.00
16	0.00	8.89	22.22	55.56	13.33
17	8.89	24.44	37.78	26.67	2.22
18	26.67	46.67	24.44	2.22	0.00
19	2.22	8.89	37.78	44.44	6.67
20	0.00	2.22	40.00	46.67	11.11
21	2.22	4.44	46.67	46.67	0.00
22	0.00	6.67	55.56	33.33	4.44
23	24.44	64.44	11.11	0.00	0.00
24	20.00	57.78	4.44	17.78	0.00
25	0.00	22.22	40.00	33.33	4.44
26	0.00	11.11	22.22	60.00	6.67
27	0.00	11.11	35.56	48.89	4.44
28	0.00	2.22	28.89	53.33	15.56
29	4.44	26.67	60.00	8.89	0.00
30	4.44	13.33	37.78	40.00	4.44
Avg.total	6.96	17.11	31.41	38.74	5.78

SECTION D
CUMULATIVE
AVERAGE

mean = 0.19
s.d. = 0.34
mode = 1.00
median = 0.30

Fully eighty percent of teachers returning surveys responded positively toward the need for the inclusion of computer use by students in high school science instruction, while only forty-nine percent indicated that such use could enhance the topics offered in science program. Only one respondent indicated that computer use by students might be detrimental to the development of scientific thinking skills; seventy-one percent indicating that it would not be harmful, with fifty-eight percent indicating that it may aid in the development of logical reasoning skills, and sixty-two percent endorsing such use to assist in developing independent learning skills. Fifty-eight percent report no concern that computer use by students encourages rote learning, though forty percent of respondents expressed "no opinion" on this issue; and only fifty-three percent indicate the opinion that student use of computers might aid in organizational problem-solving skills. Only thirty-eight percent report that computers aid in the development of scientific process skills, while fifty-six percent express "no opinion". Only four respondents (9%) indicate feeling that student use of computers distracts from the primary purposes of high school science instruction, though twenty-two percent indicate that there are better ways to utilize science class time.

While only fifty-three percent indicate that integrating computers into their classrooms would be worth the extra effort, and only twenty-nine percent feel it is "easy" to integrate computers into their programs; even fewer (22%) indicate that integration would be too difficult to bother with. Only one respondent reports thinking that student use of computers would be disruptive of classroom management and discipline, while sixty-nine percent report that such use would not disrupt their routines. Seventy-three percent report that computers may offer increased opportunities for individualization of instruction; a significant number (62%) endorse the use of tutorial and/or drill & practice programs for reinforcement of concepts; and fifty-eight percent report feeling that computer use may increase student interest in science. One area of possible concern appears to be the replacement of "hands-on" experience by computer programs: forty-nine percent reporting "no opinion" about whether or not computers might replace practical laboratory work. As well, though fifty-eight percent of respondents indicate that laboratory interface devices may improve the value of student experiments, fully forty-two percent were of no opinion on the value of such peripherals. Never-the-less, seventy-three percent of respondents indicate thinking that computer simulations may provide good alternatives to some hands-on learning activities.

Fully seventy-one percent of respondents report that school districts do not necessarily encourage teachers to integrate computer use into their science programs, and seventy-three percent report that there is not sufficient organizational support for teachers who wish to undertake integration. Limited access to computers is cited as a major restriction to integration by seventy-eight percent of respondents, and very few respondents (only three) report access to suitable software. Sixty percent of respondents report "no opinion" on the applicability of available software to the Alberta curriculum, and thirty-one percent indicate that available software is not applicable to their programs. While only eight respondents (18%) report that science money would not be well spent on computer software, only forty-four percent indicate endorsing such expenditure.

Written Comments:

Few respondents (24%) included comments concerning actual uses of computers in their senior high school science instruction. A compilation of all written comments submitted by respondents is contained in appendix 6. Of these, three indicate the use by students of word processing programs to complete written assignments and/or to make notes. One respondent describes his/her own use of the computer for writing tests and assignments, and for the processing of student marks. Another respondent describes student use of application software such as data base and spreadsheet, while yet another lists student use of tutorial programs and laboratory simulations, and a third mentions the development of Hypercard programs for use with "Macintosh" micro-computers. Three respondents explain why they did not use computers in their science programs; citing problems with budgets, access, and software compatibility. A final respondent describes his/her computer use as "none".

Under "additional comments", a significant number of the twenty-five respondents who appended comments (56% of the total return) cite their own lack of knowledge about and experience with the educational use of computers in science instruction as a major hindrance to their confidence in their ability to evaluate the efficacy of such use. A large majority of comments mention lack of availabilty of good software and/or funds to purchase software as a crucial element in teachers' reluctance to invest much effort in developing strategies for the implementation of computer use in their science programs. A few respondents mention succesfully implemented software and devices (eg. "smart pulley", "application" programs, and "Hypercard" programs), but cite, additionally, problems with shortage of funds, poor access, and lack of good applicable software as major drawbacks. Other respondents describe their own reluctance to invest resources into a venture from which they do not feel a reasonable educational return can be realized. Mention is also made of the need to ensure that software made available to schools be directly related to the provincial curricula, and the necessity of funding assistance to encourage purchase of software. Never-the-less, a significant number of respondents express a belief in possible benefits available from the integration of computers with science programs.

VIII. <u>DISCUSSION AND ANALYSIS</u>

In order to be able to compare the results from each section of the survey, I have attempted to assign a "pseudo-quantitative" value to responses wherever possible. It is important to note, however, in consideration of these results, that the method of assigning values is arbitrary, and intended simply to assist in drawing an overview of the results obtained. I have attempted to use these assigned values to describe what I believe to be actually happening in local high schools and to draw a few conclusions relevant to my objectives for this study. The data collected is basically of three forms: simple descriptive or demographic information, such as years of training, teaching experience, access to computers, and self-evaluation of computer "literacy" skills; quantitative assessment of the extent to which respondents and their students use computers as a component of their high school science program; and, a quantitative assessment of respondent attitudes toward the integration of computers with the science program.

I have attempted to quantify user skills evaluation on a simple five-point scale ranging from "poor" (0) to "excellent" (4). Similarily the computer use survey asks respondents to rate their own and their students' use of computers on a similar five-point scale ranging from "never" used (0) to "regularly" used (4). Respondent attitudes are ranked, likewise on a five-point scale for each question, responses being assigned values ranging from highy unfavorable (-2) to highly favorable (+2), as described previously. I have intended, thus, to be able to assess and compare teachers' computer skills, actual uses of computers, and attitudes toward the place of computers in the senior high school science classroom. By totalling and averaging responses to each question, and for each section or sub-section of the survey, I have attempted to provide a broad portrait of computer uses and attitudes in southern Alberta high school science classes. In order to be able to draw some comparative results (and in accordance with my premise that teachers may in fact fall into identifiable "user categories"), respondents have been ranked in order of computer use (section "C" of the survey questionnaire), and these rankings then compared to rankings of computer skills (question "A - 8") and user attitudes (section "D").

While respondents did not, on the average, profess to be computer "experts", they appear relatively confident with computer operations, applications, and with their ability to evaluate educational software; displaying an overall "skills average" of 1.78 on a scale of 0 - 4. The distrubution of average skills evaluation (similar, as will be seen, to the distributions of user rating and attitude rating) display a majority (68%) of "average" skill levels (within +/- 1 s.d. of the mean). Six respondents rate their skills at significantly higher levels, and eight at significantly lower levels. Of interest, is the fact that while (as should be expected) most of the "low skill" respondents are relative "non-users" or "low-users"; a number of respondents who rate their "skill" as low are indeed average users of micro-computer technology. Conversely, all of the "high users" rate their skills as average to above average.

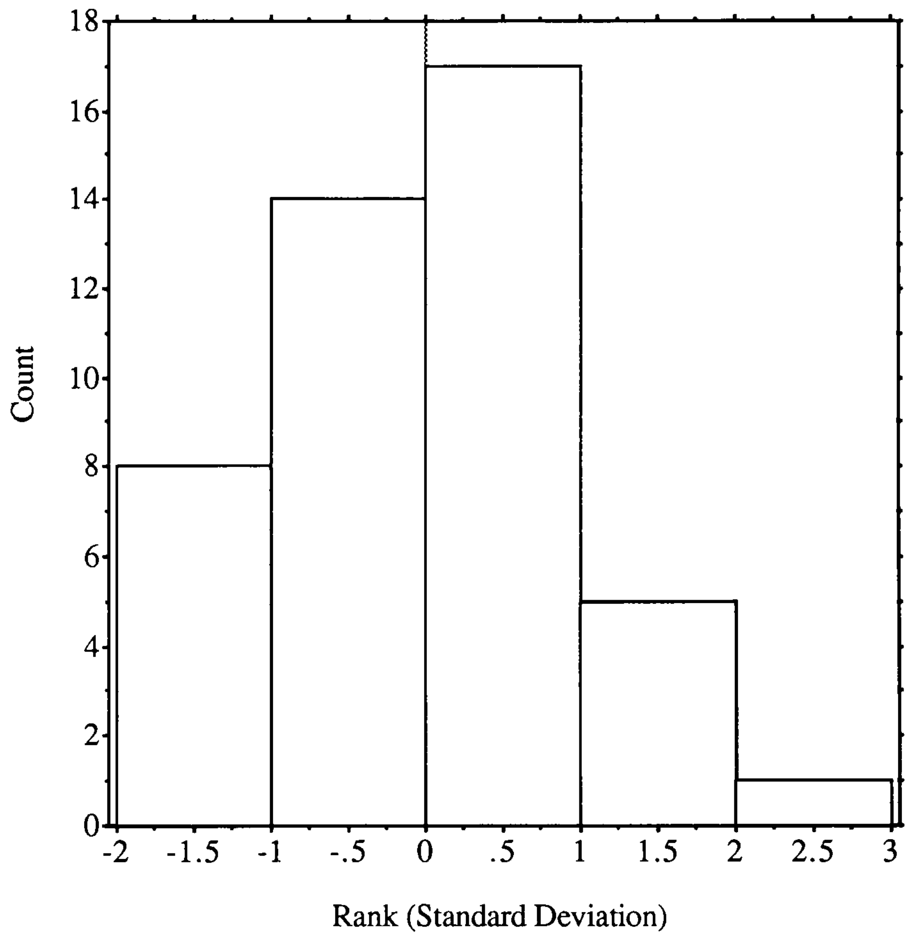

Figure 1

"Computer Skills Self-Evaluation Rank Distribution"

(section A - que. 8)

On the average, there appears to be some relationship between user skills and both the amount of use made of computers, and attitudes toward computer use in science instruction. It is interesting to note, however, individuals who rate their average skills relatively highly, but who are non-users or very low frequency users of micro-computer technology in their science classes. Additionally, though the overall use rate by all respondents is quite low (0.53 on a scale from 0 to 4), many actually do or have taught computer courses at various levels. It is significant as well, that though the average use rate is 0.53, the use rate by students is only 0.26 and the highest student use rate reported by one respondent is only 1.22. Eight respondents report never using computers at all, and eighteen report that their students never use computers as a part of their science instruction. It appears, thus, that regardless of the availability of hardware, the confidence level of teachers, or their experience with micro-computer technology; few high school science teachers actually devote much of their class time to the student use of micro-computers as a part of their science program. Of the forty-five respondents who returned questionnaires, twenty-five fall below the average use rate, and only five are significantly (ie. more than one standard deviation) above the average use rate. It seems, that while only few respondents are actually none-users or high-users, the majority (71%) make some - very limited - use of computers as aids in science instruction. Of the respondents who fall in the "high-use" category, however, it is worthy of note that three of the five reporting high use rates are over +2 s.d. above the mean user rating. Overall, however, the primary (and only significant) teacher use of the technology, it appears, is preparational assistance in the form of word processing and calculation of student grades. Only very few respondents report using computers in any significant manner as instructional aids in their classrooms. While a few respondents report uses of simulation, tutorial, drill, or interfacing programs by students; again the only significantly higher student use of micro-computers is for word processing. The written comments seem to support the conclusion that little use, overall, is made of micro-computer technology - especially by students. There seems to be a small cadre of "innovators" who make significantly greater use of micro-computers in their science teaching; a large number of "implementors" who appear willing to utilize the new technology in limited ways; and a small number of "reactionaries" who (for whatever reason) do not include micro-computer use in their instructional programs in any way.

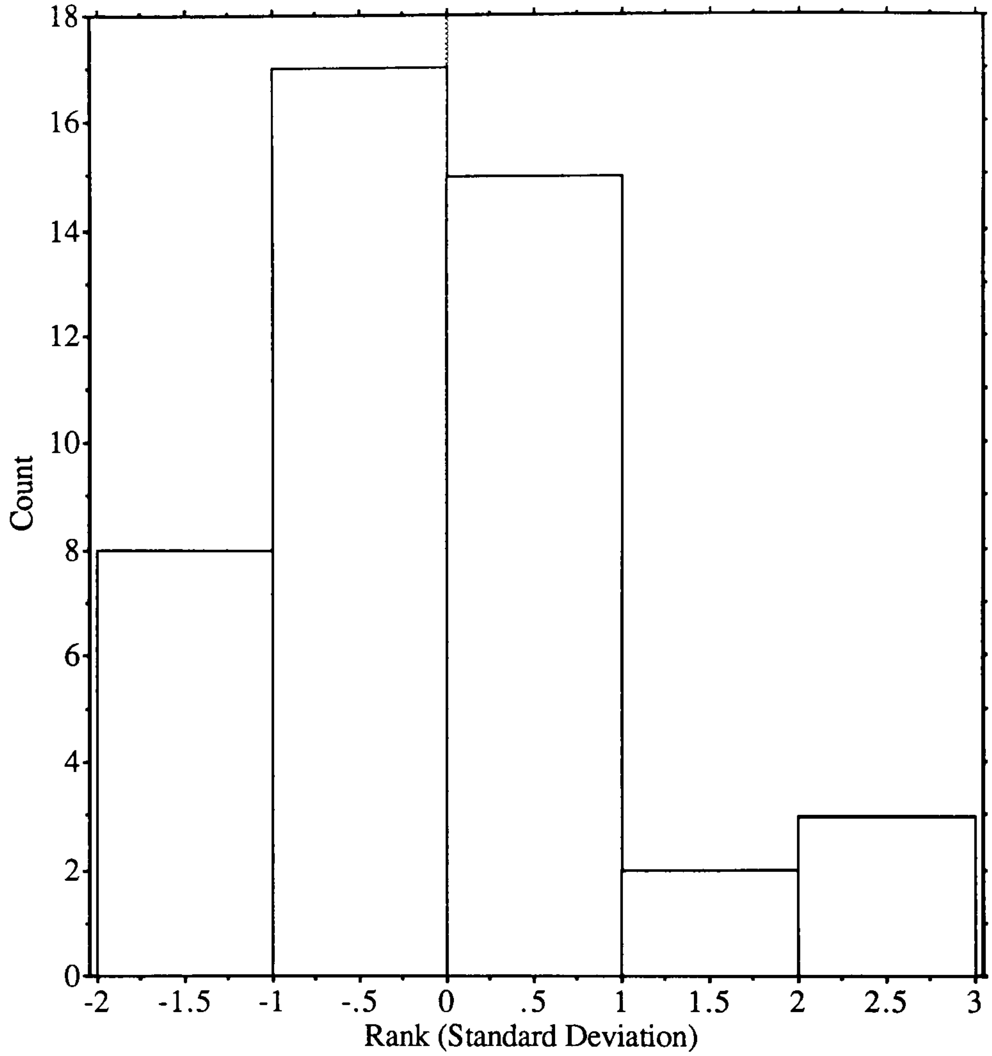

Figure 2

"Computer Use Rank Distribution" (section C)

Section "D" of the questionnaire attempted to identify some of the more "attitudinal" factors which may affect the way in which teachers use micro-computer technology in science instruction at the senior level. These questions were aimed at what teachers believe about the intrinsic value of micro-computers in the science classroom, at how easily teachers feel such technology can be implemented, and at their perceptions about the support (official & informal) available to teachers attempting such implementation. Overall, teacher attitudes toward computer implementation in senior high school science instruction are very slightly favorable (+0.19 on a scale from -2 to +2). Again a majority of (73%) respondents report average attitude ratings within +/- 1 s.d. of the mean (which hovers around the "no opinion" mark). Six respondents report significantly low attitude ratings, while another six report significantly higher attitude ratings. The highest overall average attitude rating, never-the-less, is only +0.90 on the five-point scale. Overall, there appears to be a minority of very positive or very negative responses to the question of computer use in science instruction. There appears to be some relationship between positive attitude ranking and user frequency ranking. It is notable, however, that five of the the eight non-users are not clustered at the low end of the attitude spectrum, but can be found scattered throughout the attitude rankings. As well, a few of the "low attitude" respondents, are in fact found among the higher ranks of user rating!

Of even greater interest within the responses to section "D" is the breakdown of questions with respect to three categories of attitudes: (a) the applicability of micro-computer technology to science instruction, (b) the implementational support available to teachers wishing to use micro-computers in their classes, and (c) the effect that such use may have on regular instructional programs and routines. The highest average positive response (+0.56) occurs in category (a), with a 59% positive response overall, and only a 9% overall negative response. The greatest positive response is toward the belief that computers should be a part of regular high school science programs. Additionally, teachers report positive beliefs about the pedagogical benefits (problem solving and logical reasoning skills, for example) to be derived by students from the use of computers as a part of their science classes. Areas which reflect the greatest degree of uncertainty include the replacement of practical laboratory activities with computer simulations, and the value of computer activities in the development of process skills. It seems, thus that regardless of the extent to which respondents actually make use of micro-computers in their instructional programs, they feel that such use has a legitimate place in senior high science classes.

Table 6

"Attitudes - category (a)" - tally

que #	-2.00	-1.00	0.00	1.00	2.00	average
1	0.00	2.00	7.00	29.00	7.00	.91
2	2.00	9.00	12.00	19.00	3.00	.27
4	0.00	1.00	12.00	23.00	9.00	.89
6	1.00	2.00	14.00	21.00	7.00	.69
7	2.00	8.00	22.00	12.00	1.00	.04
8	0.00	4.00	15.00	24.00	2.00	.53
9	0.00	1.00	19.00	22.00	3.00	.60
10	1.00	2.00	16.00	25.00	1.00	.51
13	2.00	5.00	5.00	30.00	3.00	.60
14	0.00	2.00	15.00	28.00	0.00	.58
16	0.00	4.00	10.00	25.00	6.00	.73
20	0.00	1.00	18.00	21.00	5.00	.67
22	0.00	3.00	25.00	15.00	2.00	.36
26	0.00	5.00	10.00	27.00	3.00	.62
27	0.00	5.00	16.00	22.00	2.00	.47
avg.total	.53	3.60	14.40	22.87	3.60	.56

"Attitudes - category (a)" - percentage

que #	-2.00	-1.00	0.00	1.00	2.00
1	0.00	4.44	15.56	64.44	15.56
2	4.44	20.00	26.67	42.22	6.67
4	0.00	2.22	26.67	51.11	20.00
6	2.22	4.44	31.11	46.67	15.56
7	4.44	17.78	48.89	26.67	2.22
8	0.00	8.89	33.33	53.33	4.44
9	0.00	2.22	42.22	48.89	6.67
10	2.22	4.44	35.56	55.56	2.22
13	4.44	11.11	11.11	66.67	6.67
14	0.00	4.44	33.33	62.22	0.00
16	0.00	8.89	22.22	55.56	13.33
20	0.00	2.22	40.00	46.67	11.11
22	0.00	6.67	55.56	33.33	4.44
26	0.00	11.11	22.22	60.00	6.67
27	0.00	11.11	35.56	48.89	4.44
avg.total	1.19	8.00	32.00	50.81	8.00

SECTION D(a)
CUMULATIVE
AVERAGE

mean = +0.56
s.d. = 0.45
mode = +1.00
median = +0.44

Respondents are slightly less positive (+0.34 on the average) in category (c); reporting overall a 51% average positive response and a 20% negative response. Questions dealing with the relative ease with which computers can be integrated into existing programs drew overall negative responses; while those dealing with the ability of micro-computer application to enhance or expand science programs drew more positive responses. There appears, in contrast to support for the concept of computers as a part of regular senior science programs, slightly less conciliation with the impact of micro-computer integration on classroom pedagogy and practice. More importantly, there appears to be concern with the practical aspects of attempting to implement student use of computers into current science courses.

