INTEGRATING THE USE OF VERNIER INTERFACE INTO THE SCIENCE CURRICULUM
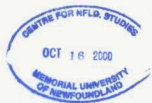
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<u>**Graduate Internship Report**</u>

Integrating the Use of Vernier Interface into the Science Curriculum

by

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An internship report submitted to the School of Graduate Studies in partial fulfilment of

the requirements for the degree of Master of Education

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Abstract

The purpose of this internship was to provide support to science teachers under the jurisdiction of the Burin Peninsula School Board for the integration of the Vernier interface into the science curriculum. A support system was provided that involved many activities, including one-on-one sessions with teachers, group sessions, classroom visitations, equipment set up and trouble shooting, an on-line support forum, and resource material development. The support provided was based on the individual needs and concerns of the participating teachers. Participating teachers completed a demographic form and the Stages of Concern Questionnaire at the beginning of the internship. This information highlighted teacher perceptions of obstacles that impeded their use of the Vernier interface, as well as the concerns they held at that time regarding the use of this technology. A post-questionnaire and an evaluation of the support provided were administered at the completion of the internship. The data collected from 13 teachers who had completed all questionnaires was used in the analysis. The major area of focus in the research component of the internship was changes in teachers' concerns after their participation in the internship activities. It was found that generally teachers moved from lower end or self-concerns at the beginning of the internship to higher level refocusing concerns at the end. However, many teachers still indicated in the post-measure of the Stages of Concern Questionnaire that self-concerns were still intense. It has been suggested that this may be due to participants encountering new dimensions of the multi-faceted innovation. The results of this study indicate that ongoing support for teachers is essential to the successful integration of technology into the curriculum. Additionally,

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those who provided professional development support to teachers must be cognizant of individual teacher needs and concerns that change over time. Support provided should be developed in light of these unique concerns. The support provided by the intern was perceived by participating teachers to be worthwhile and facilitated participants' use of the Vernier interface. The practical experience provided to the intern was considered invaluable in terms of its contribution to the personal and professional growth of the intern.

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CHAPTER ONE

OVERVIEW OF THE INTERNSHIP REPORT

Rationale for the Internship

The author chose the internship route for the completion of a Masters program primarily for the practical experience it offers. An initial decision to pursue a Masters degree three years ago was based on the author's goal to integrate technology into the classroom environment. The internship was perceived as a means to the partial realization of this goal.

A specific focus of an internship was much more difficult to decide upon. With the constant evolution and growth of computer use in the classroom, numerous pertinent issues could be explored. Advancements in technology have led to the development of computer programs and the related hardware for use in science education. Computers have the potential to provide educators with a newer, more dynamic means to communicate knowledge to students (Norton, 1992). The National Science Teachers Association (1992), in an adopted position statement, held that computers facilitate the learning of science, as well as, the development and application of scientific knowledge.

There are numerous applications for the use of computers in science education. Tutorials can promote the acquisition of facts, skills, and concept learning and enhance understanding. Simulations provide opportunities for students to experience phenomena that otherwise would be impractical due to issues such as expense, danger and time. Science students can organize, analyse and present data with databases and spreadsheets.

Communication between teachers and students is possible without physical limitations, by the use of email or the internet. Finally, students can collect data, make observations, manipulate variables and analyse findings through the use of microcomputer-based laboratory devices or computer interfaces. It is the implementation of the latter into the science curriculum that was the focus of this internship. Computer-based sensing and control, data acquisition, analysis and presentation tools and methods are available to replace traditional tools and methods. In addition to the technology itself, strides have been made to promote the utilization and implementation of this equipment into the science curriculum. In the context of science teaching and learning, interfacing refers to the practice of employing computer-based hardware and software tools to collect data in real time. The interface is the part that sits between the computer and the real-world event that is being observed. It consists of three distinct components - a computer card, software and sensors. Analog sensors produce a voltage in response to external stimuli. Digital sensors respond to on-off events. The card reads the changes and converts them to digital numbers.

The decision to concentrate on computer interfacing was based on the author's experience with computer-aided experimentation in the teaching of science. Any strategies for the use of technology in schools must address a fundamental educational issue, that is, what is the relationship of the technology to educational goals (Fontana & Ochoa, 1985). Support for this argument was offered by Wallinger (1997), who contended that technology is not the ultimate goal of schools. Rather, educators need to recognize that technological tools can aid in reaching educational goals effectively.