Table 7

"Attitudes - category (c)" - tally"

que #	-2.00	-1.00	0.00	1.00	2.00	average
2	2.00	9.00	12.00	19.00	3.00	.27
3	0.00	8.00	13.00	19.00	5.00	.47
5	0.00	2.00	10.00	29.00	4.00	.78
7	2.00	8.00	22.00	12.00	1.00	.04
9	0.00	1.00	19.00	22.00	3.00	.60
13	2.00	5.00	5.00	30.00	3.00	.60
16	0.00	4.00	10.00	25.00	6.00	.73
17	4.00	11.00	17.00	12.00	1.00	-.11
19	1.00	4.00	17.00	20.00	3.00	.44
24	9.00	26.00	2.00	8.00	0.00	-.80
25	0.00	10.00	18.00	15.00	2.00	.20
28	0.00	1.00	13.00	24.00	7.00	.82
avg.total	1.67	7.42	13.17	19.58	3.17	.34

"Attitudes - category (c)" - percentage

que #	-2.00	-1.00	0.00	1.00	2.00
2	4.44	20.00	26.67	42.22	6.67
3	0.00	17.78	28.89	42.22	11.11
5	0.00	4.44	22.22	64.44	8.89
7	4.44	17.78	48.89	26.67	2.22
9	0.00	2.22	42.22	48.89	6.67
13	4.44	11.11	11.11	66.67	6.67
16	0.00	8.89	22.22	55.56	13.33
17	8.89	24.44	37.78	26.67	2.22
19	2.22	8.89	37.78	44.44	6.67
24	20.00	57.78	4.44	17.78	0.00
25	0.00	22.22	40.00	33.33	4.44
28	0.00	2.22	28.89	53.33	15.56
avg.total	3.70	16.48	29.26	43.52	7.04

SECTION D(c)
CUMULATIVE
AVERAGE

mean = +0.34
s.d. = 0.44
mode = +1.00
median = +0.38

From the written comments, it seems obvious that the greatest drawbacks to implementation are the availability of quality, applicable, software, and funds for the purchase of any software. Others mention, (and survey results reveal) as well, limited access to the hardware itself. Respondents indicate that regardless of the intrinsic value of computer use in science instruction, lack of access (particularly access to good software) is the major hindrance to implemention. Responses to category (b) questions indicate the highest level of malaise with the support (financial and instructional) available to science teachers attempting classroom implemention of micro-computer technology. The average response in this category is -0.48 on the five-point scale; with a total average 51% negative response and only 19% positive response. One area drawing significant negative response deals with perceived organizational and administrative support available to teachers wishing to implement micro-computer technology in their science classes (displaying average responses of -0.98 and -0.80). As well respondents cite better training and more workshops in computer applications as the most pressing needs for those interested in implementation (at average response levels of -1.22 and -1.13). Respondents are relatively positive (71%) about the potential benefits of implementation regardless of hurdles to be overcome, with an average response of +0.47.

Table 8

"Attitudes - category (b)" - tally

que #	-2.00	-1.00	0.00	1.00	2.00	average
3	0.00	8.00	13.00	19.00	5.00	.47
11	13.00	19.00	11.00	2.00	0.00	-.96
12	9.00	11.00	22.00	3.00	0.00	-.58
15	22.00	15.00	4.00	4.00	0.00	-1.22
18	12.00	21.00	11.00	1.00	0.00	-.98
21	1.00	2.00	21.00	21.00	0.00	.38
23	11.00	29.00	5.00	0.00	0.00	-1.13
24	9.00	26.00	2.00	8.00	0.00	-.80
29	2.00	12.00	27.00	4.00	0.00	-.27
30	2.00	6.00	17.00	18.00	2.00	.27
avg.total	8.10	14.90	13.30	8.00	.70	-.48

"Attitudes - category (b)" - percentage

que #	-2.00	-1.00	0.00	1.00	2.00
3	0.00	17.78	28.89	42.22	11.11
11	28.89	42.22	24.44	4.44	0.00
12	20.00	24.44	48.89	6.67	0.00
15	48.89	33.33	8.89	8.89	0.00
18	26.67	46.67	24.44	2.22	0.00
21	2.22	4.44	46.67	46.67	0.00
23	24.44	64.44	11.11	0.00	0.00
24	20.00	57.78	4.44	17.78	0.00
29	4.44	26.67	60.00	8.89	0.00
30	4.44	13.33	37.78	40.00	4.44
avg.total	18.00	33.11	29.56	17.78	1.56

SECTION D(b)
CUMULATIVE
AVERAGE

mean = -0.48
s.d. = 0.27
mode = -1.00
median = -0.50

Other slightly average positve responses with respect to implementation concern the role of fellow teachers as innovatory agents (+0.38), and the use of funds to purchase science software (+0.27). Written comments reiterate the impression that the greatest concern among respondents is not the technology itself, but rather the support - primarily financial - which is not forthcoming from school, district, and provincial administrations. On the whole, respondents seem relatively well disposed (within limits) to the implementation of micro-computer technology into senior high school science programs, but appear to feel a serious lack of support for the innovatory process.

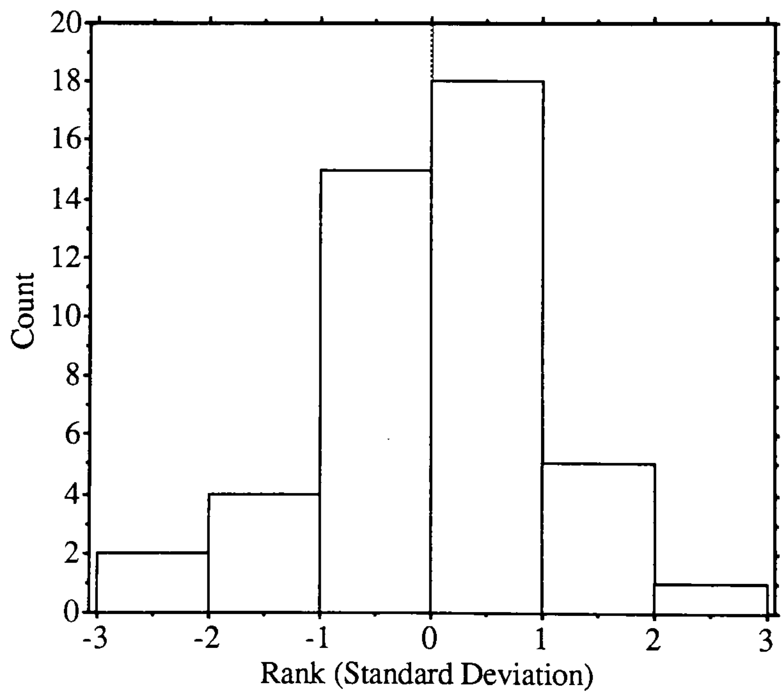

Figure 3

"Computer Attitudes Rank Distribution" (section D)

IX. <u>INTERVIEWS</u>

Summaries of the four interviews conducted are found in Appendix 7. I have attempted, in these summaries, to record the gist of the approximately two and one-half hours of conversation with four different teachers which I tape recorded. I did not include complete transcripts of the four conservations; since (not unexpectedly) the conversations were informal, collegial, often humorous, occasionally personal, and replete (by nature) with digression. In the appended summaries, thus, I have recorded each of the four interviews retaining (as much as possible) the exact comments of each respondent which are germane to the "interview format" outlined previously. (See Appendix 4.) The areas of discussion listed in the summary of each interview are in generally chronological order, as indicated by the topical headings, and (as informal conversations tend to jump around) I have grouped each respondent's comments appropriately under these broad topics of discussion. As much as possible, the written summaries reflect the actual, verbatim, comments of the respondents vis-a-vis the topics of discussion. I have taken the liberty of editing out any possible "identifying" information; converational fillers such as "um", "you know", "like", etc.; and extraneous conversational exchanges. As well, I have attempted to organize, consolidate and/or collate, for each interview, digressions and collateral comments which occured at various points throughout any one conversation.

Of the forty-five respondents to the survey questionnaire, fourteen volunteered their names as candidates to be interviewed. My purpose in designing the interview portion of this project was not to produce any "new" data for consideration; but rather to complement the data generated by the survey questions. It is hoped that the information from the four interviews conducted with volunteer respondents, may (1) in some way, "validate" the data and conclusions drawn from the survey questionnaire; and (2) provide some "depth" to the responses and comments on the questionnaires returned. Primarily, the purpose of the interview data was to provide a qualitative, contextual, conceptualization of the "real" classrooms from which the survey responses evolved (Walker, 1986). While the survey analysis, hopefully, provides a plethora of "facts" about what science teachers do with and think about computers in education, the interview information may help in making that data a bit more "three-dimensional" in nature. Interviews can put a "human face" on otherwise cold and impersonal statistics. In this instance I have limited my selection to only four candidates. There seemed little point in conducting "interview overkill", once I sensed a definite commonality of response among the interviewees, and since the purpose of the interviews was simply to clarify, "color in", and add perspective to the survey data. The four candidates selected, were chosen primarily to reflect the differentiation of respondents evident in the survey results. One interviewee was a complete "non-user" of computers in science instruction, and another was among the few "high-use" respondents identified by section "C" of the survey. Since "average users" represented the largest group of respondents, the other two respondents were selected from among this median group. Upon telephone contact with a number of suitable cadidates for interview, the final selections were based upon mutually agreeable schedules and time constraints as the end of the school term rapidly approached. The selected interviewees represent four different schools in four different school districts, and all report science teaching experience ranging from ten to twenty years. Each interview was begun with a brief review of the purpose of this study, an explanation of the purpose and format of the interview specifically, and an informal discussion of any general concerns about the interview process and/or the use of the interview content. Each interview was directed by the interview format outline described in Appendix 4, and attempted to elucidate and illuminate the data reported on the individual's questionnaire.

Though not quantitative in nature, the information from the interviews certainly tends to confirm the results of the survey questionnaires. While each of the four interviews was certainly unique in content and "flavor"; definite commonalities of concern appeared throughout. All four respondents stated that access to hardware is sufficient, reporting that though they cannot usually access computers at a moment's notice; with a bit of advance planning and organization, hardware is certainly available to them. However, the need for more money for software and better inservice training in educational applications was mentioned by all. The three users all expressed considerable optimism about the potential for use of computers in senior high school science instruction, as do many of the survey respondents; yet none make extensive use of computers in their classes. The high-use respondent, while attempting considerably greater use of computers in his instructional program, reported having to sacrifice curricular content in order to allow time for significant student use of computers. He, of all, displayed the highly optimistic attitude of the true "technophile" - certain that if given enough money for hardware and software, and enough time to implement its use; new technologies could revolutionize science teaching. The non-user, conversely, expresses reluctance to use computers primarily because of lack of knowledge, training, or experience. This respondent, as well, expresses a degree of skepticism about the potential for computer use in science instruction; reporting a "wait and see" attitude. While reporting being impressed with some displays of the new technologies (such as laser disc video), he expresses general dissatisfaction with the kinds of information presented at local workshops and district inservice courses - as do the three users. Never-the-less, the non-user reports that both district and school-site administrations are promoting the use of computers through long-range planning for expansion of facilities and hardware resources.

The three users (as would be expected from the survey results) employ micro-computers primarily for their own use - for word processing and grade calculations. The two who make use of a modem to access computer networks or information systems report little satisfaction with the services or information available in this manner. Two of the users report having taken university level courses in computing, but express little direct benefit from learning how to program. Perhaps, none-the-less, enrollment in such a program reflects - or generates - some degree of acceptance of computer technology and predilection to its use. None report any need to learn how to write their own programs; rather the need for access to good quality software that they can apply directly to their courses. All three users report using some "pre-packaged" software with their students; but reiterate the need for money to purchase quality software, assistance in finding and selecting such programs, training in application of software to their courses, and time (actual and curricular) to integrate student use of computers with their courses. All respondents express the caveat that computer assisted learning could in no way make up for the personal attention of the classroom teacher or the hands-on experience of actual lab activities. The high-user reports that, without a teacher, even the best CML (computer managed learning) program is nothing better than an electronic correspondence course.

It is worthy of note that it is the high-user who reports the greatest degree of encouragement and support from his school district - especially financial support. In this case, the school district not only made a considerable amount of money available for hardware purchases, but implemented, additionally, a long-range plan for the acquisition of hardware and relevant software. It is obvious that, regardless of the "grassroots" interest in computer applications in science instruction, until district and school-site administrators will make hardware and software available to the classroom teachers little progress can be made. Respondents (to both interview and survey questions) express that while the impetus for innovation may come from the classroom practitioner, the momentum (in terms of time and money) can only come from the district and provincial levels. Never-the-less, even where support is minimal, as reported by the two average users, teachers who believe in the value of the new technology are willing (as much as possible) to make use of it where they feel it fills a need. All three users report, basically, that the benefits of computer use by science students are real, but in each instance a particular benefit must be greater than the difficulties with implementation. Certainly, all educators ideally want every advantage with no disadvantages; but realistically, the three users express the willingness to put in extra effort to give innovations a try if the potential benefits are obvious.

The one critical need expressed by the three users (and implicit in the reluctance of the non-user) is for access to good quality software. The survey results, as well, confirm that teachers report frustration with poor quality software, software which does not fit the provincial curriculum nor their own specific programs of study, the extreme high cost (relative to the usual science department annual budget) of software, and the lack of adminsitrative support for the purchase of software. Additionally, all four respondents (and most of the survey respondents) express the need for good quality workshops on specific programs and applications. The non-user interviewed, as well, reports that much of his own reluctance may stem from being unaware of what is available, and how it can be used specifically in his courses. While all interviewees report that other users in their schools are willing to share information and assistance, the "push" for innovation and implementation seems to rest with each individual. The two average users report that while moral support for implementation is readily available, administrative assistance does not seem to be forthcoming. The three users interviewed imply that as students become more computer literate and as more fellow teachers begin integrating computers into their classes, it should be easier to make use of computers in their own classes. One warns, however, that as computer use by other teachers increases, access to hardware may become more difficult due to increased demand. The non-user expresses the concern that student interest in computers may wane with over-exposure; a criticism echoed by the high user and one of the average users that, once the novelty of using the computer has worn off, unless students have access to quality, interactive, intellectually stimulating software they are just as satisfied doing traditional paper and pencil worksheets and actual hands-on lab activities. The three users reiterate, however, that as students gain familiarity with application software (word processing, data bases, and spreadsheets, for example), it becomes easy to encourage the use of micro-computer technology for completion of regular assigned learning activities.

Certainly, the information forthcoming from the four interviews, seems to confirm both the descriptive and interpretive results of the survey questionnaires. On the whole, high school science teachers appear to be positive toward the potentials inherent in student use of computer technology in science classes. Never-the-less, they tend to make little use of such technolgy due to the exigencies of curricular and financial demands. As expected from the survey results, there appears to be a correlation between one's experience and confidence with computers, and one's actual use of computer technology in the classroom. As well, not surprisingly, higher rate users of the technology (the innovators and implementors) have significantly more positive attitudes toward the potential benefits of such use than do non-users. The major concern, reflected by both the interviews and the survey data, is for serious administrative support (at all levels) for innovatory programs and implementation of existing technologies; and for provision of and access to quality, relevant, applicable software. A majority of senior high school science teachers, it would appear, are willing to see what micro-computer technology can do for their present and future programs, and are willing to make significant effort of their own to experiment with innovatory technologies. They need, however, to encounter bridges not walls along the road to implementation.

X. CONCLUSION

I have attempted in this study to answer, for my own purposes, real questions I hold concerning my own attitudes and practices concerning micro-computer applications in senior high school science instruction. The motivation for this study has been an attempt to relate my own classroom to the classrooms of my colleagues in southern Alberta. The data collected is a qualitative portrait of how science teachers in this region are integrating micro-computers into their programs, and some of the under-lying factors associated with their use of micro-computer technology. The data collected during this study indicates the potential for research into the effect of specific factors on the use of micro-computers in the classroom, and the effect of such use on the classroom itself. There appear to be certain common concerns constraining those teachers who do not use computers to any extent in their teaching, while those who appear to be the "innovators" in this area seem to operate in uniquely supportive environments. While the findings of this study does not examine any of these factors in depth, it hints at possible relationships between computer use by teachers and such factors as administrative and financial support, teacher experience and training, provincial assistance and support, curricular constraints and concerns, school-site constraints, curricular methodologies, and teacher attitudes toward technology in general. This project has examined the manner in which senior high school science teachers in southern Alberta use (or mostly do not use) micro-computer technology in their classes. While most express the belief that such technology should occupy an important place in the high school science program, most, also, make little or no use of computer technology - especially in their teaching methods.

In concurrence with other studies (Vemette, etal, 1986), this research reveals an underlying conservatism amongst educational professionals - that teachers may be very positive to the ideas of technological innovation, but seem much less receptive to the demands required by integration into their normal routines and practices. The respondents in this study do not, on the whole, express a reactionary attitude toward micro-computer technolgy, as much as a conservative one. They report (on the survey and through the personal interviews) an interest in the capabilities of micro-computers as a component of their science classes, and an optimism in their potential for enhancement of science education. Regardless of this, and authoritative imprecations to make computer technology an increasing part of all school courses (Alberta Education, 1987), most of the high school science teachers responding to this survey make little use of micro-computer technology in their teaching beyond applying word processing capabilities to lesson planning, and perhaps using computer software packages to calculate student grades. Even the few respondents who report much higher than average use of computers by their students lament the inability (for various reasons) to fully utilize the capabilities of the technology that is at hand.

Educational innovations (particularly technological innovations) seldom revolutionize classroom methodology (Wright, 1987) for a variety of reasons. This study points out, as other researchers have found (Komoski, 1987, for example), that while exposure to and experience with computer technology may predilect one to attempt implementation; factors such as paucity of funds, poor access to hardware and/or software, insufficient training, lack of administrative support or encouragement, the demands of curricular expectations, and the exigencies of time often present formidable barriers to even the most willing disciple. The apparent "bottom line" of this study is that, generally, high school science teachers in southern Alberta schools would like to make more, and better, use of micro-computers in their classrooms. Regardless of "grassroots" impetus for innovatory change, however, some of the key ingredients for successful implementation are missing. As the "users" responding to this study express, and as reiterated in other studies (Small & Haley, 1986), teachers who will really be able to use computers are those who believe that computer use by students can be a beneficial part of a science program, are confident with their own "computer literacy" skills, are excited about the potential of the technology, and receive unequivocal administrative support (at all levels) for implementation. Kloosterman, etal (1987) report the need for ease of access to hardware, provision of quality software, curricular changes to encourage integration of technology, inservice workshops on integration strategies, and the evolution of programs which incite willingness to implement computer use; if any significant implementation of micro-computer technology in the classroom is to occur.

Teachers responding to this study cite lack of real support in these same areas as the major hindrance to successful implementation of micro-computer technology in senior science classrooms. While the provincial government itself identifies the same areas of concern (Alberta Education, 1987), survey respondents mention the lack of support forthcoming both locally and provincially as critical reasons for not including student use of computers in their programs. These findings disclose a need for definitive financial commitment on the part of both provincial and local authorities to the implementation of micro-computer technology in science classrooms. In the one instance where this kind of commitment is reported in this study, the actual use of computers by students is at one of the highest levels. Comments by the teacher reporting this situation reflect an excitement and optimism glaringly absent among the other respondents.

Since real innovation only occurs at the classroom level, regardless of hierarchial edict (Lieberman & Miller, 1984), it is essential that classroom practitioners be assisted, rather than hindered, on the path to implementation of innovations. The implementation of computer use in science classrooms is not without its pitfalls. Streibel (1985) reports many of the same concerns as those expressed by survey respondents regarding poor quality software. Many respondents express extreme dissatisfaction with the majority (in some cases, all) of the software programs that they have access to; and report receiving no assistance from local or provincial jurisdictions in addressing this need. Respondents reflect an attitude, not of unwillingness to undertake new ventures, but rather of reluctance to commit time and energy to an endeavor for which they (1) perceive there to be little support, (2) are unconvinced of the actual benefits, and (3) lack actual, practical, knowledge and experience. Olson & Eaton (1986), among others, report in a similar study that teachers tend to resist any proposed change which is perceived to adversely affect established routines or familiar programs of study. Yet, respondents to this study failed to express this as a significant obstacle to integration of computers with senior high school science instruction. Most, in fact indicated that, if sufficient, good quality, applicable, relevant, software were available, they would willingly make the effort to integrate computer use by students into their programs. The three "users" interviewed reported that while obtaining access to computers may require a bit of organization and pre-planning, it was among the least of the obstacles to implementation.

The other major hurdle to integration identified by survey respondents, and reflected in previous studies (Komoski, 1987; Vemette, etal, 1986), is the need for appropriate inservice training in the identification and use of relevant software programs, and time to acquire the experience and confidence necessary to make appropriate use of the hardware and software available to them. Users and non-users alike report the need to know what is available for use in science instruction, and how to use it specifically in their classrooms. While almost all respondents report having attended some type of workshop on educational computing, it seems apparent that these sessions are not meeting the specific, practical, needs of teachers considering classroom implementation of computer technology. Many respondents report having "no opinion" on a number of issues surrounding computer applications in high school science; and indicate, further, lacking the experience and/or expertise to offer opinions on these issues. Additionally, teachers report that to undertake the integration of student use of computers into their science programs would require significant changes in the demands on both class time and preparation time currently presented by diverse teaching assignments, curricular constraints, demands for high student achievement on diploma examinations, and the numerous other demands which accompany employment as a high school teacher. It would seem, thus, that there exists a compelling need for the design and provision of adequate, specific, practical inservice workshops for science teachers in the capabilities, applications, and potentials of micro-computer use in senior high school classrooms; and the provision of opportunities for teachers to become familiar and confident with this technology.

Senior high school science teachers in southern Alberta, appear to be favorably disposed to the concepts and philosophies implicit in the student use of micro-computers in science education. Overall, they express the belief that such use should be an integral part of any science education curriculum; and reflect a confidence in the ability of the technology to enhance student learning opportunities in a number of ways. However, in actual practice, little use is made of micro-computers by these teachers, and their students make practically no use of micro-computer technology as a regular part of their science courses. Salient reasons for this discrepancy, appear to be the need for support - financial, educational, and administrative - for innovatory programs and implementational practices. Imprecations to implement innovational changes ring hollow when teachers fail to realize any serious commitment of support from those whose avowed responsibility is the assistance and encouragement of such change. The teachers responding to this study, are not reactionary toward educational innovation. Many are attempting to implement change as much as is possible in their particular circumstances, and some are even "revolutionary" in their enthusiasm. The innovators and implementors in this study, however, are able to progress only as far as the path for change is open to them.

Did this study answer my own questions about why I don't utilize computer technologies as much as I think I should? Yes and no. The respondents to this study express many of the same concerns which I believe hinder my own enthusiasm for integration of micro-computers into my classes. It seems as if I and the majority of my colleagues suffer the same malaise - we believe in the potential benefits offered by the use of micro-computer technology in the classroom. We are basically "computer literate" and generally believe that computer applications should be an essential component of a "science, technology, society" emphasis in senior high school science instruction. It appears, from the responses received, that most senior high science teachers would be willing "implementors", if not active "innovators", but for the numerous (primarily external) hindrances to integration. The "innovators" do exist, but seem to either reflect an almost religious zeal for computer integration, and work in highly supportive and innovative environments. The "reactionaries" it seems are rare indeed, unless they constitute the approximately thirty percent of the sample who did not return surveys. The majority of respondents, not unexpectedly, reflect a willingness to become active implementors of micro-computer technology, but demand that those "experts" imprecating integration lend real support to the innovative and integrative processes. On the other hand, I found few real operative solutions to the problems identified by my colleagues. Our enthusiasm not-with-standing, numerous obstacles on the path to integration of micro-computer technology still stand. If the innovatory processes are to succeed, teachers, adminstrators, and legislators must work toward common goals to remove or circumvent these barriers to eductional progress.

Where to go from here? It seems that high school science teachers believe in the value of integrating micro-computers into their programs. The obstacles implementation appear, however, to exist in adminstrative arenae beyond the classroom walls. Answers to questions about micro-computer implementation must be sought at these levels. What are the attitudes of school-site and central office adminstrators? What steps do they undertake to encourage innovation and implementation? What constraints do they perceive hinder innovatory changes?

If innovation and implementation are to occur, all participants in the innovatory process, at all levels, need to recognize and accept their own unique opportunities, roles, and responsibilities.

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APPENDIX 1

page

<u>Computer Use in Senior High School Science Instruction</u>
A Survey of Senior High School Science Teachers
in Southern Alberta

district	school	# staff
County of Forty Mile #8	Foremost School	(19)
	Senator Gershaw School	(16)
County of Lethbridge #26	Coalhurst High School	(16)
	Kate Andrews High School	(25)
	Noble Central School	(11)
	Picture Butte High School	(23)
County of Vulcan #2	County Central High School	(18)
	Lomond School	(8)
County of Warner #5	Erle Rivers High School	(12)
	Raymond High School	(14)
	Warner School	(14)
Cardston School Div. #2	Cardston Sr High School	(28)
	Magrath School	(38)
Crowsnest Pass Schl.Div.#63	Crowsnest Cons. High School	(24)
Pincher Creek Schl.Div.#29	Livingstone School	(20)
	Matthew Halton Comm. School	(30)
Taber School Div. #6	Chamberlain School	(13)
	Vauxhall Jr-Sr High School	(16)
	W.R. Myers High School	(20)
Willow Creek Schl.Div.#28	F.P. Walshe School	(27)
	J.T. Foster School	(21)
	Willow Creek Comp. High School	(28)
Lethbridge Schl.Dist.#51	Lethbridge Collegiate Institute	(68)
	Winston Churchill High School	(36)
Stirling Schl.Dist.#647	Stirling School	(17)
Bow Island RCSS Dist. #82	St. Michaels School	(12)
Lethbridge RCSS Dist. #9	Catholic Central High School	(36)
Pincher Creek RCSSDist.#18	St. Michael's Secondary School	(28)
Taber RCSS Dist. #54	St. Mary's RCS School	(17)

APPENDIX 2

page

Computers in Science - Survey

Part A - Teacher Profile: Please answer each of the following questions by checking the appropriate information, and/or filling in the blanks.

1. What senior high school SCIENCE subject(s) do you usually teach? (please check)

_____Science _____Biology _____Chemistry _____Physics

2. How many years have you been teaching

(a) in total? __________ (b) high school science? _________

3. How many years of university training do you have? ________

4. How many courses in computer programming, computer applications, computer operations, etc. have you taken

(a) at university? _______ (b) at college or technical school? _______

5. **Approximately** how many workshops, seminars, inservice sessions, etc. in computer applications have you attended? (please check)

_____ 0 _____ 1 - 10 _____ more than 10

6. Do you have a computer at home? ______ yes ______no

7. Please check if you have taught a course or workshop on computing or computer applications

(a) to school students ______ (b) for teachers in your school or district ______

(c) at a conference/convention ______ (d) at a post-secondary level ______

8. Please rate your own computer background on the following scale:

	poor				excellent
(a) knowledge of how computers operate	0	1	2	3	4
(b) ability to write own programs	0	1	2	3	4
(c) ability to evaluate educational software	0	1	2	3	4
(d) knowledge of educational computer applications	0	1	2	3	4

Part B - Classroom Equipment Profile: Please answer the following questions concerning computer access in your science classroom:

1. How many computers are kept permanently in your science classroom?______

2. How many computers are available for your use which can be moved into your classroom?

____

3. How many computers are available for your use at another location in the school where you can teach your class? (ie. in a computer lab, etc.)

____

4. Please check the peripheral devices available for use in your classroom, or at another location where you can teach your class:

_____ printer(s) _____modem(s) _____laboratory interface device(s)

5. Please check if you have access anywhere at school via a terminal or modem to a(n)

_____ mini- or main-frame computer _____ "electronic mail" service

_____ information network service _____ educational data base service

6. Please indicate how many computer programs relevant to the instruction of senior high school science are available to you which

(a) are your own _________ (b) belong to the school or district _________

Part C - Computer Use Profile: Please answer the following questions concerning how you and your students use microcomputers in your senior high science program.

For each of the computer applications described, please indicate the extent to which you or your students make use of this application in your senior high science courses, using the scale below:

0 - never 1 - rarely 2 - occasionally 3 - frequently 4 - regularly

I. Teacher use of computers for senior high science instruction:

1. Teacher uses computer for lesson-planning, preparation of tests, preparation of student handouts, etc.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

2. Teacher uses "electronic mail" or network to comunicate with other science teachers, or to access science related information from other sources.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

3. Teacher uses a computer data base to keep an inventory of science equipment, supplies, references, audio-visual materials, etc.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

4. Teacher uses a marks management program or spreadsheet to maintain student achievement and/or attendance records

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

5. Teacher uses computer simulations to demonstrate experiments, environments, or phenomena.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

6. Teacher uses computer-laboratory interface device(s) to control experiments, and/or to collect data during a classroom demonstration.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

7. Teacher demonstrates use of computer to record data and/or carry out calculations related to experiments or problems.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

8. Teacher writes computer programs for use by self or students as part of a science lesson.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

II. Student use of computers during senior high science instruction:

1. Students are required to use a computer to complete written assignments.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

2. Students use a data base (on disk, or accessible via modem/terminal) to locate information related specifically to their science lesson.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

3. Students use computer simulations of experiments, environments, or phenomena as part of a science lesson.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

4. Students use scientific computer "game" programs as part of a science lesson.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

5. Students use computer "drill & practice" programs as part of a science lesson.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

6. Students use computer "tutorial" programs on new or review information as part of a science lesson.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

7. Students use computer-laboratory interface device(s) to control experiments and/or to collect data during an experiment.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

8. Students use computers to record data and/or carry out calculations related to experiments or assigned problems.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

9. Students write own computer programs to solve specific questions related to experiments or assigned problems.

never	rarely	occasionally	frequently	regularly
0	1	2	3	4

III. Please describe any other ways in which you or your students use microcomputers as a part of your senior high school science program.

____

____

____

____

____

Part D - Teacher Opinion Profile: Please answer the following questions concerning _your_ opinion about computer applications in the instruction of _senior high school science_. Please use the following five point scale in response to each question:

SD - strongly disagree D - disagree N - no opinion A - agree SA - strongly agree

1. Students should use computers in high school science classes as part of their preparation for living and working in a technological world.

SD D N A SA

2. Extensive use of computers enhances greatly what topics can be taught in a high school science course.

SD D N A SA

3. The difficulties involved in using computers in science teaching outweigh any possible benefits of such use.

SD D N A SA

4. The use of computers by students tends to reduce their ability to develop independent thinking and problem solving skills.

SD D N A SA

5. The use of computers in high school science instruction increases opportunities for the individualization of instruction.

SD D N A SA

6. The use of "tutorial" and "drill & practice" computer programs greatly aids students in the acquisition and retention of science concepts.

SD D N A SA

7. The use of computers in the high school science classroom reduces the amount of time spent on practical laboratory, research, or field work.

SD D N A SA

8. The use of computers in high school science instruction increases students' interest in learning science.

SD D N A SA

9. The use of computer-laboratory interface devices greatly enhances the possible benefit students can derive from experiments and demonstrations.

SD D N A SA

10. The use of computers in high school science aids students in the development of logical reasoning skills.

SD D N A SA

11. School districts encourage science teachers to integrate the use of computers into their high school science programs.

SD D N A SA

12. There is sufficient good quality software available for use in the instruction of high school science.

SD D N A SA

13. Computer simulations provide students with good alternatives to laboratory and field studies.

SD D N A SA

14. The use of computers in science instruction helps students develop independent learning skills.

SD D N A SA

15. Teachers require better training in order to be able to make beneficial use of computers in high school science instruction.

SD D N A SA

16. The use of computers in the high school science classrocm distracts from the primary purposes of science instruction.

SD D N A SA

17. It is relatively easy to integrate computer use into many aspects of the high school science program.

SD D N A SA

18. There is good organizational support for teachers who wish to use computers in their high school science program.

SD D N A SA

19. Computers facilitate the effective use of teaching time and resources.

SD D N A SA

20. Computer use in high school science instruction emphasizes rote learning and dogmatic thinking.

SD D N A SA

21. Teachers who make use of computers in their classes encourage others to do the same.

SD D N A SA

22. The use of computers in the science class greatly aids students in the development of scientific process skills.

SD D N A SA

23. Workshops and courses on the effective use of computers in high school science are readily available.

SD D N A SA

24. Limited access to computers greatly restricts any advantage that might be gained by computer use in science instruction.

SD D N A SA

25. Science class time can be used more effectively in ways other than having students using computers.

SD D N A SA

26. Computer programs and simulations give students a poor understanding of the true nature of science.

SD D N A SA

27. Computers greatly assist students in their ability to solve problems and organize information.

SD D N A SA

28. The use of computers in the high school science classroom disrupts classroom routines and discipline.

SD D N A SA

29. Available computer programs for science instruction are not directly applicable to the Alberta high school science curricula.

SD D N A SA

30. Money spent on computer software for high school science instruction could be much better spent on other resources, supplies, or equipment.

SD D N A SA

Additional Comments:

APPENDIX 3

page

D. Orr
SS 1 - 2 - 94
Lethbridge, Alberta
T1J 4B3
May 22, 1990

Dr./Ms./Mr.
Superintendent of Schools

Dear

As part of the requirement for a Master of Education degree at the University of Lethbridge, I am conducting research into the use of microcomputers in senior high school science instruction. A portion of this research involves a survey of senior high school science teachers to identify what computer hardware and software is available to science teachers, the way in which they make use of computer equipment, and some opinions concerning applications of computer technology in senior high school science instruction. Additionally, I will be interviewing a few of the respondents to determine some of the reasons why they do or do not use computers in certain ways in their classes.

Dr. Frank Sovka has contacted your district and has received permission to conduct this study. I would therefore like to contact the principals at the following schools in your school district, and ask them to distribute these surveys to their senior high science teachers. Unless I hear otherwise from Dr. Sovka or your office, I would hope there is no objection to the distribution of these surveys to the schools listed below. I plan to conduct this survey before the end of June in order that I may conclude my research before the end of the school year.

Please find enclosed a copy of the survey I wish to use, and the covering letters which will accompany them to the schools. If you have any concerns, or require further information about this project, please contact me at school (345-3383) or at home (328-3617), Dr. R. Mrazek (Faculty Supervisor) at 329-2452 or Dr. David Townsend (Chairperson, Faculty Research Ethics Committee) at 329-2731.

Thank you for your assistance with my research project.

Sincerely,

Douglas Orr

D. Orr
SS 1 - 2 - 94
Lethbridge, Alberta
T1J 4B3
May 22, 1990

Ms./Mr.
Principal

Dear :

As part of the requirement for a Master of Education degree at the University of Lethbridge, I am conducting research into the use of microcomputers in senior high school science instruction. A portion of this research involves a survey of senior high school science teachers to identify what computer hardware and software is available to science teachers, the way in which they make use of computer equipment, and some opinions concerning applications of computer technology in senior high school science instruction. Additionally, I will be interviewing a few of the respondents to determine some of the reasons why they do or do not use computers in certain ways in their classes.

As you may be aware, your central office has allowed me to contact you to ask that you distribute the enclosed survey questionnaires to each member of your staff who teaches any senior high science courses in your school. Each survey includes a stamped, addressed envelope for return, so you need not worry about collecting or returning these forms. Your assistance is required only in ensuring that each high school science teacher receives a survey form. Additionally, I will be contacting a few of the respondents who agree to be interviewed, in order to elicit some further information concerning computer uses in senior high school science classes.

Thank you for your assistance with my research. If you have any questions or concerns about this project, please contact me at school (345-3383), home (328-3617), Dr. R. Mrazek (Faculty Supervisor) at 329-2452 or Dr. David Townsend (Chairperson, Faculty Research Ethics Committee) at 329-2731).

Sincerely,

Douglas Orr
Encls.

D. Orr
SS 1 - 2 - 94
Lethbridge, Alberta
T1J 4B3
May 22, 1990

Dear Colleague:

As part of the requirement for a Master of Education degree at the University of Lethbridge, I am conducting research into the use of microcomputers in senior high school science instruction. A portion of this research involves a survey of senior high school science teachers to identify what computer hardware and software is available to science teachers, the way in which they make use of computer equipment, and some opinions concerning applications of computer technology in senior high school science instruction. Additionally, I will be interviewing a few of the respondents to determine some of the reasons why they do or do not use computers in certain ways in their classes.

The enclosed survey should not take more than a few minutes of your time to complete. It asks a few simple questions about your background with computers, the facilities available to you at your school, how you do or do not use computers in your senior high science classes, and your opinions about computer applications in senior high science classes, and your opinions about computer applications in senior high science instruction. I appreciate you taking the time to complete this survey and returning it to me in the envelope provided. All responses will be kept confidential, and your responses will be strictly anonymous, even if you agree to a further interview.

You are under no obligation to participate in this study. If you do not wish to be contacted further but are willing to take part in the first part of this study, just complete the survey and return it to me. However, as a follow-up to this survey I need to identify a few teachers who do or do not use computers in certain ways, and conduct a few short interviews with them to complete my research. If you would be willing to take part in a follow-up interview, please complete the form on the bottom of this page and return it with your survey in the same envelope. I will only be actually interviewing a very few of the respondents who volunteer, but I don't know who they will be until I have the results from the surveys. If you have any concerns or questions about this survey, please call me at school (345-3383), home (328-3617), Dr. R. Mrazek (Faculty Supervisor) at 329-2452 or Dr. David Townsend (Chairperson, Faculty Research Ethics Committee) at 329-2731.