Willis (1997) echoed these concerns and called for teacher training that illustrates how technology can improve education rather than just getting educators to use computers in the classroom. Technology needs to be seen as an extension that complements the curriculum rather than replaces it. The current objectives of both the physics and chemistry curriculum necessitate the use of computer interfacing technology. The intent of this internship was to promote an understanding of how computer interfacing can facilitate the meeting of educational goals within the science curriculum.

The focus on the use of a specific make of hardware and software produced by the Vernier Company was justified based on the availability of this equipment in all senior high schools under the School Board's jurisdiction. Unfortunately, the mere presence of such equipment (both hardware and software) in schools does not mean that such equipment is being used, or being used to its maximum potential. Although the equipment is available, it may not be available in adequate numbers to address the needs of all class sizes. The lack of available software and hardware is a major obstacle for the integration of technology into the curriculum. Throughout this experience, the intern attempted to address the needs of individual schools and teachers with respect to the optimum availability and accessibility of the necessary equipment.

Based on personal experience and communication with other teachers, the intern contended that some teachers may not feel comfortable using the Vernier interface in their classrooms due to their lack of experience and training in the use of this technology. Fox, Hershman and Peard (1994) suggested that both middle and high school teachers need support and training in the use of computer interfacing for experimentation. Also,

the use of computer-aided experimentation in classrooms will vary based on teacher background. Even those educators who use computers as an integral part of experiments may require new ideas for experimentation. The literature in the area of the use of computer interfacing in science classrooms promoted the involvement of teachers at a much higher level (Anderson, 1989; Braun & Mulstay, 1993; Durham, 1990; Fox, Hershman & Peard, 1994; Krause, 1988; Westling & Bahe, 1986).

Furthermore, teachers may have limited access to computers and the school computer laboratory. In a study on the use of microcomputer-based laboratory (MBL) techniques of secondary science teachers in the state of Hawaii, Heck (1990) found that teachers perceived adequate access to equipment as the greatest concern with respect to making a program successful. The participants in Heck's study also noted that the completion of a laboratory activity required too much time because of lack of access to equipment.

Appropriate utilization of Vernier interface may provide students with a better understanding of scientific concepts. If the Vernier interface is not used, students may miss opportunities for independent scientific studies that might be undertaken as class projects for such events as science fairs. A microcomputer-based laboratory approach can also assist students' development in other ways. Fox, Hershman and Peard (1994) suggested that projects developed by students through such approaches promote student ownership of the inquiries and motivate them to become self-directed learners.

Overall, this internship focussed on the delivery and support of professional development activities related to a specific type of interfacing equipment and the related

computer software. Such activities were aimed at promoting the integration of Vernier software and hardware into science courses at the junior and senior high level.

The Internship Setting

The 15 week internship was completed with the cooperation of the Burin Peninsula School Board (District 7). A formal request to complete the internship was made by the intern after informal discussions with board personnel (Appendix A). Approval for this request was given by the Director of the Burin Peninsula School Board. Mr. Michael Siscoe (Appendix B). The Burin Peninsula School Board covers a large geographic area. A total of 21 schools is encompassed by this district, including 10 schools that serve senior high students. The choice of this setting was based on the opportunities provided by such an environment. This setting allowed the intern to work with Mr. Graham Wood (Program Specialist - Senior High) and Ms. Lynn Fitzpatrick-Antle (Itinerant Teacher for Technology), as well as other Board staff. Most significantly, it provided opportunities for the intern to network with colleagues in the geographic area covered by the School Board in an attempt to improve and evolve the integration of computing interfacing (specifically the Vernier System) into science classrooms. The Memorial University, Faculty of Education supervisor was Dr. Dennis Sharpe.

The author has been employed by the Burin Peninsula School Board for the past 11 years. During this time, the Board has been very supportive of the continued professional development of this intern. Such a supportive environment was perceived

by the intern as an ideal setting for the completion of an internship. Notwithstanding the above, the geographic location of the School Board offered obvious advantages to the intern in terms of place of residence and familiarity.

The Internship Goals

The goals of this internship were divided into three key areas. Each of these is outlined below.