Sincerely,

Douglas Orr
Encls.

OPTIONAL - Identification Information - Follow-up Interview
(If you would be willing to participate in a short follow-up interview at your convenience, please complete this information and return it with your survey. Only a few such interviews will actually be conducted.)

Name:____

School:____

SS - 1 - 2 - 94
Lethbridge, AB
T1J 4B3
1990 06 15

Senior High Science Department
High School

Dear Colleagues;

A few weeks ago, I sent out to your school some short questionnaires concerning the use of micro-computers in senior high school science instruction. If you have already completed and returned your questionnaire to me, thank you for taking the time to assist me with my research project.

If you have not yet had a chance to complete this short survey, I would greatly appreciate if you could find a few minutes before the end of the school term to complete the questionnaire and return it to me. (If your desk is like mine; you'll probably find it buried under a pile of labs to be marked, attendance forms to complete, memos from the office to ignore, and exams to be made-up.)

As I am attempting to complete my research by the end of the summer holidays, I appreciate you taking a few minutes during this hectic time to complete and return my survey.

Thank you.

Sincerely,

Douglas Orr

APPENDIX 4

Computer Use in Science - Interview Format

1. Introduction
    a. description of study and purpose
    b. nature and purpose of interview
    c. format and guidelines for interview
    d. discussion of general concerns

2. Teacher Profile
    a. teaching background, training and experience
    b. knowledge of, familiarity and comfort with computers
    c. familiarity with computer applications in education
    d. familiarity with educational software
    e. "problems" with background wrt. computers - solutions

3. Access Profile
    a. resources available
    b. "problems" with access/acquisition - solutions
    c. access to specific "needs"
    d. support/assistance available/needed

4. Implementational Profile
    a. actual uses - reasons
    b. desired uses - reasons
    c. difficulties, benefits, problems. solutions
    d. support systems/limitations
    e. innovatory/implementational processes and agents

5. Attitudes
    a. effect on teaching/learning
    b. educational/pedegogical concerns
    c. benefits/detriments
    d. ideals/goals wrt. computer uses
    e. implementational supports/problems/contexts

APPENDIX 5

page

Demographic Descriptors: que #

	A:2(a)	A:2(b)	A:3	A:4(a)	A:4(b)	B:1	B:2	B:3
	years teaching:		years	comp courses:		comp access:		
survey #	total	sr sci	univ	univ	tech	class	port	avail
4	13	1	5	1				30
5	2	2	4	1	1			15
13	22	6	5	1		1	1	21
16	7	6	5	4				20
17	6	6	4	2			1	24
18	16	16	5					25
22	25	3	6	1				20
23	22	3	4	1	1			14
26	14	8	5			1		30
32	4	4	6	2		1	3	30
38	27	27	5		2	1	3	
48	5	5	5	2				
49	4	2	5	2				30
52	26	24	4		1		1	20
53	12	12	5			1	5	25
57	20	10	5	2				10
58	12	10	4				1	25
60	12	3	5	1			2	24
63	35	28	4				1	12
64	22	12	5				12	14
68	2	2	5	5			1	20
71	18	18	4	2		12	4	6
72	n/a	n/a	n/a					n/a
74	26	21	6					12
75	23	20	4					20
81	11	5	5				1	25
82	25	25	6	2	2	1	2	2
87	1	1	4	1				n/a
88	18	18	6	2				20
96	18	17	5	1				
97	21	21	5		1			20
101	6	5	5	1				20
104	29	29	5					20
105	11	5	6				n/a	30
106	25	5	6			1	1	many
107	10	10	4	1				30
108	30	20	6				3	60
110	5	4	4	1		1	10	20
114	22	15	4				4	14
116	11	11	4				2	16
119	3	3	6	3			1	10
122	24	24	5				10	60
125	5	5	6	3			1	n/a
126	17	17	7					24
133	18	18	6			1	3	15
N=45			total:	23	6	10	23	38
			percent:	51	13	22	51	84
average:	16	12	5	2	1	2	3	22

Demographic Tally: que #

N=45 // — 1 subjects taught: — 5 # of — 6 comp — 7(a) 7(b) 7(c) 7(d) comp courses taught:

survey #	Sci	Bio	Chem	Phys	wkshp	home	stdnt	tchr	conf	p-sec
4		1			1			1		
5	1	1	1	1	1					
13	1	1	1		1	1	1			
16	1				1	1				
17		1			1		1			
18			1	1	1	1				
22	1				1					
23				1	1	1	1	1		
26		1			1	1	1	1		
32		1	1	1	1	1				
38			1		1	1				
48		1	1							
49	1	1	1		1		1			
52				1	1		1			
53		1	1		1					
57				1	1	1				
58	1		1	1	1	1				
60		1			10	1	1	1	1	
63			1		1	1	1			
64	1	1	1	1	1	1	1			
68				1	1	1		1	1	
71			1	1	1	1	1		1	
72			1							
74			1	1	1	1				
75	1	1			1					
81	1	1	1	1	1	1				
82				1	1	1	1	1		
87	1		1		1		1			
88				1	1		1			
96		1			1	1				
97				1			1			
101		1	1							
104			1		1					
105		1	1			1				
106		1								
107		1		1	1		1			
108	1				1	1				
110	1	1	1	1	1		1			
114			1		1	1				
116		1	1		10	1	1	1		
119	1	1	1	1	1		1			
122		1				1				
125		1	1		1					
126		1	1	1	1	1				
133	1		1	1						
total:	14	24	26	20	37	24	18	7		

1 2

percent:	82	53	40	16

2 4

78
4

Access Tally que #	4			5				6(a)	6(b)
N=45 //	peripheral devices:			external access:				program source	
survey #	prntr	mdm	lab	m/m	mail	info	dbse	own	schl
4	1			1	1	1			10
5	1				1				
13	1	1			1	1	1		n/a
16	1				1	1			
17	1			1	1	1	1		
18	1	1		1	1	1	1	6	
22	1				1	1		1	
23	1			1	1	1			2
26	1	1				1		5	
32	1				1	1			3
38	1								3
48								1	1
49	1								
52	1	1				1		3	n/a
53	1	1			1	1	1		
57	1		1						
58	1		1						6
60	1		1					3	1
63	1								3
64	1							5	1
68	1								2
71	1								2
72									
74									
75		1							
81	1	1					1		
82	1			1	1	1	1		8
87		1		1					
88	1	1						2	n/a
96									3
97	1	1		1	1				
101	1			n/a	n/a	n/a	n/a		n/a
104						1			
105	1								10
106	1	n/a	n/a	n/a	n/a	n/a	n/a		n/a
107	1							3	5
108	1			1				1	60
110	1	1	1	1	1	1	1		15
114	1	1				1			2
116	1	1			1				3
119	1								5
122									
125	1				1			2	5
126	1								4
133	1								2
total:	37	13	4	9	15	15	7	11	23
percent:	82	29	9	20	33	33	16	24	51
							average:	3	7

Knowledge Eval: Section A: que #

Survey #	8 (a) ops	8 (b) prog	8 (c) eval	8 (d) app	average	Sec A order
004	3.00	2.00	3.00	3.00	2.75	38.00
005	2.00	1.00	3.00	3.00	2.25	31.00
013	2.00	1.00	0.00	2.00	1.25	14.00
016	3.00	2.00	2.00	2.00	2.25	31.00
017	3.00	3.00	3.00	2.00	2.75	38.00
018	2.00	2.00	3.00	2.00	2.25	31.00
022	3.00	1.00	2.00	1.00	1.75	20.50
023	3.00	3.00	3.00	3.00	3.00	41.00
026	4.00	0.00	3.00	3.00	2.50	35.50
032	2.00	2.00	3.00	3.00	2.50	35.50
038	1.00	1.00	2.00	2.00	1.50	17.50
048	1.00	0.00	2.00	2.00	1.25	14.00
049	2.00	2.00	2.00	2.00	2.00	25.00
052	3.00	3.00	1.00	2.00	2.25	31.00
053	0.00	0.00	2.00	2.00	1.00	10.00
057	1.00	0.00	2.00	1.00	1.00	10.00
058	1.00	0.00	3.00	2.00	1.50	17.50
060	4.00	4.00	4.00	4.00	4.00	45.00
063	2.00	2.00	2.00	2.00	2.00	25.00
064	4.00	4.00	2.00	2.00	3.00	41.00
068	4.00	3.00	3.00	2.00	3.00	41.00
071	2.00	1.00	2.00	2.00	1.75	20.50
072	0.00	0.00	0.00	0.00	0.00	2.50
074	1.00	0.00	0.00	1.00	.50	6.00
075	0.00	0.00	0.00	0.00	0.00	2.50
081	2.00	4.00	3.00	2.00	2.75	38.00
082	3.00	3.00	4.00	3.00	3.25	43.00
087	1.00	1.00	1.00	2.00	1.25	14.00
088	2.00	2.00	3.00	2.00	2.25	31.00
096	2.00	0.00	0.00	0.00	.50	6.00
097	3.00	0.00	0.00	2.00	1.25	14.00
101	1.00	0.00	1.00	1.00	.75	8.00
104	0.00	0.00	0.00	0.00	0.00	2.50
105	1.00	1.00	1.00	1.00	1.00	10.00
106	2.00	0.00	0.00	0.00	.50	6.00
107	2.00	2.00	2.00	2.00	2.00	25.00
108	2.00	0.00	3.00	2.00	1.75	20.50
110	1.00	3.00	2.00	3.00	2.25	31.00
114	1.00	1.00	2.00	3.00	1.75	20.50
116	4.00	4.00	3.00	3.00	3.50	44.00
119	2.00	1.00	3.00	3.00	2.25	31.00
122	0.00	0.00	0.00	0.00	0.00	2.50
125	2.00	1.00	3.00	2.00	2.00	25.00
126	2.00	0.00	3.00	3.00	2.00	25.00
133	0.00	0.00	3.00	2.00	1.25	14.00
N = 45 //	1.91	1.33	1.98	1.91	1.78	

Comp. Use Survey #	// Section C I: (teacher use) que # // 1 prep	2 mail	3 d.bse	4 marks	5 sim	6 lab	7 calc	8 prog
004	3.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
005	4.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
013	3.00	1.00	3.00	4.00	0.00	0.00	0.00	0.00
016	4.00	0.00	2.00	4.00	0.00	0.00	0.00	0.00
017	2.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
018	4.00	3.00	0.00	4.00	0.00	0.00	0.00	0.00
022	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
023	4.00	0.00	0.00	4.00	1.00	0.00	0.00	0.00
026	4.00	2.00	1.00	4.00	2.00	2.00	2.00	0.00
032	4.00	1.00	2.00	4.00	2.00	1.00	2.00	0.00
038	0.00	0.00	0.00	4.00	1.00	0.00	0.00	0.00
048	4.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
049	4.00	0.00	2.00	4.00	0.00	2.00	1.00	1.00
052	3.00	0.00	0.00	4.00	2.00	2.00	0.00	0.00
053	3.00	0.00	3.00	4.00	1.00	0.00	0.00	0.00
057	4.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
058	4.00	0.00	0.00	4.00	1.00	1.00	0.00	0.00
060	4.00	0.00	0.00	4.00	2.00	0.00	0.00	3.00
063	1.00	0.00	0.00	4.00	2.00	0.00	2.00	1.00
064	4.00	0.00	2.00	1.00	1.00	0.00	1.00	1.00
068	2.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00
071	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
072	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
074	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
075	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
081	4.00	0.00	2.00	4.00	0.00	0.00	0.00	0.00
082	4.00	1.00	2.00	4.00	2.00	0.00	1.00	2.00
087	3.00	1.00	0.00	4.00	0.00	0.00	0.00	0.00
088	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
096	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
097	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101	2.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
104	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00
105	3.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
106	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
107	0.00	0.00	0.00	4.00	1.00	0.00	0.00	0.00
108	3.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
110	4.00	0.00	2.00	4.00	2.00	2.00	0.00	0.00
114	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
116	1.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00
119	2.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
122	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	1.00	0.00	0.00	4.00	1.00	0.00	0.00	0.00
126	4.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00
133	2.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00
N = 45 //	2.29	.24	.51	2.56	.49	.22	.22	.18

Comp. Use Survey #	// Section C II: (student use) que # // 1 assgn	2 d.bse	3 sim	4 game	5 drill	6 tut	7 lab	8 calc	9 prog
004	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
005	4.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00
013	1.00	1.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00
016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
017	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
018	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
022	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
023	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00
026	2.00	2.00	1.00	0.00	2.00	2.00	0.00	1.00	0.00
032	2.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	0.00
038	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
048	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
049	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
052	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00
053	0.00	2.00	0.00	0.00	2.00	1.00	0.00	0.00	1.00
057	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
058	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
060	0.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00	0.00
063	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00
064	2.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	0.00
068	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
071	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
072	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
074	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
075	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
081	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
082	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00
087	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
088	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
096	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
097	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
106	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
107	0.00	1.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00
108	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
110	0.00	0.00	2.00	0.00	0.00	1.00	2.00	0.00	0.00
114	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
116	2.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
119	1.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00	0.00
122	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	0.00	0.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00
126	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
133	0.00	0.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00
N = 45 //	.62	.22	.33	.20	.36	.29	.11	.16	.07

Comp. Use Survey #	C I: average	C II average	sec. C: average	Sec CI order	Sec CII order	Sec C order
004	.88	.11	.47	24.50	21.00	23.50
005	.62	.67	.65	17.50	41.00	32.00
013	1.38	.44	.88	37.50	36.50	38.50
016	1.25	0.00	.59	33.00	9.50	28.00
017	.50	.22	.35	14.50	26.50	14.00
018	1.38	.11	.71	37.50	21.00	34.50
022	.25	.33	.29	10.50	32.00	12.50
023	1.12	.22	.65	30.00	26.50	32.00
026	2.12	1.11	1.59	45.00	43.50	45.00
032	2.00	1.11	1.53	43.50	43.50	44.00
038	.62	0.00	.29	17.50	9.50	12.50
048	1.00	.33	.65	28.00	32.00	32.00
049	1.75	1.22	1.47	41.00	45.00	43.00
052	1.38	.22	.76	37.50	26.50	36.50
053	1.38	.67	1.00	37.50	26.50	36.50
057	1.00	0.00	.47	28.00	9.50	23.50
058	1.25	0.00	.59	33.00	9.50	28.00
060	1.62	.33	.94	40.00	32.00	40.00
063	1.25	.22	.71	33.00	26.50	34.50
064	1.25	.56	.88	33.00	39.50	38.50
068	.62	.22	.41	17.50	26.50	18.00
071	.12	.11	.12	9.00	21.00	9.00
072	0.00	0.00	0.00	4.50	9.50	4.50
074	0.00	0.00	0.00	4.50	9.50	4.50
075	0.00	0.00	0.00	4.50	9.50	4.50
081	1.25	0.00	.59	33.00	9.50	28.00
082	2.00	.78	1.35	43.50	42.00	42.00
087	1.00	0.00	.47	28.00	9.50	23.50
088	0.00	0.00	0.00	4.50	9.50	4.50
096	0.00	0.00	0.00	4.50	9.50	4.50
097	0.00	0.00	0.00	4.50	9.50	4.50
101	.75	.11	.41	21.00	21.00	18.00
104	.25	.11	.18	10.50	21.00	10.50
105	.88	0.00	.41	24.50	9.50	18.00
106	0.00	0.00	0.00	4.50	9.50	4.50
107	.62	.33	.47	17.50	32.00	23.50
108	.88	0.00	.41	24.50	9.50	18.00
110	1.75	.56	1.12	42.00	39.50	41.00
114	.38	0.00	.18	12.50	9.50	10.50
116	.50	.33	.41	14.50	32.00	18.00
119	.38	.44	.41	12.50	36.50	18.00
122	0.00	0.00	0.00	4.50	9.50	4.50
125	.75	.44	.59	21.00	36.50	28.00
126	.88	0.00	.41	24.50	9.50	18.00
133	.75	.44	.59	21.00	36.50	28.00
N = 45 //	.84	.26	.53			

Section D: <u>RESPONSE VALUE ASSIGNMENT</u>

SD - strongly disagree D - disagree N - no opinion A - agree SA - strongly agree

1. Students should use computers in high school science classes as part of their preparation for living and working in a technological world.

SD	D	N	A	SA
-2	-1	0	+1	+2

2. Extensive use of computers enhances greatly what topics can be taught in a high school science course.

SD	D	N	A	SA
-2	-1	0	+1	+2

3. The difficulties involved in using computers in science teaching outweigh any possible benefits of such use.

SD	D	N	A	SA
+2	+1	0	-1	-2

4. The use of computers by students tends to reduce their ability to develop independent thinking and problem solving skills.

SD	D	N	A	SA
+2	+1	0	-1	-2

5. The use of computers in high school science instruction increases opportunities for the individualization of instruction.

SD	D	N	A	SA
-2	-1	0	+1	+2

6. The use of "tutorial" and "drill & practice" computer programs greatly aids students in the acquisition and retention of science concepts.

SD	D	N	A	SA
-2	-1	0	+1	+2

7. The use of computers in the high school science classroom reduces the amount of time spent on practical laboratory, research, or field work.

SD	D	N	A	SA
+2	+1	0	-1	-2

8. The use of computers in high school science instruction increases students' interest in learning science.

SD	D	N	A	SA
-2	-1	0	+1	+2

9. The use of computer-laboratory interface devices greatly enhances the possible benefit students can derive from experiments and demonstrations.

SD	D	N	A	SA
-2	-1	0	+1	+2

10. The use of computers in high school science aids students in the development of logical reasoning skills.

SD	D	N	A	SA
-2	-1	0	+1	+2

11. School districts encourage science teachers to integrate the use of computers into their high school science programs.

SD	D	N	A	SA
-2	-1	0	+1	+2

12. There is sufficient good quality software available for use in the instruction of high school science.

SD	D	N	A	SA
-2	-1	0	+1	+2

13. Computer simulations provide students with good alternatives to laboratory and field studies.

SD	D	N	A	SA

14. The use of computers in science instruction helps students develop independent learning skills.

SD	D	N	A	SA
-2	-1	0	+1	+2

15. Teachers require better training in order to be able to make beneficial use of computers in high school science instruction.

SD	D	N	A	SA
+2	+1	0	-1	-2

16. The use of computers in the high school science classroom distracts from the primary purposes of science instruction.

SD	D	N	A	SA
+2	+1	0	-1	-2

17. It is relatively easy to integrate computer use into many aspects of the high school science program.

SD	D	N	A	SA
-2	-1	0	+1	+2

18. There is good organizational support for teachers who wish to use computers in their high school science program.

SD	D	N	A	SA
-2	-1	0	+1	+2

19. Computers facilitate the effective use of teaching time and resources.

SD	D	N	A	SA
-2	-1	0	+1	+2

20. Computer use in high school science instruction emphasizes rote learning and dogmatic thinking.

SD	D	N	A	SA
+2	+1	0	-1	-2

21. Teachers who make use of computers in their classes encourage others to do the same.

SD	D	N	A	SA
-2	-1	0	+1	+2

22. The use of computers in the science class greatly aids students in the development of scientific process skills.

SD	D	N	A	SA
-2	-1	0	+1	+2

23. Workshops and courses on the effective use of computers in high school science are readily available.

SD	D	N	A	SA
-2	-1	0	+1	+2

24. Limited access to computers greatly restricts any advantage that might be gained by computer use in science instruction.

SD	D	N	A	SA
+2	+1	0	-1	-2

25. Science class time can be used more effectively in ways other than having students using computers.

SD	D	N	A	SA
+2	+1	0	-1	-2

26. Computer programs and simulations give students a poor understanding of the true nature of science.

SD	D	N	A	SA
+2	+1	0	-1	-2

27. Computers greatly assist students in their ability to solve problems and organize information.

SD	D	N	A	SA
-2	-1	0	+1	+2

28. The use of computers in the high school science classroom disrupts classroom routines and discipline.

SD	D	N	A	SA
+2	+1	0	-1	-2

29. Available computer programs for science instruction are not directly applicable to the Alberta high school science curricula.

SD	D	N	A	SA
+2	+1	0	-1	-2

30. Money spent on computer software for high school science instruction could be much better spent on other resources, supplies, or equipment.

SD	D	N	A	SA
+2	+1	0	-1	-1

Attitudes: Section D: que #

Survey #	1	2	3	4	5	6	7	8	9
004	1.00	1.00	1.00	1.00	1.00	1.00	-1.00	1.00	0.00
005	2.00	2.00	2.00	1.00	1.00	2.00	1.00	1.00	1.00
013	1.00	-1.00	-1.00	0.00	0.00	1.00	-2.00	0.00	1.00
016	1.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
017	1.00	0.00	1.00	1.00	0.00	0.00	-1.00	0.00	0.00
018	1.00	1.00	1.00	2.00	-1.00	1.00	1.00	1.00	0.00
022	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00
023	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
026	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	0.00
032	2.00	-1.00	1.00	1.00	1.00	-1.00	1.00	1.00	1.00
038	0.00	0.00	-1.00	0.00	1.00	1.00	0.00	0.00	0.00
048	1.00	-1.00	1.00	1.00	1.00	1.00	0.00	0.00	1.00
049	1.00	1.00	0.00	1.00	1.00	1.00	-1.00	1.00	1.00
052	1.00	1.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00
053	1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
057	1.00	1.00	0.00	1.00	0.00	1.00	-1.00	1.00	1.00
058	1.00	1.00	1.00	2.00	1.00	0.00	0.00	1.00	1.00
060	2.00	1.00	2.00	2.00	2.00	2.00	1.00	2.00	1.00
063	1.00	-1.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00
064	1.00	1.00	0.00	2.00	1.00	1.00	0.00	1.00	2.00
068	1.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00
071	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
072	1.00	1.00	-1.00	1.00	1.00	1.00	0.00	1.00	1.00
074	1.00	0.00	-1.00	1.00	2.00	2.00	1.00	0.00	1.00
075	0.00	-1.00	-1.00	0.00	1.00	0.00	0.00	0.00	0.00
081	0.00	-1.00	-1.00	2.00	1.00	1.00	0.00	-1.00	-1.00
082	1.00	1.00	-1.00	0.00	1.00	0.00	1.00	1.00	1.00
087	1.00	1.00	-1.00	1.00	1.00	2.00	-1.00	1.00	1.00
088	1.00	0.00	0.00	2.00	1.00	0.00	1.00	1.00	1.00
096	-1.00	-2.00	1.00	-1.00	-1.00	0.00	2.00	-1.00	0.00
097	1.00	0.00	1.00	0.00	1.00	1.00	-1.00	0.00	1.00
101	1.00	0.00	1.00	1.00	1.00	0.00	-1.00	0.00	0.00
104	1.00	0.00	0.00	1.00	0.00	2.00	0.00	0.00	0.00
105	1.00	0.00	0.00	2.00	1.00	0.00	1.00	0.00	0.00
106	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
107	1.00	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00
108	2.00	2.00	2.00	2.00	2.00	2.00	0.00	2.00	2.00
110	0.00	-1.00	0.00	0.00	1.00	-2.00	0.00	-1.00	1.00
114	1.00	-2.00	1.00	1.00	1.00	1.00	-2.00	1.00	1.00
116	1.00	1.00	2.00	2.00	2.00	1.00	0.00	1.00	0.00
119	1.00	1.00	1.00	1.00	1.00	-1.00	0.00	1.00	2.00
122	-1.00	-1.00	0.00	0.00	1.00	0.00	-1.00	-1.00	1.00
125	2.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00	0.00
126	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
133	1.00	1.00	1.00	0.00	1.00	2.00	0.00	0.00	0.00
N=45//	.91	.27	.47	.89	.78	.69	.04	.53	.60

Attitudes Survey #	10	11	12	13	14	15	16	17	18
004	1.00	0.00	0.00	1.00	1.00	-1.00	1.00	0.00	0.00
005	1.00	-1.00	0.00	2.00	1.00	1.00	1.00	2.00	-2.00
013	0.00	-2.00	0.00	-1.00	1.00	-1.00	1.00	-1.00	0.00
016	0.00	-2.00	0.00	0.00	0.00	-2.00	1.00	0.00	-1.00
017	0.00	-1.00	-1.00	-1.00	0.00	-1.00	0.00	0.00	-1.00
018	1.00	0.00	-2.00	1.00	1.00	-1.00	2.00	1.00	0.00
022	0.00	0.00	0.00	0.00	0.00	-1.00	0.00	1.00	0.00
023	1.00	-2.00	-2.00	1.00	1.00	-2.00	2.00	0.00	-2.00
026	1.00	1.00	-1.00	1.00	1.00	-2.00	2.00	-1.00	-1.00
032	1.00	-1.00	-1.00	-1.00	1.00	-1.00	1.00	1.00	-1.00
038	0.00	-1.00	-1.00	1.00	0.00	-2.00	0.00	-1.00	-1.00
048	1.00	-1.00	0.00	1.00	1.00	-1.00	1.00	1.00	-1.00
049	0.00	0.00	0.00	-2.00	-1.00	1.00	-1.00	1.00	0.00
052	1.00	-1.00	0.00	1.00	1.00	-2.00	1.00	-1.00	1.00
053	1.00	-2.00	0.00	1.00	1.00	-2.00	1.00	0.00	-2.00
057	0.00	-1.00	-1.00	1.00	0.00	-2.00	0.00	-1.00	-2.00
058	1.00	-2.00	-2.00	1.00	1.00	-2.00	2.00	-1.00	-1.00
060	1.00	-2.00	-2.00	1.00	1.00	-1.00	2.00	1.00	-2.00
063	0.00	-2.00	-1.00	-1.00	0.00	-2.00	1.00	1.00	-1.00
064	1.00	-1.00	-2.00	0.00	1.00	1.00	1.00	-2.00	-2.00
068	1.00	-1.00	0.00	1.00	0.00	0.00	1.00	1.00	-1.00
071	1.00	0.00	1.00	1.00	1.00	-1.00	0.00	1.00	0.00
072	1.00	-1.00	0.00	1.00	1.00	-2.00	1.00	1.00	-1.00
074	0.00	-2.00	-1.00	1.00	1.00	-2.00	1.00	-2.00	-2.00
075	0.00	-2.00	-1.00	-1.00	0.00	-2.00	-1.00	0.00	-2.00
081	0.00	-2.00	0.00	1.00	1.00	-2.00	-1.00	-1.00	-1.00
082	1.00	-1.00	-2.00	1.00	1.00	0.00	2.00	1.00	-1.00
087	1.00	0.00	-1.00	1.00	1.00	-2.00	1.00	0.00	-1.00
088	0.00	-1.00	1.00	1.00	1.00	-1.00	1.00	-1.00	-1.00
096	-2.00	-1.00	0.00	-2.00	-1.00	-1.00	0.00	0.00	-1.00
097	-1.00	-1.00	0.00	1.00	1.00	-2.00	1.00	-1.00	-2.00
101	1.00	0.00	0.00	1.00	0.00	-2.00	1.00	0.00	0.00
104	0.00	-2.00	-2.00	1.00	0.00	-2.00	0.00	0.00	-1.00
105	1.00	-1.00	0.00	1.00	0.00	-1.00	1.00	0.00	-2.00
106	1.00	-1.00	0.00	0.00	0.00	-1.00	0.00	0.00	0.00
107	1.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00
108	2.00	-2.00	1.00	2.00	0.00	-2.00	1.00	-2.00	-2.00
110	-1.00	1.00	-2.00	1.00	1.00	1.00	0.00	1.00	-1.00
114	1.00	-1.00	0.00	1.00	1.00	-2.00	1.00	0.00	-1.00
116	1.00	0.00	0.00	1.00	1.00	-2.00	1.00	0.00	0.00
119	1.00	-1.00	-1.00	1.00	1.00	-1.00	1.00	0.00	-1.00
122	1.00	0.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00
125	0.00	-1.00	0.00	1.00	1.00	-2.00	1.00	0.00	-1.00
126	0.00	0.00	0.00	0.00	0.00	0.00	1.00	-1.00	0.00
133	0.00	-2.00	-2.00	2.00	0.00	-2.00	0.00	-2.00	-2.00
N = 45 //	.51	-.96	-.58	.60	.58	-1.22	.73	-.11	-.98

Attitudes Survey #	19	20	21	22	23	24	25	26	27
004	2.00	1.00	1.00	0.00	-1.00	1.00	1.00	1.00	1.00
005	2.00	2.00	1.00	2.00	-2.00	-2.00	1.00	1.00	2.00
013	0.00	0.00	0.00	1.00	-1.00	-1.00	-1.00	1.00	1.00
016	2.00	0.00	-1.00	0.00	-2.00	-2.00	0.00	-1.00	0.00
017	1.00	0.00	1.00	0.00	-1.00	1.00	0.00	0.00	1.00
018	1.00	1.00	1.00	0.00	-2.00	-1.00	-1.00	1.00	1.00
022	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
023	1.00	1.00	-2.00	1.00	-2.00	1.00	1.00	1.00	1.00
026	1.00	2.00	1.00	1.00	-1.00	1.00	2.00	-1.00	2.00
032	1.00	1.00	1.00	1.00	-1.00	1.00	0.00	0.00	1.00
038	0.00	0.00	0.00	0.00	-1.00	-1.00	0.00	0.00	0.00
048	0.00	0.00	0.00	1.00	-1.00	-1.00	1.00	1.00	1.00
049	1.00	0.00	0.00	0.00	-1.00	-1.00	-1.00	0.00	-1.00
052	0.00	1.00	0.00	1.00	-1.00	1.00	0.00	1.00	1.00
053	1.00	2.00	1.00	1.00	-1.00	-1.00	1.00	1.00	1.00
057	1.00	0.00	0.00	0.00	-1.00	-1.00	0.00	1.00	0.00
058	-1.00	1.00	1.00	1.00	-1.00	-1.00	0.00	1.00	0.00
060	1.00	2.00	1.00	0.00	-2.00	-2.00	0.00	2.00	1.00
063	1.00	1.00	1.00	1.00	-1.00	1.00	1.00	1.00	0.00
064	1.00	1.00	0.00	0.00	-1.00	-1.00	1.00	2.00	1.00
068	1.00	1.00	1.00	0.00	-1.00	-2.00	0.00	1.00	1.00
071	0.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	1.00	0.00
072	1.00	1.00	1.00	1.00	-2.00	-1.00	-1.00	1.00	1.00
074	0.00	1.00	-1.00	-1.00	-2.00	-2.00	1.00	1.00	1.00
075	-1.00	0.00	0.00	-1.00	-2.00	-2.00	-1.00	-1.00	1.00
081	-2.00	1.00	1.00	0.00	-1.00	-2.00	-1.00	1.00	1.00
082	1.00	1.00	1.00	2.00	-1.00	1.00	1.00	1.00	1.00
087	1.00	1.00	1.00	1.00	-1.00	-1.00	1.00	1.00	-1.00
088	0.00	1.00	0.00	0.00	0.00	-1.00	1.00	1.00	0.00
096	-1.00	0.00	0.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00
097	-1.00	0.00	0.00	0.00	-1.00	-1.00	0.00	1.00	-1.00
101	0.00	0.00	0.00	0.00	0.00	-1.00	0.00	1.00	-1.00
104	1.00	2.00	0.00	0.00	-2.00	-1.00	0.00	0.00	0.00
105	0.00	1.00	0.00	0.00	-1.00	-1.00	0.00	1.00	0.00
106	0.00	0.00	0.00	0.00	-1.00	-1.00	-1.00	0.00	0.00
107	1.00	0.00	1.00	1.00	0.00	-1.00	1.00	1.00	1.00
108	0.00	1.00	0.00	1.00	-2.00	-1.00	2.00	1.00	1.00
110	1.00	1.00	1.00	0.00	-1.00	-1.00	0.00	-1.00	-1.00
114	1.00	1.00	1.00	1.00	-1.00	-1.00	0.00	1.00	1.00
116	0.00	0.00	1.00	0.00	-1.00	-2.00	1.00	2.00	1.00
119	0.00	0.00	0.00	0.00	-1.00	-1.00	1.00	1.00	0.00
122	0.00	-1.00	1.00	0.00	-1.00	-1.00	-1.00	1.00	0.00
125	1.00	0.00	0.00	0.00	-1.00	-2.00	0.00	0.00	0.00
126	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
133	0.00	0.00	0.00	0.00	-2.00	-1.00	0.00	0.00	0.00
N = 45 //	.44	.67	.38	.36	-1.13	-.80	.20	.62	.47

Attitudes Survey #	28	29	30	sec. D: average	Sec D order
004	1.00	0.00	1.00	.60	42.00
005	2.00	0.00	0.00	.90	45.00
013	1.00	0.00	-1.00	-.13	7.50
016	1.00	-1.00	1.00	-.13	7.50
017	1.00	0.00	-1.00	0.00	15.00
018	0.00	1.00	1.00	.43	36.00
022	0.00	0.00	0.00	.13	19.00
023	1.00	0.00	1.00	.40	33.50
026	2.00	1.00	2.00	.83	44.00
032	1.00	0.00	1.00	.40	33.50
038	0.00	-1.00	0.00	-.23	5.50
048	1.00	-1.00	1.00	.33	27.50
049	0.00	0.00	0.00	.03	16.00
052	0.00	0.00	1.00	.43	36.00
053	1.00	-1.00	1.00	.37	31.00
057	0.00	-1.00	0.00	-.07	10.00
058	2.00	0.00	1.00	.30	24.00
060	2.00	-2.00	0.00	.57	40.50
063	1.00	-1.00	1.00	.20	22.00
064	1.00	-1.00	0.00	.33	27.50
068	1.00	1.00	1.00	.37	31.00
071	0.00	0.00	0.00	.43	36.00
072	1.00	0.00	0.00	.33	27.50
074	2.00	-1.00	-1.00	-.03	12.50
075	0.00	-1.00	-1.00	-.63	1.00
081	-1.00	-1.00	-2.00	-.37	3.00
082	2.00	-1.00	1.00	.57	40.50
087	1.00	0.00	1.00	.37	31.00
088	1.00	0.00	0.00	.33	27.50
096	0.00	0.00	-1.00	-.57	2.00
097	1.00	0.00	1.00	-.03	12.50
101	1.00	0.00	0.00	.13	19.00
104	0.00	0.00	1.00	-.03	12.50
105	1.00	0.00	0.00	.17	21.00
106	0.00	0.00	0.00	-.10	9.00
107	0.00	0.00	0.00	.50	38.00
108	2.00	0.00	2.00	.70	43.00
110	1.00	0.00	0.00	-.03	12.50
114	1.00	0.00	1.00	.30	24.00
116	1.00	0.00	1.00	.53	39.00
119	1.00	1.00	0.00	.30	24.00
122	1.00	0.00	-2.00	-.23	5.50
125	1.00	-1.00	0.00	.10	17.00
126	1.00	0.00	1.00	.13	19.00
133	0.00	-2.00	-1.00	-.27	4.00
N = 45 //	.82	-.27	.27	.19	

Section D: category (a) - que #

Survey #	1	2	4	6	7	8	9	10	13
004	1.00	1.00	1.00	1.00	-1.00	1.00	0.00	1.00	1.00
005	2.00	2.00	1.00	2.00	1.00	1.00	1.00	1.00	2.00
013	1.00	-1.00	0.00	1.00	-2.00	0.00	1.00	0.00	-1.00
016	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
017	1.00	0.00	1.00	0.00	-1.00	0.00	0.00	0.00	-1.00
018	1.00	1.00	2.00	1.00	1.00	1.00	0.00	1.00	1.00
022	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00
023	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
026	2.00	2.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00
032	2.00	-1.00	1.00	-1.00	1.00	1.00	1.00	1.00	-1.00
038	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
048	1.00	-1.00	1.00	1.00	0.00	0.00	1.00	1.00	1.00
049	1.00	1.00	1.00	1.00	-1.00	1.00	1.00	0.00	-2.00
052	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
053	1.00	-1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00
057	1.00	1.00	1.00	1.00	-1.00	1.00	1.00	0.00	1.00
058	1.00	1.00	2.00	0.00	0.00	1.00	1.00	1.00	1.00
060	2.00	1.00	2.00	2.00	1.00	2.00	1.00	1.00	1.00
063	1.00	-1.00	1.00	0.00	0.00	0.00	1.00	0.00	-1.00
064	1.00	1.00	2.00	1.00	0.00	1.00	2.00	1.00	0.00
068	1.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00
071	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
072	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
074	1.00	0.00	1.00	2.00	1.00	0.00	1.00	0.00	1.00
075	0.00	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.00
081	0.00	-1.00	2.00	1.00	0.00	-1.00	-1.00	0.00	1.00
082	1.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
087	1.00	1.00	1.00	2.00	-1.00	1.00	1.00	1.00	1.00
088	1.00	0.00	2.00	0.00	1.00	1.00	1.00	0.00	1.00
096	-1.00	-2.00	-1.00	0.00	2.00	-1.00	0.00	-2.00	-2.00
097	1.00	0.00	0.00	1.00	-1.00	0.00	1.00	-1.00	1.00
101	1.00	0.00	1.00	0.00	-1.00	0.00	0.00	1.00	1.00
104	1.00	0.00	1.00	2.00	0.00	0.00	0.00	0.00	1.00
105	1.00	0.00	2.00	0.00	1.00	0.00	0.00	1.00	1.00
106	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00
107	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00
108	2.00	2.00	2.00	2.00	0.00	2.00	2.00	2.00	2.00
110	0.00	-1.00	0.00	-2.00	0.00	-1.00	1.00	-1.00	1.00
114	1.00	-2.00	1.00	1.00	-2.00	1.00	1.00	1.00	1.00
116	1.00	1.00	2.00	1.00	0.00	1.00	0.00	1.00	1.00
119	1.00	1.00	1.00	-1.00	0.00	1.00	2.00	1.00	1.00
122	-1.00	-1.00	0.00	0.00	-1.00	-1.00	1.00	1.00	1.00
125	2.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
126	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
133	1.00	1.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00
N = 45 //	.91	.27	.89	.69	.04	.53	.60	.51	.60