A.   Professional and Personal goals of the intern

Through the experience offered during the internship, the intern planned to:

Goal 1   Gain experience with Vernier software and hardware;

Goal 2   Increase her personal awareness of teaching practices of colleagues;

Goal 3   Have opportunities to apply theories studied throughout the Masters program to practical settings;

Goal 4   Improve personal understanding of the issues involved with integrating technology into the curriculum;

Goal 5   Expand professional knowledge of effective inservice methods for educators; and

Goal 6   Improve leadership skills that will contribute to the author's abilities to promote future technological initiatives within the classroom or school.

B.   Technology Integration goals

In addition to the personal and professional goals that would be of benefit to the intern, the internship would, it was anticipated, promote technology integration into the schools under the Burin Peninsula School Board's jurisdiction. Specifically, these technology integration goals were to:

Goal 7   Promote the use of computer interfacing in the science curriculum and encourage teachers to take responsibilities for their continued learning in this area;

Goal 8   Provide teachers and students with direction in the use of computer interfacing in their classrooms;

Goal 9   Provide suggestions for the setup and organization of computers in science laboratories;

Goal 10   Provide opportunity for teacher inservice and continued support that addresses both technology skills and curriculum issues;

Goal 11   Help teachers reach solutions to any obstacles that deter the use of computer interfacing in their classrooms;

Goal 12   Promote the cooperation and interaction of teachers in their use of computer interfacing; and

Goal 13   Identify the needs of individual schools based on technical support, hardware, and software requirements and to initiate the meeting of these needs.

C.   Research goals

Finally, the internship included a research component which demonstrated creative and reflective research. This aspect of the internship focussed on the responses of teachers to professional development inservice activities. The specific research goals were to:

Goal 14   Determine the value, as perceived by teachers, of the inservice and continued support provided;

Goal 15   Evaluate the inservice and support provided;

Goal 16   Determine any discrepancy between the intent of the inservice training and what was actually achieved;

Goal 17   Measure any change in the use of the Vernier software and hardware in the classrooms of educators involved in the study;

Goal 18   Suggest possible future needs and research questions to address the concerns of teachers; and

Goal 19   Measure changes in teachers concerns regarding the integration of Vernier software and hardware into the classroom.

The Internship Activities

The accomplishment of the goals stated above was possible through the implementation of a number of activities. The rationale for these activities was grounded in current research into the implementation of innovations into classrooms and teacher inservice training. The initial proposal for the internship included a one day inservice for

participating teachers early in the internship. Unfortunately, this activity was not realized due to restrictions on the number of available substitute days for teacher inservice.

The specific activities the intern embarked upon are outlined below:

1) <u>Preinservice Interviews</u>: during the first two weeks of the internship, the intern visited each of the 10 senior high schools under the jurisdiction of the Burin Peninsula School Board. During these visits the intern met with the principal of each school to receive approval for the participation of schools and to explain the aims of the internship. Also, the intern met individually with teachers involved to develop a rapport, explain the intent of the internship, and to get a commitment from the educators to participate in the research study. Initially senior high teachers were targeted. However, due to the presence of many K-12 schools in the district, some junior high teachers were also invited to participate based on their interest. During this time the intern attempted to gain a better understanding of the needs and concerns of teachers regarding the use of the Vernier interface and technology in general. Also, the intern visited both the science laboratory and the computer laboratory in each school to determine the setup and availability of computer equipment. After the meetings with teachers they were sent a pre-questionnaire (Appendices F and G) to determine their current concerns regarding the implementation of the Vernier interface into the science curriculum.

2) <u>Structured Coaching/Classroom Visitations</u>: after the initial meeting with teachers, they were contacted to set up meeting times for individual or small group sessions with the intern. The sessions that resulted from this contact included one-on-one sessions with individual teachers, group sessions with teachers in particular schools, and

classroom visits where the students used the Vernier interface and the intern served as either a facilitator or observer. These sessions continued throughout the internship and varied in their structure based on the individual requests of the teachers involved. The purpose of these sessions was to provide teachers with a one-on-one interaction and to aid teachers in the setup and demonstration of the use of the Vernier interface with the students. Additionally, these visitations provided an opportunity for the author to observe students during their interaction with the equipment. During these sessions teachers were either introduced to the Vernier interface or provided with support to expand their knowledge of this technology.