Survey #	14	16	20	22	26	27	sec. D: (a) average	order
004	1.00	1.00	1.00	0.00	1.00	1.00	.73	28.00
005	1.00	1.00	2.00	2.00	1.00	2.00	1.47	45.00
013	1.00	1.00	0.00	1.00	1.00	1.00	.27	13.50
016	0.00	1.00	0.00	0.00	-1.00	0.00	.20	10.50
017	0.00	0.00	0.00	0.00	0.00	1.00	.07	6.00
018	1.00	2.00	1.00	0.00	1.00	1.00	1.00	39.00
022	0.00	0.00	0.00	0.00	0.00	0.00	.13	8.00
023	1.00	2.00	1.00	1.00	1.00	1.00	1.13	41.50
026	1.00	2.00	2.00	1.00	-1.00	2.00	1.13	41.50
032	1.00	1.00	1.00	1.00	0.00	1.00	.60	22.50
038	0.00	0.00	0.00	0.00	0.00	0.00	.13	8.00
048	1.00	1.00	0.00	1.00	1.00	1.00	.67	25.50
049	-1.00	-1.00	0.00	0.00	0.00	-1.00	0.00	5.00
052	1.00	1.00	1.00	1.00	1.00	1.00	.93	36.00
053	1.00	1.00	2.00	1.00	1.00	1.00	.87	33.00
057	0.00	0.00	0.00	0.00	1.00	0.00	.47	19.00
058	1.00	2.00	1.00	1.00	1.00	0.00	.93	36.00
060	1.00	2.00	2.00	0.00	2.00	1.00	1.40	43.50
063	0.00	1.00	1.00	1.00	1.00	0.00	.33	16.00
064	1.00	1.00	1.00	0.00	2.00	1.00	1.00	39.00
068	0.00	1.00	1.00	0.00	1.00	1.00	.60	22.50
071	1.00	0.00	1.00	1.00	1.00	0.00	.87	33.00
072	1.00	1.00	1.00	1.00	1.00	1.00	.93	36.00
074	1.00	1.00	1.00	-1.00	1.00	1.00	.73	28.00
075	0.00	-1.00	0.00	-1.00	-1.00	1.00	-.27	2.00
081	1.00	-1.00	1.00	0.00	1.00	1.00	.27	13.50
082	1.00	2.00	1.00	2.00	1.00	1.00	1.00	39.00
087	1.00	1.00	1.00	1.00	1.00	-1.00	.80	30.50
088	1.00	1.00	1.00	0.00	1.00	0.00	.73	28.00
096	-1.00	0.00	0.00	-1.00	-1.00	1.00	-.60	1.00
097	1.00	1.00	0.00	0.00	1.00	-1.00	.27	13.50
101	0.00	1.00	0.00	0.00	1.00	-1.00	.27	13.50
104	0.00	0.00	2.00	0.00	0.00	0.00	.47	19.00
105	0.00	1.00	1.00	0.00	1.00	0.00	.60	22.50
106	0.00	0.00	0.00	0.00	0.00	0.00	.13	8.00
107	1.00	1.00	0.00	1.00	1.00	1.00	.80	30.50
108	0.00	1.00	1.00	1.00	1.00	1.00	1.40	43.50
110	1.00	0.00	1.00	0.00	-1.00	-1.00	-.20	3.00
114	1.00	1.00	1.00	1.00	1.00	1.00	.60	22.50
116	1.00	1.00	0.00	0.00	2.00	1.00	.87	33.00
119	1.00	1.00	0.00	0.00	1.00	0.00	.67	25.50
122	1.00	-1.00	-1.00	0.00	1.00	0.00	-.07	4.00
125	1.00	1.00	0.00	0.00	0.00	0.00	.47	19.00
126	0.00	1.00	1.00	0.00	0.00	0.00	.20	10.50
133	0.00	0.00	0.00	0.00	0.00	0.00	.40	17.00
N = 45 //	.58	.73	.67	.36	.62	.47	.56	

Survey #	Section D: category (b) - que # 3	11	12	15	18	21
004	1.00	0.00	0.00	-1.00	0.00	1.00
005	2.00	-1.00	0.00	1.00	-2.00	1.00
013	-1.00	-2.00	0.00	-1.00	0.00	0.00
016	0.00	-2.00	0.00	-2.00	-1.00	-1.00
017	1.00	-1.00	-1.00	-1.00	-1.00	1.00
018	1.00	0.00	-2.00	-1.00	0.00	1.00
022	0.00	0.00	0.00	-1.00	0.00	0.00
023	1.00	-2.00	-2.00	-2.00	-2.00	-2.00
026	2.00	1.00	-1.00	-2.00	-1.00	1.00
032	1.00	-1.00	-1.00	-1.00	-1.00	1.00
038	-1.00	-1.00	-1.00	-2.00	-1.00	0.00
048	1.00	-1.00	0.00	-1.00	-1.00	0.00
049	0.00	0.00	0.00	1.00	0.00	0.00
052	0.00	-1.00	0.00	-2.00	1.00	0.00
053	1.00	-2.00	0.00	-2.00	-2.00	1.00
057	0.00	-1.00	-1.00	-2.00	-2.00	0.00
058	1.00	-2.00	-2.00	-2.00	-1.00	1.00
060	2.00	-2.00	-2.00	-1.00	-2.00	1.00
063	1.00	-2.00	-1.00	-2.00	-1.00	1.00
064	0.00	-1.00	-2.00	1.00	-2.00	0.00
068	1.00	-1.00	0.00	0.00	-1.00	1.00
071	1.00	0.00	1.00	-1.00	0.00	1.00
072	-1.00	-1.00	0.00	-2.00	-1.00	1.00
074	-1.00	-2.00	-1.00	-2.00	-2.00	-1.00
075	-1.00	-2.00	-1.00	-2.00	-2.00	0.00
081	-1.00	-2.00	0.00	-2.00	-1.00	1.00
082	-1.00	-1.00	-2.00	0.00	-1.00	1.00
087	-1.00	0.00	-1.00	-2.00	-1.00	1.00
088	0.00	-1.00	1.00	-1.00	-1.00	0.00
096	1.00	-1.00	0.00	-1.00	-1.00	0.00
097	1.00	-1.00	0.00	-2.00	-2.00	0.00
101	1.00	0.00	0.00	-2.00	0.00	0.00
104	0.00	-2.00	-2.00	-2.00	-1.00	0.00
105	0.00	-1.00	0.00	-1.00	-2.00	0.00
106	0.00	-1.00	0.00	-1.00	0.00	0.00
107	1.00	0.00	0.00	0.00	0.00	1.00
108	2.00	-2.00	1.00	-2.00	-2.00	0.00
110	0.00	1.00	-2.00	1.00	-1.00	1.00
114	1.00	-1.00	0.00	-2.00	-1.00	1.00
116	2.00	0.00	0.00	-2.00	0.00	1.00
119	1.00	-1.00	-1.00	-1.00	-1.00	0.00
122	0.00	0.00	-1.00	-1.00	-1.00	1.00
125	1.00	-1.00	0.00	-2.00	-1.00	0.00
126	0.00	0.00	0.00	0.00	0.00	0.00
133	1.00	-2.00	-2.00	-2.00	-2.00	0.00
N = 45 //	.47	-.96	-.58	-1.22	-.98	.38

Survey #	23	24	29	30	sec. D: average	(b) order
004	-1.00	1.00	0.00	1.00	.20	44.00
005	-2.00	-2.00	0.00	0.00	-.30	29.50
013	-1.00	-1.00	0.00	-1.00	-.70	12.50
016	-2.00	-2.00	-1.00	1.00	-1.00	5.00
017	-1.00	1.00	0.00	-1.00	-.30	29.50
018	-2.00	-1.00	1.00	1.00	-.20	33.00
022	0.00	0.00	0.00	0.00	-.10	37.50
023	-2.00	1.00	0.00	1.00	-.90	8.50
026	-1.00	1.00	1.00	2.00	.30	45.00
032	-1.00	1.00	0.00	1.00	-.10	37.50
038	-1.00	-1.00	-1.00	0.00	-.90	8.50
048	-1.00	-1.00	-1.00	1.00	-.40	24.50
049	-1.00	-1.00	0.00	0.00	-.10	37.50
052	-1.00	1.00	0.00	1.00	-.10	37.50
053	-1.00	-1.00	-1.00	1.00	-.60	16.50
057	-1.00	-1.00	-1.00	0.00	-.90	8.50
058	-1.00	-1.00	0.00	1.00	-.60	16.50
060	-2.00	-2.00	-2.00	0.00	-1.00	6.00
063	-1.00	1.00	-1.00	1.00	-.40	24.50
064	-1.00	-1.00	-1.00	0.00	-.70	12.50
068	-1.00	-2.00	1.00	1.00	-.10	37.50
071	-1.00	-1.00	0.00	0.00	0.00	41.00
072	-2.00	-1.00	0.00	0.00	-.70	12.50
074	-2.00	-2.00	-1.00	-1.00	-1.50	1.00
075	-2.00	-2.00	-1.00	-1.00	-1.40	2.00
081	-1.00	-2.00	-1.00	-2.00	-1.10	4.00
082	-1.00	1.00	-1.00	1.00	-.40	24.50
087	-1.00	-1.00	0.00	1.00	-.50	20.00
088	0.00	-1.00	0.00	0.00	-.30	29.50
096	-1.00	-1.00	0.00	-1.00	-.50	20.00
097	-1.00	-1.00	0.00	1.00	-.50	20.00
101	0.00	-1.00	0.00	0.00	-.20	33.00
104	-2.00	-1.00	0.00	1.00	-.90	8.50
105	-1.00	-1.00	0.00	0.00	-.60	16.50
106	-1.00	-1.00	0.00	0.00	-.40	24.50
107	0.00	-1.00	0.00	0.00	.10	42.50
108	-2.00	-1.00	0.00	2.00	-.40	24.50
110	-1.00	-1.00	0.00	0.00	-.20	33.00
114	-1.00	-1.00	0.00	1.00	-.30	29.50
116	-1.00	-2.00	0.00	1.00	-.10	37.50
119	-1.00	-1.00	1.00	0.00	-.40	24.50
122	-1.00	-1.00	0.00	-2.00	-.60	16.50
125	-1.00	-2.00	-1.00	0.00	-.70	12.50
126	0.00	0.00	0.00	1.00	.10	42.50
133	-2.00	-1.00	-2.00	-1.00	-1.30	3.00
N = 45 //	-1.13	-.80	-.27	.27	-.48	

Section D: category (c) - que #

Survey #	2	3	5	7	9	13	16
004	1.00	1.00	1.00	-1.00	0.00	1.00	1.00
005	2.00	2.00	1.00	1.00	1.00	2.00	1.00
013	-1.00	-1.00	0.00	-2.00	1.00	-1.00	1.00
016	1.00	0.00	0.00	0.00	0.00	0.00	1.00
017	0.00	1.00	0.00	-1.00	0.00	-1.00	0.00
018	1.00	1.00	-1.00	1.00	0.00	1.00	2.00
022	0.00	0.00	1.00	0.00	0.00	0.00	0.00
023	1.00	1.00	1.00	1.00	1.00	1.00	2.00
026	2.00	2.00	1.00	1.00	0.00	1.00	2.00
032	-1.00	1.00	1.00	1.00	1.00	-1.00	1.00
038	0.00	-1.00	1.00	0.00	0.00	1.00	0.00
048	-1.00	1.00	1.00	0.00	1.00	1.00	1.00
049	1.00	0.00	1.00	-1.00	1.00	-2.00	-1.00
052	1.00	0.00	1.00	0.00	1.00	1.00	1.00
053	-1.00	1.00	1.00	1.00	0.00	1.00	1.00
057	1.00	0.00	0.00	-1.00	1.00	1.00	0.00
058	1.00	1.00	1.00	0.00	1.00	1.00	2.00
060	1.00	2.00	2.00	1.00	1.00	1.00	2.00
063	-1.00	1.00	1.00	0.00	1.00	-1.00	1.00
064	1.00	0.00	1.00	0.00	2.00	0.00	1.00
068	0.00	1.00	0.00	0.00	0.00	1.00	1.00
071	1.00	1.00	0.00	1.00	1.00	1.00	0.00
072	1.00	-1.00	1.00	0.00	1.00	1.00	1.00
074	0.00	-1.00	2.00	1.00	1.00	1.00	1.00
075	-1.00	-1.00	1.00	0.00	0.00	-1.00	-1.00
081	-1.00	-1.00	1.00	0.00	-1.00	1.00	-1.00
082	1.00	-1.00	1.00	1.00	1.00	1.00	2.00
087	1.00	-1.00	1.00	-1.00	1.00	1.00	1.00
088	0.00	0.00	1.00	1.00	1.00	1.00	1.00
096	-2.00	1.00	-1.00	2.00	0.00	-2.00	0.00
097	0.00	1.00	1.00	-1.00	1.00	1.00	1.00
101	0.00	1.00	1.00	-1.00	0.00	1.00	1.00
104	0.00	0.00	0.00	0.00	0.00	1.00	0.00
105	0.00	0.00	1.00	1.00	0.00	1.00	1.00
106	0.00	0.00	0.00	0.00	0.00	0.00	0.00
107	1.00	1.00	0.00	0.00	1.00	1.00	1.00
108	2.00	2.00	2.00	0.00	2.00	2.00	1.00
110	-1.00	0.00	1.00	0.00	1.00	1.00	0.00
114	-2.00	1.00	1.00	-2.00	1.00	1.00	1.00
116	1.00	2.00	2.00	0.00	0.00	1.00	1.00
119	1.00	1.00	1.00	0.00	2.00	1.00	1.00
122	-1.00	0.00	1.00	-1.00	1.00	1.00	-1.00
125	1.00	1.00	1.00	0.00	0.00	1.00	1.00
126	0.00	0.00	0.00	0.00	0.00	0.00	1.00
133	1.00	1.00	1.00	0.00	0.00	2.00	0.00
N = 45 //	.27	.47	.78	.04	.60	.60	.73

Survey #	17	19	24	25	28	sec. D: (c) average	order
004	0.00	2.00	1.00	1.00	1.00	.75	39.00
005	2.00	2.00	-2.00	1.00	2.00	1.25	45.00
013	-1.00	0.00	-1.00	-1.00	1.00	-.42	3.50
016	0.00	2.00	-2.00	0.00	1.00	.25	17.00
017	0.00	1.00	1.00	0.00	1.00	.17	13.50
018	1.00	1.00	-1.00	-1.00	0.00	.42	27.00
022	1.00	0.00	0.00	1.00	0.00	.25	17.00
023	0.00	1.00	1.00	1.00	1.00	1.00	41.50
026	-1.00	1.00	1.00	2.00	2.00	1.17	44.00
032	1.00	1.00	1.00	0.00	1.00	.58	36.00
038	-1.00	0.00	-1.00	0.00	0.00	-.08	9.00
048	1.00	0.00	-1.00	1.00	1.00	.50	32.50
049	1.00	1.00	-1.00	-1.00	0.00	-.08	9.00
052	-1.00	0.00	1.00	0.00	0.00	.42	27.00
053	0.00	1.00	-1.00	1.00	1.00	.50	32.50
057	-1.00	1.00	-1.00	0.00	0.00	.08	9.00
058	-1.00	-1.00	-1.00	0.00	2.00	.50	32.50
060	1.00	1.00	-2.00	0.00	2.00	1.00	41.50
063	1.00	1.00	1.00	1.00	1.00	.58	36.00
064	-2.00	1.00	-1.00	1.00	1.00	.42	27.00
068	1.00	1.00	-2.00	0.00	1.00	.33	21.00
071	1.00	0.00	-1.00	-1.00	0.00	.33	21.00
072	1.00	1.00	-1.00	-1.00	1.00	.42	27.00
074	-2.00	0.00	-2.00	1.00	2.00	.33	21.00
075	0.00	-1.00	-2.00	-1.00	0.00	-.58	2.00
081	-1.00	-2.00	-2.00	-1.00	-1.00	-.75	1.00
082	1.00	1.00	1.00	1.00	2.00	1.00	41.50
087	0.00	1.00	-1.00	1.00	1.00	.42	27.00
088	-1.00	0.00	-1.00	1.00	1.00	.42	27.00
096	0.00	-1.00	-1.00	-1.00	0.00	-.42	3.50
097	-1.00	-1.00	-1.00	0.00	1.00	.17	13.50
101	0.00	0.00	-1.00	0.00	1.00	.25	17.00
104	0.00	1.00	-1.00	0.00	0.00	.08	9.00
105	0.00	0.00	-1.00	0.00	1.00	.33	21.00
106	0.00	0.00	-1.00	-1.00	0.00	-.17	5.50
107	0.00	1.00	-1.00	1.00	0.00	.50	32.50
108	-2.00	0.00	-1.00	2.00	2.00	1.00	41.50
110	1.00	1.00	-1.00	0.00	1.00	.33	21.00
114	0.00	1.00	-1.00	0.00	1.00	.17	13.50
116	0.00	0.00	-2.00	1.00	1.00	.58	36.00
119	0.00	0.00	-1.00	1.00	1.00	.67	38.00
122	-1.00	0.00	-1.00	-1.00	1.00	-.17	5.50
125	0.00	1.00	-2.00	0.00	1.00	.42	27.00
126	-1.00	0.00	0.00	0.00	1.00	.08	9.00
133	-2.00	0.00	-1.00	0.00	0.00	.17	13.50
N = 45 //	-.11	.44	-.80	.20	.82	.34	

Stat.Comp// Sec A: Stat.Comp// Sec C: Stat.Comp// Sec D

N=45	que # 8 (K=4)		C I: (K=8)		C II: (K=9)		sec. C: (K=17)		sec D: (K=30)	
Survey #	average	sq.dev	average	sq.dev	average	sq.dev	average	sq.dev	average	sq.dev
004	2.75	.94	.88	.00	.11	.02	.47	.00	.60	.17
005	2.25	.22	.62	.05	.67	.17	.65	.01	.90	.50
013	1.25	.28	1.38	.29	.44	.03	.88	.12	-.13	.10
016	2.25	.22	1.25	.17	0.00	.07	.59	.00	-.13	.10
017	2.75	.94	.50	.12	.22	.00	.35	.03	0.00	.04
018	2.25	.22	1.38	.29	.11	.02	.71	.03	.43	.06
022	1.75	.00	.25	.35	.33	.01	.29	.06	.13	.00
023	3.00	1.49	1.12	.08	.22	.00	.65	.01	.40	.04
026	2.50	.52	2.12	1.65	1.11	.72	1.59	1.12	.83	.41
032	2.50	.52	2.00	1.35	1.11	.72	1.53	1.00	.40	.04
038	1.50	.08	.62	.05	0.00	.07	.29	.06	-.23	.18
048	1.25	.28	1.00	.03	.33	.01	.65	.01	.33	.02
049	2.00	.05	1.75	.83	1.22	.93	1.47	.88	.03	.02
052	2.25	.22	1.38	.29	.22	.00	.76	.06	.43	.06
053	1.00	.61	1.38	.29	.22	.00	.76	.06	.37	.03
057	1.00	.61	1.00	.03	0.00	.07	.47	.00	-.07	.07
058	1.50	.08	1.25	.17	0.00	.07	.59	.00	.30	.01
060	4.00	4.93	1.62	.62	.33	.01	.94	.17	.57	.14
063	2.00	.05	1.25	.17	.22	.00	.71	.03	.20	.00
064	3.00	1.49	1.25	.17	.56	.09	.88	.12	.33	.02
068	3.00	1.49	.62	.05	.22	.00	.41	.01	.37	.03
071	1.75	.00	.12	.51	.11	.02	.12	.17	.43	.06
072	0.00	3.17	0.00	.71	0.00	.07	0.00	.28	.33	.02
074	.50	1.64	0.00	.71	0.00	.07	0.00	.28	-.03	.05
075	0.00	3.17	0.00	.71	0.00	.07	0.00	.28	-.63	.68
081	2.75	.94	1.25	.17	0.00	.07	.59	.00	-.37	.31
082	3.25	2.16	2.00	1.35	.78	.27	1.35	.68	.57	.14
087	1.25	.28	1.00	.03	0.00	.07	.47	.00	.37	.03
088	2.25	.22	0.00	.71	0.00	.07	0.00	.28	.33	.02
096	.50	1.64	0.00	.71	0.00	.07	0.00	.28	-.57	.57
097	1.25	.28	0.00	.71	0.00	.07	0.00	.28	-.03	.05
101	.75	1.06	.75	.01	.11	.02	.41	.01	.13	.00
104	0.00	3.17	.25	.35	.11	.02	.18	.12	-.03	.05
105	1.00	.61	.88	.00	0.00	.07	.41	.01	.17	.00
106	.50	1.64	0.00	.71	0.00	.07	0.00	.28	-.10	.08
107	2.00	.05	.62	.05	.33	.01	.47	.00	.50	.10
108	1.75	.00	.88	.00	0.00	.07	.41	.01	.70	.26
110	2.25	.22	1.75	.83	.56	.09	1.12	.35	-.03	.05
114	1.75	.00	.38	.22	0.00	.07	.18	.12	.30	.01
116	3.50	2.96	.50	.12	.33	.01	.41	.01	.53	.12
119	2.25	.22	.38	.22	.44	.03	.41	.01	.30	.01
122	0.00	3.17	0.00	.71	0.00	.07	0.00	.28	-.23	.18
125	2.00	.05	.75	.01	.44	.03	.59	.00	.10	.01
126	2.00	.05	.88	.00	0.00	.07	.41	.01	.13	.00
133	1.25	.28	.75	.01	.44	.03	.59	.00	-.27	.21
average	1.78		.84		.26		.53		.19	
standard deviation		.97		.61		.32		.41		.34

Survey #	Sec A order	Sec CI order	Sec CII order	Sec C order	Sec D(a) order	Sec D(b) order	Sec D(c) order	Sec D order
004	38.00	24.50	21.00	23.50	28.00	44.00	39.00	42.00
005	31.00	17.50	41.00	32.00	45.00	29.50	45.00	45.00
013	14.00	37.50	36.50	38.50	13.50	12.50	3.50	7.50
016	31.00	33.00	9.50	28.00	10.50	5.00	17.00	7.50
017	38.00	14.50	26.50	14.00	6.00	29.50	13.50	15.00
018	31.00	37.50	21.00	34.50	39.00	33.00	27.00	36.00
022	20.50	10.50	32.00	12.50	8.00	37.50	17.00	19.00
023	41.00	30.00	26.50	32.00	41.50	8.50	41.50	33.50
026	35.50	45.00	43.50	45.00	41.50	45.00	44.00	44.00
032	35.50	43.50	43.50	44.00	22.50	37.50	36.00	33.50
038	17.50	17.50	9.50	12.50	8.00	8.50	9.00	5.50
048	14.00	28.00	32.00	32.00	25.50	24.50	32.50	27.50
049	25.00	41.00	45.00	43.00	5.00	37.50	9.00	16.00
052	31.00	37.50	26.50	36.50	36.00	37.50	27.00	36.00
053	10.00	37.50	26.50	36.50	33.00	16.50	32.50	31.00
057	10.00	28.00	9.50	23.50	19.00	8.50	9.00	10.00
058	17.50	33.00	9.50	28.00	36.00	16.50	32.50	24.00
060	45.00	40.00	32.00	40.00	43.50	6.00	41.50	40.50
063	25.00	33.00	26.50	34.50	16.00	24.50	36.00	22.00
064	41.00	33.00	39.50	38.50	39.00	12.50	27.00	27.50
068	41.00	17.50	26.50	18.00	22.50	37.50	21.00	31.00
071	20.50	9.00	21.00	9.00	33.00	41.00	21.00	36.00
072	2.50	4.50	9.50	4.50	36.00	12.50	27.00	27.50
074	6.00	4.50	9.50	4.50	28.00	1.00	21.00	12.50
075	2.50	4.50	9.50	4.50	2.00	2.00	2.00	1.00
081	38.00	33.00	9.50	28.00	13.50	4.00	1.00	3.00
082	43.00	43.50	42.00	42.00	39.00	24.50	41.50	40.50
087	14.00	28.00	9.50	23.50	30.50	20.00	27.00	31.00
088	31.00	4.50	9.50	4.50	28.00	29.50	27.00	27.50
096	6.00	4.50	9.50	4.50	1.00	20.00	3.50	2.00
097	14.00	4.50	9.50	4.50	13.50	20.00	13.50	12.50
101	8.00	21.00	21.00	18.00	13.50	33.00	17.00	19.00
104	2.50	10.50	21.00	10.50	19.00	8.50	9.00	12.50
105	10.00	24.50	9.50	18.00	22.50	16.50	21.00	21.00
106	6.00	4.50	9.50	4.50	8.00	24.50	5.50	9.00
107	25.00	17.50	32.00	23.50	30.50	42.50	32.50	38.00
108	20.50	24.50	9.50	18.00	43.50	24.50	41.50	43.00
110	31.00	42.00	39.50	41.00	3.00	33.00	21.00	12.50
114	20.50	12.50	9.50	10.50	22.50	29.50	13.50	24.00
116	44.00	14.50	32.00	18.00	33.00	37.50	36.00	39.00
119	31.00	12.50	36.50	18.00	25.50	24.50	38.00	24.00
122	2.50	4.50	9.50	4.50	4.00	16.50	5.50	5.50
125	25.00	21.00	36.50	28.00	19.00	12.50	27.00	17.00
126	25.00	24.50	9.50	18.00	10.50	42.50	9.00	19.00
133	14.00	21.00	36.50	28.00	17.00	3.00	13.50	4.00

N = 45

N=45 Survey #	Order// Sec A: que # 8 average	rel order	Order// Sec C: C I: average	rel order	C II: average	rel order	sec. C: average	rel order	Order// Sec D: sec D: average	rel order
072	0.00	2.50	0.00	4.50	0.00	9.50	0.00	4.50	.33	27.50
075	0.00	2.50	0.00	4.50	0.00	9.50	0.00	4.50	-.63	1.00
122	0.00	2.50	0.00	4.50	0.00	9.50	0.00	4.50	-.23	5.50
074	.50	6.00	0.00	4.50	0.00	9.50	0.00	4.50	-.03	12.50
096	.50	6.00	0.00	4.50	0.00	9.50	0.00	4.50	-.57	2.00
106	.50	6.00	0.00	4.50	0.00	9.50	0.00	4.50	-.10	9.00
097	1.25	14.00	0.00	4.50	0.00	9.50	0.00	4.50	-.03	12.50
088	2.25	31.00	0.00	4.50	0.00	9.50	0.00	4.50	.33	27.50
071	1.75	20.50	.12	9.00	.11	21.00	.12	9.00	.43	36.00
104	0.00	2.50	.25	10.50	.11	21.00	.18	10.50	-.03	12.50
114	1.75	20.50	.38	12.50	0.00	9.50	.18	10.50	.30	24.00
038	1.50	17.50	.62	17.50	0.00	9.50	.29	12.50	-.23	5.50
022	1.75	20.50	.25	10.50	.33	32.00	.29	12.50	.13	19.00
017	2.75	38.00	.50	14.50	.22	26.50	.35	14.00	0.00	15.00
101	.75	8.00	.75	21.00	.11	21.00	.41	18.00	.13	19.00
105	1.00	10.00	.88	24.50	0.00	9.50	.41	18.00	.17	21.00
108	1.75	20.50	.88	24.50	0.00	9.50	.41	18.00	.70	43.00
126	2.00	25.00	.88	24.50	0.00	9.50	.41	18.00	.13	19.00
119	2.25	31.00	.38	12.50	.44	36.50	.41	18.00	.30	24.00
068	3.00	41.00	.62	17.50	.22	26.50	.41	18.00	.37	31.00
116	3.50	44.00	.50	14.50	.33	32.00	.41	18.00	.53	39.00
057	1.00	10.00	1.00	28.00	0.00	9.50	.47	23.50	-.07	10.00
087	1.25	14.00	1.00	28.00	0.00	9.50	.47	23.50	.37	31.00
107	2.00	25.00	.62	17.50	.33	32.00	.47	23.50	.50	38.00
004	2.75	38.00	.88	24.50	.11	21.00	.47	23.50	.60	42.00
133	1.25	14.00	.75	21.00	.44	36.50	.59	28.00	-.27	4.00
058	1.50	17.50	1.25	33.00	0.00	9.50	.59	28.00	.30	24.00
125	2.00	25.00	.75	21.00	.44	36.50	.59	28.00	.10	17.00
081	2.75	38.00	1.25	33.00	0.00	9.50	.59	28.00	-.37	3.00
016	2.25	31.00	1.25	33.00	0.00	9.50	.59	28.00	-.13	7.50
048	1.25	14.00	1.00	28.00	.33	32.00	.65	32.00	.33	27.50
005	2.25	31.00	.62	17.50	.67	41.00	.65	32.00	.90	45.00
023	3.00	41.00	1.12	30.00	.22	26.50	.65	32.00	.40	33.50
063	2.00	25.00	1.25	33.00	.22	26.50	.71	34.50	.20	22.00
018	2.25	31.00	1.38	37.50	.11	21.00	.71	34.50	.43	36.00
053	1.00	10.00	1.38	37.50	.22	26.50	.76	36.50	.37	31.00
052	2.25	31.00	1.38	37.50	.22	26.50	.76	36.50	.43	36.00
013	1.25	14.00	1.38	37.50	.44	36.50	.88	38.50	-.13	7.50
064	3.00	41.00	1.25	33.00	.56	39.50	.88	38.50	.33	27.50
060	4.00	45.00	1.62	40.00	.33	32.00	.94	40.00	.57	40.50
110	2.25	31.00	1.75	42.00	.56	39.50	1.12	41.00	-.03	12.50
082	3.25	43.00	2.00	43.50	.78	42.00	1.35	42.00	.57	40.50
049	2.00	25.00	1.75	41.00	1.22	45.00	1.47	43.00	.03	16.00
032	2.50	35.50	2.00	43.50	1.11	43.50	1.53	44.00	.40	33.50
026	2.50	35.50	2.12	45.00	1.11	43.50	1.59	45.00	.83	44.00
average	1.78		.84		.26		.53		.19	

User.Rank N=45 Survey #	sec. C: average	rel order	sec D: average	rel order	A - 8 average	rel order
072	0.00	4.50	.33	27.50	0.00	2.50
075	0.00	4.50	-.63	1.00	0.00	2.50
122	0.00	4.50	-.23	5.50	0.00	2.50
074	0.00	4.50	-.03	12.50	.50	6.00
096	0.00	4.50	-.57	2.00	.50	6.00
106	0.00	4.50	-.10	9.00	.50	6.00
097	0.00	4.50	-.03	12.50	1.25	14.00
088	0.00	4.50	.33	27.50	2.25	31.00
071	.12	9.00	.43	36.00	1.75	20.50
104	.18	10.50	-.03	12.50	0.00	2.50
114	.18	10.50	.30	24.00	1.75	20.50
038	.29	12.50	-.23	5.50	1.50	17.50
022	.29	12.50	.13	19.00	1.75	20.50
017	.35	14.00	0.00	15.00	2.75	38.00
101	.41	18.00	.13	19.00	.75	8.00
105	.41	18.00	.17	21.00	1.00	10.00
108	.41	18.00	.70	43.00	1.75	20.50
126	.41	18.00	.13	19.00	2.00	25.00
119	.41	18.00	.30	24.00	2.25	31.00
068	.41	18.00	.37	31.00	3.00	41.00
116	.41	18.00	.53	39.00	3.50	44.00
057	.47	23.50	-.07	10.00	1.00	10.00
087	.47	23.50	.37	31.00	1.25	14.00
107	.47	23.50	.50	38.00	2.00	25.00
004	.47	23.50	.60	42.00	2.75	38.00
133	.59	28.00	-.27	4.00	1.25	14.00
058	.59	28.00	.30	24.00	1.50	17.50
125	.59	28.00	.10	17.00	2.00	25.00
081	.59	28.00	-.37	3.00	2.75	38.00
016	.59	28.00	-.13	7.50	2.25	31.00
048	.65	32.00	.33	27.50	1.25	14.00
005	.65	32.00	.90	45.00	2.25	31.00
023	.65	32.00	.40	33.50	3.00	41.00
063	.71	34.50	.20	22.00	2.00	25.00
018	.71	34.50	.43	36.00	2.25	31.00
053	.76	36.50	.37	31.00	1.00	10.00
052	.76	36.50	.43	36.00	2.25	31.00
013	.88	38.50	-.13	7.50	1.25	14.00
064	.88	38.50	.33	27.50	3.00	41.00
060	.94	40.00	.57	40.50	4.00	45.00
110	1.12	41.00	-.03	12.50	2.25	31.00
082	1.35	42.00	.57	40.50	3.25	43.00
049	1.47	43.00	.03	16.00	2.00	25.00
032	1.53	44.00	.40	33.50	2.50	35.50
026	1.59	45.00	.83	44.00	2.50	35.50
average	.53		.19		1.78	
stn. dev.	.41		.34		.97	

Attitude.Rank

N=45 Survey #	sec D: average	rel order	sec. C: average	rel order	A - 8 average	rel order
075	-.63	1.00	0.00	4.50	0.00	2.50
096	-.57	2.00	0.00	4.50	.50	6.00
081	-.37	3.00	.59	28.00	2.75	38.00
133	-.27	4.00	.59	28.00	1.25	14.00
122	-.23	5.50	0.00	4.50	0.00	2.50
038	-.23	5.50	.29	12.50	1.50	17.50
016	-.13	7.50	.59	28.00	2.25	31.00
013	-.13	7.50	.88	38.50	1.25	14.00
106	-.10	9.00	0.00	4.50	.50	6.00
057	-.07	10.00	.47	23.50	1.00	10.00
097	-.03	12.50	0.00	4.50	1.25	14.00
104	-.03	12.50	.18	10.50	0.00	2.50
110	-.03	12.50	1.12	41.00	2.25	31.00
074	-.03	12.50	0.00	4.50	.50	6.00
017	0.00	15.00	.35	14.00	2.75	38.00
049	.03	16.00	1.47	43.00	2.00	25.00
125	.10	17.00	.59	28.00	2.00	25.00
022	.13	19.00	.29	12.50	1.75	20.50
126	.13	19.00	.41	18.00	2.00	25.00
101	.13	19.00	.41	18.00	.75	8.00
105	.17	21.00	.41	18.00	1.00	10.00
063	.20	22.00	.71	34.50	2.00	25.00
114	.30	24.00	.18	10.50	1.75	20.50
119	.30	24.00	.41	18.00	2.25	31.00
058	.30	24.00	.59	28.00	1.50	17.50
048	.33	27.50	.65	32.00	1.25	14.00
064	.33	27.50	.88	38.50	3.00	41.00
088	.33	27.50	0.00	4.50	2.25	31.00
072	.33	27.50	0.00	4.50	0.00	2.50
053	.37	31.00	.76	36.50	1.00	10.00
068	.37	31.00	.41	18.00	3.00	41.00
087	.37	31.00	.47	23.50	1.25	14.00
023	.40	33.50	.65	32.00	3.00	41.00
032	.40	33.50	1.53	44.00	2.50	35.50
018	.43	36.00	.71	34.50	2.25	31.00
052	.43	36.00	.76	36.50	2.25	31.00
071	.43	36.00	.12	9.00	1.75	20.50
107	.50	38.00	.47	23.50	2.00	25.00
116	.53	39.00	.41	18.00	3.50	44.00
060	.57	40.50	.94	40.00	4.00	45.00
082	.57	40.50	1.35	42.00	3.25	43.00
004	.60	42.00	.47	23.50	2.75	38.00
108	.70	43.00	.41	18.00	1.75	20.50
026	.83	44.00	1.59	45.00	2.50	35.50
005	.90	45.00	.65	32.00	2.25	31.00
average	.19		.53		1.78	
stn. dev.	.34		.41		.97	

APPENDIX 6

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Written Comments - Summary

A. Comments concerning actual uses of computers:

"Students use computers to make notes."

"library computers are available to prepare papers"

"they have not been availabe to use, or there are not sufficient funds to purchase a lot of software"

"our school has very limited science budget; no money is alotted for software or interface equipment."

"We switched from apple computers to the Stride system. After we did this we found out that there was no science software avialable. Hopefully we are going to get an IMB system to go with the stride system so we can use science programs again."

"I've built and used my own Hypercard stacks for the Macintosh"

"Word processor to write reports"

"Establish data bases in Science 14 & Bio 10. Look for comparisons for data/relationships. Graphing from spreadsheet"

"None"

"Reviews of concepts covered in class. Computer simulation of electrochemical cells for example"

"I have used my own computer to design assignments, tests, and for the evaluation of students."

B. Additional comments:

"Since I rarely use the computer & have few programs that are suitable, I must offer a 'no opinion' answer quite frequently. I am rather reluctant to use computers since I am basicallly 'computer illiterate' and have no budget for programs, nor are there many programs suitable to the Alta Curriculum."

"Difficult to answer some questions as no experience to relate to. with a couple of st'ns <u>good</u> software and sufficient training it would be helpful. Keep in mind the curric is changing so much of this is shooting in the dark."

"Teachers in this school division are neither given the time not the money to go to workshops etc. Without professional development money we will never have computers integrated into our science programs!"

"I am reluctant to have students use computer programs because: (1) cost of software - some software pack. are more than my yearly budget - (2) I'd rather them do the actual lab and hands on assign. (3) Less hassle to book computer room and est. procedures for using computers. I have better use of budget money than computers for science. I don't think computer simulation can be as good as the real thing."

"Because I haven't used or seen recent science software packages, I can't really evaluate their effectiveness of educational significance."

"Computers work for note preparation with low achievers."

"Interfaces such a 'Smart Pulley' are very useful. Availability of software and overall quality is poor for most sciences. Tutorials have not been a good use of computer capabilities for the sciences."

"Would like to see all experiements & demos by simulation thus eliminating problem with hazardous chemicals"

"cost and availability of software to teachers (as well as the availability of computers) are major hurdles to the use of computers in the class"

"Some questions were answered based on my experience in other classes, not science. Since I have limited access & limited exposure to science programs other than MECC. I have a very limiting budget for my science programs from 7 - 12."

"Many of your questions can be interpreted in different ways; it depends upon how the program is used and what support mechanisms exist to supplement computer activity"

"With copyright laws, the cost of software , and Education budgets being cut, our science program will not be involved with computer education in the sciences" "very little money available, the choice is between computer software or lab supplies. The access to computers during class is very limited"

"most answers are based on my personal use of software not student use of software in my classroom."

"I feel computers could be very beneficially used in teaching high school science programs. Because we do not have any software, I personally have not attempted to use them. Because of my lack of experience I could not express an opinion on many of these questions."

"There is currently no monies available to purchase programs - no one has indicated availability nor have I checked hence I am not using the computers."

"I haven't found any really good software. The science dept has never bought any software - it is too risky - high price and who knows if its any good. Spreadsheets would be good to teach some organization and calculation for number problems."

"Because of my lack of experience in using computers in the classroom I don't feel I'm able to evaluate their effectiveness. I do feel however thay have a place and could be beneficial to Science Education."