3) <u>Laboratory Design and Restructuring</u>: the use of technology in a science classroom or laboratory is enhanced by the availability of computer equipment in the science laboratory itself as compared to a separate computer laboratory. The author actively promoted the procurement of computers, and the necessary equipment, for the science laboratories in the schools under the jurisdiction of the Burin Peninsula School Board. The intern explored possible sources of any available computers that could be effectively utilized in science laboratories. This activity was more demanding than initially anticipated by the intern, as many science laboratories in the district did not have computers. A number of computers became available through the Computers for Schools organization. This nonprofit organization supplies computers to schools across the province. Information regarding these computers was received during the second week of the internship. These computers were assigned specific school destinations. However, they did not arrive in the schools until the first week in November. Prior to the arrival of

these computers, the majority of the sessions were spent in schools which had computers available. Once the computers arrived, a tremendous amount of time was spent checking the computers, installing hardware and ensuring they were calibrated and ready for use.

Another concern that was addressed under this area was the construction of photogate kits that were present in the schools, but unusable in their unassembled condition. Through discussion with two instructors at the College of the North Atlantic, a solution was reached that was mutually beneficial to the schools and the College of the North Atlantic. The construction of the photogates was used by an instructor as an activity for his students. The College of the North Atlantic was extremely cooperative in this area. The schools in the district were contacted to send in their unassembled kits. Although some schools opted to keep the kits for construction by their own students, a total of 15 kits was assembled.

4)   On Line Support: early in the internship the development of a web page was initiated. The purpose of this web page was to provide a medium of support for educators that would continue after the completion of the internship. This web page included general information about the Vernier interface, a question and answer forum, a trouble shooting section, various activities that can be downloaded to a personal computer and a number of links to internet sources related to the use of computer interfacing in science education (Appendix J).

5)   Curriculum Materials: throughout the internship, the intern developed a booklet of laboratory activities utilizing the Vernier interface that specifically addressed current objectives of the science curriculum in Newfoundland and Labrador for both the junior

and senior high level science courses. The decision to pursue the development of this resource for teachers was based on the concerns of teachers regarding the availability of activities that specifically addressed curriculum topics. This concern was particularly evident among Biology teachers and junior high science teachers. This resource was provided to teachers in the district in a hard copy format and also on floppy disk (Appendix I).

6)   Support for Distance Education Students: two schools under the jurisdiction of the Burin Peninsula School Board were offering senior high physics courses by distance education during the time of the internship. Through discussion with principals, school teachers and the distance education coordinator, a concern was identified regarding the use of the Vernier interface by these students. The difficulties associated with the independent completion of the required laboratory activities were familiar to the intern. Having experienced this before, the intern concluded that assistance to these students could be another form of support to the science teacher in the school. The support provided to these students was intended to help students become more independent in their use of this technology. The intern visited both schools throughout the internship and provided technical assistance to the students. Additionally, dialogue with the student before, during and after the activities was aimed at improving the students' understanding of the scientific concepts being explored. This area of the internship was not used in the research component. Although there was no attempt made to measure the effectiveness of this support, it was a very rewarding aspect of the internship.

The Research Component

The internship included a creative and reflective research component. The aim of the research component of the internship was to determine the effect of the inservice activities and support provided on the concerns and actions of teachers regarding the integration of Vernier applications into their science classrooms. Approval for this component of the internship was provided by the Ethics Review Committee, Memorial University of Newfoundland (Appendix C).

Schools and individual teachers were asked to participate in the research component of the internship. This participation included the completion of questionnaires and interviews, and scheduled classroom visits. Prior consent was obtained from principals and teachers with their completion of a consent form (Appendixes D and E). Teachers were informed that they were free to end their participation at any time, as well as refrain from answering any questions they deemed inappropriate.

Teachers participating in this internship were assured that their anonymity would be protected and all information would be kept confidential. At no time was a teacher's name associated with any data collected. Identification of the subjects participating was accomplished through a coding system. Only the intern had access to teachers' names and their respective codes. After the completion and acceptance of the internship report, all data collected will be physically destroyed to ensure the continued confidentially of the participants.

A number of instruments were used to collect data for the research component of

this internship. All information collected was of direct relevance to the internship. The Stages of Concern Questionnaire, developed by Gene Hall and colleagues at the University of Texas (1977), was used to determine if and how teachers' concerns regarding the integration of Vernier applications into their science classrooms had changed after teachers have been provided with support and direction to facilitate this process. Teachers completed a questionnaire at the initial stages of the internship and again after the conclusion of the internship (Appendix F). Comparisons of these pre- and post-questionnaires were made to determine changes, if any, in teachers concerns. The results of these questionnaires were analysed in light of the teacher's participation in the internship activities in an attempt to draw conclusions regarding the support provided by the intern. Additional information was collected using interview questions that focussed on general computer use and the use of Vernier software and hardware by the participating teachers (Appendix G).

Data collected during the initial stages of the research component helped direct the intern toward the needs of individual teachers. In addition to guiding subsequent activities of the internship, the data collected allowed the intern to analyse the effectiveness of the professional development activities provided. Analysis of changing concerns of participating teachers helped determine the effectiveness of the internship activities. Additionally, these findings were useful in guiding future professional activities that may be implemented by the intern or by the Burin Peninsula School Board.

Limitations of the Internship

This internship was conducted to facilitate the implementation of the Vernier interface into the science curriculum. It involved a limited number of participants in a specific geographic area in the province of Newfoundland and Labrador.

Since the research involved such a specific and small number of participants, it is unlikely that the results can be generalized to other groups. The limited sample is justified however in the overall intent of the internship: To provide individualized support to teachers.

Another limitation of this internship was its duration. Change has been identified as a time dependent process. Therefore, professional development support that spans only 15 weeks may not be a desirable way to produce long-lasting changes in a teacher's concerns regarding the implementation of the technology which was the focus of this internship.

Further to this limitation of the internship duration was the restricted time available to teachers to attend sessions. Every attempt was made by the intern to accommodate the hectic schedules of the participating teachers. Most sessions were held after regular school hours. However, professional, extracurricular and personal commitments prevented teachers from partaking in more sessions.

The setting in which the internship was completed involved schools from the northern part of the Burin Peninsula to its most southerly points. This physical expanse dictated many hours of travel to reach the participants in their respective schools. Obviously, this commuting time decreased the time spent focussing on the internship

itself.

A final limitation involves the instruments used to collect data. Every effort was made to choose a survey instrument that was valid, reliable and unambiguous. However, the responses to such measurement devices depended on the participants responding in a frank and conscientious manner. Additionally, some participants indicated that they were unsure about the intent of some of the questions posed in the Stages of Concern Questionnaire.

Organization of the Report

The next chapter provides an in-depth discussion of related literature in areas pertinent to the internship. The literature reviewed included the general perception of the role of computer interfacing in science, conditions necessary for providing effective professional development support to teachers and a comprehensive analysis of an effective means to measure changes in teachers' concerns as they are involved in the implementation of an innovation.

In Chapter Three a detailed research methodology is outlined. The instruments used in the research component, the participants and the professional development support provided (including a weekly account of the internship), are discussed. Chapter Four provides an analysis and interpretation of the data obtained. The report concludes with a discussion of the findings in Chapter Five. In this chapter, the accomplishment of the goals outlined in Chapter One are addressed. This final chapter also includes a personal, critical reflection of the internship, as well as recommendation for further study.

CHAPTER TWO

REVIEW OF THE LITERATURE

This chapter will focus on the research available in three key dimensions that are of utmost importance to the internship. Initially, the area of computer interfacing is reviewed. The contribution of computer interfacing to the understanding of scientific phenomena is demonstrated. Next, the implications for the provisions of effective professional development to teachers in general and in the context of technology are explored. The chapter concludes with an analysis of the use the Stages of Concern Questionnaire to examine changes in teachers' concerns as they are involved in the implementation of an innovation.

Computer Interfacing in Science Education

General support for the use of computers in science experiments is not a novel concept. Finkel (1975), suggested that "computer-aided experimentation results in 'better science' when properly applied because the scientist is relieved of tedious, repetitive jobs, thus permitting him more time for creative work" (p. 2). Nachmias and Linn (1987) contended that the use of microcomputer-based laboratories represents one of the most promising and innovative developments in science laboratory instruction. Wilson and Redish (1989) recognized that the use of computers for the acquisition of data can improve laboratory experiences for students. Rather than obscure the scientific topic under investigation, microcomputer-based laboratories can help students better

understand concepts that are difficult when presented in traditional ways. In reviewing literature in the area of computer based learning in science, Weller (1996) concluded that microcomputer-based laboratories hold the most promise of all educational computing tools since they provide opportunities to conduct science in discovery and justification contexts.