"I'd like to see more HyperCard stacks for science. I intend to continue making more of my own. The problem is that there still aren't enough Mac's available for the classroom."

"There is nothing the matter with the computers or the teachers or the availability the PROBLEM is the SOFTWARE. As anti-government involvement as I am I think the government should buy existing software or provide funds for teachers to develop software. Unfortunately software does not always turn out."

"I feel computer programs should be specifically made up to join and follow the curriculum and thus they would aid every science teacher. Also inservices that demonstrate how specific computer programs work would benefit us all."

"Our school uses application software - rather than for 'drill & kill' programs - microsoftworks - word processing and spreadsheets & data bases. I am also starting to look at using Hypercard - this program looks like it has a great deal of potential."

"Programs are too expensive and don't do what I really want them to do. Wish I could make my own."

"Some of my answers regarding the educational value of computer uses in senior high science classes are limited because I seldom use computers at senior high; have little time to work on incorporating them; and lack funds to even shop for software."

"poor quality software is the real problem"

"Uses of Computers in Science: sounds nice - bear in mind one will have to teach computers & science to get the job done. Cost of H'dw'e & Softw'e - its tough to get the basic equip't now if you look @ costs How crowded is the New Curric?? no one has seen it yet - how can one tell advantages if you don't know what is in it. Computers have a definite use in any class. Amount and purpose depend on a lot of variables. Keep this in mind - they are not a panacea."

APPENDIX 7

page

INTERVIEW SUMMARIES

Interview "A" - Non-user

Computer background:

I know what computers can do....but, I never learned to type, so I never tackled computers. I don't know what programs there are, other than when I've talked to other biology teachers. There are other teachers who've taught biology a lot longer than I have, who don't use computers in their courses. If there was a program, I might look at it, but to start a program when you don't even know how to operate a computer...

Problems with use:

I just don't know what a computer can do. If I could teach the course like Skinner... from just a set of questions... then I think I could teach it with computers. Say here's the computer, sit down, answer the questions at the end. There's no need for a lecturer or anything else. I don't think its that personal. Now if there's ways of using computers for exams or stuff lke that, maybe its different. But I don't know what they can do.

Available computer resources:

Access is sufficient, I think, if we need them. I think some of the teachers use them for their marks, so there are some computers around. There looking now at getting a complete set that is going to be integrated for a whole classroom. So their doing some good projections for the future here. There's a couple of good computer people here, and their working with people from the central office....I think they've gone on the right track. Their going to...sychronize things throughout the system, and for the future.

Computer uses:

If it's a proven thing out there and being used by other people, then I would say O.K..

Attitude questions generally:

Mostly, "no opinion" because I just don't know that much about them.

Computers and student interest:

I've seen where they have the laser disc system... if I was teach a unit on some topic that was on the disc, and could have access to that information - if that's computers, then I would use that. That would be terrific ... it's just right there. From that point of view, I've been impressed. I tape a lot from T.V. and bring it into class.

District support:

They did a census on how many teachers wanted to buy computers, and they might finance it; but when it came through and about thirty teachers wanted to, they said no we can't do it. They encourage it if you spend your own money on it. In other ways, they have the machines around, so they do encourage it that way. They leave the machines around and say try it. Their looking at computers at the lower level and at the high school level.

Computer training:

We've had a couple of workshops during P.D. days, a couple of lectures where you sit down and look at it. But, I've come in and I look at it and you play for an hour, ... and away I go. I haven't learned anything from it. Unless I'm going to put in twenty hours at home on it, where I'd have access to one that's easy, then its easier to just do things this way.

Access:

They've got one in the science area there, and I can go in and tap into it if I want, but if there's somebody else using it, we might have to line up for it.

Effective use of class time:

Not particularly effective, because I just don't know what can be done with computers. What can be done? I've got a class here and I set them down for a lab, and what do they do? They copy, they do everything; so if you've got computers, what are they going to do? If you're not lecturing and marking on it right away, what are you getting out of it? And, see, I don't know what a computer can do.

General Comments:

I just don't know what can be done with computers. I see a lot of kids using computers these days, and they all - even the slow learners - seem to know how to use them, so there's some excitement in using them. But will that stay? If every schools using computers from grade one to grade twelve, are they going to be as gung-ho in grade twelve? They play these games, pac-man and everything, an suddenly if you did it for twelve years, maybe they'd say forget it. So I don't know - I really don't know what they can do - I'd have to see it.

Interview "B" - Average User #1

Computer background:

I took a course in "BASIC" programming at university, and I started a summer course on educational software, but I gave up on it, because summer school and I don't get along.

I attended workshops put on by our local P.D. days. I remember one on "AppleWorks", and that was about all. I've never gone to a computer session at the science conferences.

When I look at a piece of software, all I do is run the thing through, and say could I use it in my situation. So my evaluation is not anything other than for my own personal use. To professionally analyze software, like for a government checklist, I wouldn't have a clue where to start.

Workshops:

I've always been able to get what I wanted for my own personal use. I would like to have access to seeing a few more software programs. For example, if the manufacturers would have it available at science council conferences or teachers' convention so you could just go and try different kinds of software, and decide whether our not you want to purchase it, rather than just hit and miss out of a catalogue. At a science conference, it would be nice to have a few sessions on how other teachers use science software in their classrooms, if in fact anybody does.

Access:

I suppose the problem is, that I couldn't decide today that I wanted to go in, because there are classes scheduled in our computer room all the time. I would have to organize - I'd either have to switch classrooms with a teacher - now some of the classes I couldn't switch because they are in fact computer classes in the computer room. Some would be easy to switch, just by talking to the teachers who teach other classes in that room.

Teacher use:

Word processor, data base, marks calculations. I have some instructional programs; I just haven't managed to work them into my programs. I have one or two that I could use. I've never even taken the time to see if they would work.

Where else I've used computers is to make up crossword puzzles for my science classes.

Student use:

Science 14 students use a "Space Station" game sometimes and use a data base ocassionally.

Students will ocassionally use the computer - word processing - to type up papers or assignments, or this year some kids typed up their science notes or some of their labs to be handed in. But, I taught the kids word processing in typing class, and if they were finished their typing assignments they opted to do these things. And I often used them as assignments for my word processing class, because the kids could make tables and stuff.

I have another piece of software, which is a simulated lab to teach the kids about controlling variables. Now I have it ready to go, but I've just never had the time or taken the time to organize it, to make it into a lesson. But, one of these days I do want to use it, because I think it will be very valuable.

Implementation:

It's a good idea, but its really just a pain in the ... Because I teach so many different science classes, and my classes are all very lab oriented, I just have never taken the time to do. It's just like one more thing that I have to plan for, and I'm always just keeping up on a daily basis. To do this computer thing, you need to sit down and plan it weeks in advance. That's really the only reason I haven't got into it. This year I had two new courses to prepare ... now maybe I'll go back and start implementing some of these things that involve a computer.

My kids come to me reasonably computer literate. They're familiar with the word processor. They know how to turn the thing on and run a piece of software. I don't think they know how to run the data base or spreadsheet until grade eleven or twelve. Also, not every kid takes that computer course. But I've found that kids will often help each other in the computer room.

Teacher support:

There are one or two teachers on staff who are very expert on the use of computers and if you have any problems, they'll certainly help you. So if you take the initiative, and want to use computers, they'll help you out.

Computers and science:

If I had a choice I'd always pick the hands-on lab rather than a computer program. That's because I have so many good lab activities that I've collected over the years.

I think it's really worthwhile. But, then, I think that all the kids are exposed to the use of computers in a computer course somewhere along the line; they learn to use word processing which I think is very valuable. If their familiar with the use of the computer, then I think they realize that computers play a major role in science and science research. So the kids become computer friendly ... I thnk it would be really valuable to be able to incorporate more computers into certain parts of science. Like you can use it to simulate experiments in physics, because the equipment is too expensive - I think that's really valuable. Now, in chemistry or biology ... all of that stuff is hands on. There's just not the same need for computer use in biology or chemistry. In chemistry ... I not sure you'd get the same learning out of a computer simulation of a chemical reaction. To really see it is much more effective than to just see the screen do something. In biology, the stuff we have is easier to do hands on. As you get into more advanced biology topics, I could see where it would certainly be good if you had the time and good software - you could certainly incorporate some good stuff.

District support:

No. There hasn't been any inservice in using computers that I'm aware of. They have made all the "MECC" stuff available to our school; but I just think they haven't had the time to do anything for us because of all the new programs. They don't even get inservice done on all the new programs, never mind computers and computer use in the classroom. Also, that software's really expensive, and they haven't given us any money to encour
age us to buy any software. There's not enough money for software, and if I had more I'd spend it on lab equipment.

Interview "C" - Average User #2

Computer background:

I've just picked it up at home; I do a little bit of programming - not much - typing in programs out of magazines, and changing them to what I want them to do. Basically self taught.

Access and use:

I rarely use them. There are twenty-eight "Apples" across the hall, and I could use them almost anytime. And there's a big monitor and one computer on a trolley that I could bring to class. We've got just about anything that I would use. I went to a workshop on making interfaces, we haven't got anything like that, but I can't see that I would use it anyway.

Support and assistance:

No assistance or support from the district, or the university, or anywhere else. I'm just on my own.

Teacher use:

I use it for marks, lesson planning, exams, worksheets - word processor, spreadsheet, that's about it. I have a modem too, but it's not really useful. I can call "Compuserve", but it's really expensive. And I got signed up with a test-bank in Florida, but those questions were almost useless. ... It doesn't work. I call ASPEN a lot too, but there's not much there - its mostly a letter bag for teachers to exchange things. I wanted to be able to exchange tests and stuff, but you can't download anything so its not much use.

Student use:

I have one physics drill & practice program that students use - that I got a copy of - that I let my students work on for one class. They enjoyed it. The thing they liked about it was they always got the right answer; if they got it wrong they could go back until they got it right. I didn't think they'd really like it because its so much work. You have to do all those calculations ... and then you punch it in and the program says sorry try again. But, they liked it, because they could get the right answer in the end. I just use the computer lab across the hall.

Value of student use:

One of my students said they could have learned the principle of ... better from that then from me. It isn't great, but its neat, though.

Like the graphics thing; I don't have a lot of lab equipment, and it a way to see things on the computer, like videos, a way to show that sort of thing. I think the computer could do anything, it could make them think or not ... there's no limit to what the computer could do really. I don't see how it could limit their thinking skills, though I guess most of the programs do. I think its possible to design programs that do encourage thinking.

I don't think that computers are very good instructors for teaching new things - more for drill and practice. For making up questions or something, maybe - or for labelling like in biology it could do instruction in that case.

Software:

I think there's not enough of it, and the price is over-priced; unless you could get it and copy it for the system. I don't think there's that much around that's really any good. I got stuff from all over that I hardly ever use. They don't seem to grab - they move slowly. You wait and wait and wait; it so slow. They need to be quicker paced, and stuff like that. Plus, for some of the calculations in physics, if there was a "pull down" calculator, or something, so you'd be more interacting with the computer; rather than just having it pose the question, you doing all the work, and then punch in the answer. Just make it more interesting. Most of it just using the computer to turn pages or draw pictures on the screen.

Computers and science instruction:

I think it could help. The potential is there. But the programs that I've seen aren't much good. There could be programs written that could enhance the primary goals of reasoning, conducting experiments, ... testing hypotheses, would be a lot better than using up chemicals. And it's really hard to do some labs. I can't think of a program that I'd recommend, though - that's the problem.

Implementation:

Suppose kids were using computers in English, using the word processor; then there's more pressure on me to let them use them for writing up lab reports. If more people would use them, then there's more pressure on everyone to do it. And, say, spreadsheets could be used in math for calculations, and same thing in physics. I set up a spreadsheet for physics a couple of years ago ... it was neat. Because, there's so many different quantities that can be related in some calculations.

I think their easy to use - it could just be part of the routine. I don't have real structured routines, so something different is no problem to me.

Workshops:

Often at those P.D. things that they have, there's often one. There was one at teachers' convention. I think there could be more though. I would sure like more. There just aren't workshops and courses available, at least not that I'm aware of.

General comments:

I think that computers could be better used, or more used, if there were better programs available, and if they were cheaper. There's no way out of our science budget. You don't have alot of money, and you look at some of those programs, two or three hundred bucks - it's just prohibitive. Especially if you can't try them out first.

Interview "D" - High-user

Computer background:

I took one programming course in "FORTRAN" in first year university, and it totally blew my mind. I dabble a little bit in "BASIC", but the software's there that I want to use. I really don't think its that important for kids to program, even at a high school level.

Software:

Our school's swithched right over to "Macs", we have a thirty station "Mac" lab. We're using them as word processors, data base and spreasheet. We'll get in a little bit this year on desktop publishing. I don't use any simulation software at all anymore. I always found it frustrating, I'd have one piece of software, and one computer, and thirty kids. Even some of the good software, I just never used. I used it a little bit for "drill & kill"; I still have a couple of things - I'll send the kids out to do - just basically for kids who've missed it; been away or is really out to lunch - missed the idea completely. But it's too time consuming. The programs are not that great, you wait and wait. To me all that stuff wasn't great; balance the chemical equation, and kid puts in the numbers and it says ah too bad try again, and the kid puts in the same numbers. I just think its not very efficient.

I think if the software was written, for the course, it would be alright. It's just that I have yet to find a really good piece of simulation software. I've never really got into a lot of it. I guess there was a lot of good stuff, where you could hook up light probes and that sort of thing, but all the stuff I could get my hands on was basically "drill & kill". And I never did find a good piece of simulation software that I could say, hey this'll work. We spend thousands of dollars on software, and it was all suppossed to be wonderful, and it was just a waste of disc space. And yet I know there's other people who think it's great. Maybe it wasn't the software, as much as lack of access to the computers. And, the software has to fit the way I want to teach some topic. Just because its good for the guy down the hall, it might not suit me.

Access:

We do have trouble, because everybody wants in there. You have to be a little bit better organized. When we had the "Apples" we had access to them all the time, but now the social studies guy's really into the data base part of the "Mac" environment, the language people are using them, plus the computer literacy courses - everybody's running through at different levels - grade eights on.

Student use:

Right now the grade eight's know a hundred times more about the "Macs" than the teachers do. Their a lot more comfortable with them than most of the staff.

I'm mostly using application software; word processing, data bases, spreasheets that sort of thing. The packaged software, I've said before, is just sort of "drill & kill"; you can do the same thing much more efficiently making up a worksheet and you can get the same effect once the novelty of using the computer wore off. The kids soon realized they were just doing a worksheet.

With the application software, we're trying to get them now into a little bit higher levels. They're taking the material and doing something. With my biology class I had them develop a data base on the invertebrates, where they had to set up the number of fields and they were sorting them and trying to manipulate them to look for common characteristics. We didn't get as far as I wanted to with it, but its a start. It sort of crashed - I got frustrated - when I ran out of computer time; I lost my access to the computers.

When we get into the hypercard and hyper-media ... there's all kinds of things we could do ... need to get the kids interacting with the computer ... so they can go off and explore. Don't be limited by punching in numbers. There's a concept, now here's where you can explore; here's where it can take you. When you put in those other pieces of technology, it almost gets unlimited.

Teacher use:

We're just into ASPEN right now. Its great for passing personal messages to the other people on it, but I haven't found anything particularly useful. I think it could work out. I don't have a modem in my room. I have to go and interupt someone else's class. Supposedly, every station will soon have access to a modem, and have access different data bases.

The computer in my room I just use for marks. Not even word processing - I use the "Macs", because we have the laser printer on them.

District support:

They made a committment about three years ago - they had all this money from the sale of teacherages, and they held on to it and the government wouldn't let them spend it any place else, so they've allowed them to access a few hundred thousand dollars.

Our board is extremely supportive of the use of technology. I'm trying to convince them now that there's more to technology than just "Macs". I want them to loosen the purse strings and get them to put a couple of laser video players and CD ROM players into the school. And I'm looking at hypercard, and getting into that environment.

There are teachers who are kind of the innovators, and the district is very supportive of them. One guy has really pushed and pushed, and the superintendent and the school board are supportive of his ideas. And we're into distance ed, so their looking for new things - the new environment. They'll get there; it'll take them a while, but they'll get there. I've been bugging them now for four years about laser video stuff. All I have to do is get one in place and show them how it can be used.

We haven't had to do that much lobbying, we expressed a need, and the board has basically said, through the superintendent, O.K.. But they were getting tired of spending money; one school on this software and type of machinery, another wanted to go this way. They said, whoa, if we're going to do this: because eventually all the kids end up in our school.

Some kids were coming in they'd had lots of computers, others had none; so they said if we're going to spend this kind of money, let's come up with a five-year plan. Let's identify needs, identify what's out there. They wanted to go "IBM" awfully bad ... but they listened to this guy who said, no the "Mac" environment's much more suitable for students. So they listened to our input. It basically came from one person; I had no idea what the "Macs" could do. But now that they're there, the potential is there for some really neat stuff to happen.

Benefits and problems:

The benefits outweigh any difficulties. Any problems are not insurmountable, and I think that the benefits will outweigh any difficulties. I think we can work around it.

I think the kids are learning a bit. I think the human element still has to be there, but I think they do have a place as another tool. I also question the CML their coming out with now. My gut feeling is, as long as their trying to do it without the presence of a teacher their going to find the students in difficulty. All it is, is a glorified correspondence course.... The kids were extremely frustrated - they missed the human element.

This little data base I tried to build with the grade tens was awfully time-consuming. I had to teach them how to build a data base; and then when we tried to use it, they had to go back and research what to put into it. It was a useful exercise, but very time-consuming. You can't get through the curriculum doing stuff like this. I have sit down and justify in my own mind; am I teaching the curriculum or am I teaching them how to use all this stuff.

Teacher training:

I think workshops would as beneficial as university courses. I think we need to look at ways of using the application software. I'm going on gut feeling all the time, and I'm not sure if my gut feelings are academically sound. I'd like to see things on how you could use the data base in a biology or chemistry program - instead of having to just punch up the numbers to balance a chemical equation like you have in the "MECC" software. There has to be something out there that would get away from the workbook approach.

I think how to use the computer - how to integrate it. We don't need anymore on how it affects their motivation ... we know that it works; let's learn how to use it and use it properly.

Implementation:

Its worthwhile, and its necessary - it has a good place. But I think that right now, until the kids are competent with the software, until I have access to the machines when I want them (not when the business ed guy says I can have them - when I have full access to them), when I can pull in stuff from whatever's out there - I don't even know what's out there yet ... I think its heading the right direction, and we're heading the right direction in our school, but it's still not that easy until we get all the technology and the pieces of the puzzle in place ... then I think the integration will fall into place then; but right now it's still going off like a shotgun, in all directions. Once in a while a piece of buckshot hits, but most of the stuff misses the mark. And the timing - we have to be able to build this into the curriculum.

It will be easier when the kids come in to my class knowing how to use the data base and spreadsheet. All the grade tens have had access to the computers and have taken computer literacy ten which involves spreadsheet, data base, and word processing - so next year we should start to see the benefits.

The key factor is the time to sit down and develop the software. That's going to limit this whole field, unless somebody takes the time. Who knows what's going on with hypercard, unless someone has the time to develop these things. Money. We have the money for the hardware; now to find somebody to write the software that I want written; or to pay me to sit down and learn how to do it, because I know what I want. You can't do it while you're still trying to teach. It just can't happen.