The advantages of integrating computer interfacing into the science curriculum can be identified in both the experimental method process and the scientific process upon which science education is focussed. Amend, Briggs, Furstenau, Tucker, Howald and Ivey (1989) and Amend and Furstenau (1992), argued that computers which allow students to complete the experimental method process in a better, faster or more accurate means, or which allow students more involvement in the scientific process have a place in the science laboratory. The experimental process includes the identification of a problem, the design of an experiment, the acquisition, organization, presentation and analysis of data, and the formulation of conclusions based on these activities. The use of computer interfacing in a science laboratory allows students to collect data, but more importantly, it allows the collection of data at rates not possible by traditional means and for periods of time that are more practical (Amend, Briggs, Furstenau, Tucker, Howald & Ivey, 1989; Hart, 1998; Price, 1989). Trumper and Wiener (1994) illustrated how a V-scope allows harmonic oscillations, which are too fast to follow in order to acquire data, to be detected and presented graphically in real time, at the same time the students observe the mechanical oscillations. Additionally, scientific data can be collected with more precision and accuracy than possible by traditional means (Amend, Briggs, Furstenau,

Tucker, Howald & Ivey, 1989; Matlock & Safford, 1989; Risley, 1988).

Software, used in conjunction with interface hardware, organizes data, presents it instantaneously and simultaneously to students as the event under investigation progresses (thus providing immediate feedback); allows students to statistically analyse the collected data and encourages collaboration among students as they discuss the validity, meaning and implication of the data presented (Brasell, 1987; Graef, 1983; Heck, 1990; MacIsaac, 1990; Mokros & Tinker, 1987; Scaife, 1993; Thompson, Seligmann & Cava, 1993; Thorton & Sokoloff, 1990). While many will argue that the construction of data tables and graphs is a valuable skill for science students, proponents of computer interfacing contend that students who are freed from the drudgery and necessary time associated with these actions, are better able to focus on the scientific processes at hand, explore experiments in more depth and perform high order skills (Adamson, Zimmerman & Nakhleh, 1997; Cordes, 1990; Findlay & Lamb, 1993; Fox & Eddy, 1990; Fox, Hershman & Peard, 1994; Friedler & McFarlane, 1997; Mokros & Tinker, 1987; Powers, 1986; Roth, 1989; Stein, 1987). The ability of students to focus on the scientific issues involved in an experiment promotes inquiry and understanding, and thereby leads students to make appropriate conclusions and generalizations. Equipment is also available that allows data to be collected outside the physical environment of the science laboratory. Such data can then be downloaded to a computer so that it can be organized, analysed and interpreted (Clark, 1993).

Although many uses of computer interfacing in schools provide students with experimental designs to follow, computer interfacing allows students to easily manipulate

variables and repeat data collection based on their individual needs (Cordes, 1990; Fox, Hershman & Peard, 1994). Fox and Eddy (1990), suggested that, through the use of computer interfacing, students can be encouraged to design their own experiments that can be used as independent projects, such as those entered in competitions or science fairs. Further support for the potential of these individual projects was echoed by Amend, Briggs, Furstenau, Tucker, Howald and Ivey (1989). As well as promoting student development of experiments, the use of computer interfacing can encourage educators to develop their own experiments and interface devices that meet their individual needs as they strive to provide students with meaningful science instruction (Fox, Hershman & Peard, 1994; Krause, 1988; Westling & Bahe, 1986).

It is important to note, that although the integration of computer interfacing into the science curriculum is promoted due to the advantages discussed above, educators must exercise caution in their use of this technology. Willis (1997) argued that computer interfacing should not be seen as a replacement for traditional instructional methodologies. Rather, it should be viewed as a means to complement and enhance traditional techniques. Others, including Amend, Briggs, Furstenau, Tucker, Howald and Ivey (1989) and National Science Teachers Association (1992), also expressed concern over an unconditional and uncritical acceptance of this technology.

Additionally, the use of the computer in science instruction should not simply be an 'add on' to current resources. Instead, educators must strive to integrate the technology into the curriculum in ways that are effective and enhance both teaching and learning (Adamson, Zimmerman & Nakhleh, 1997; Winders & Yates, 1990). The technology

itself should not be the ultimate goal. Educators need to realize that technology is a tool that can aid in reaching educational goals effectively (Wallinger, 1997). Stein (1987) cautioned that effective use of computer interfacing requires careful thought in terms of the implementation of this technology into the curriculum. Furthermore, this instructional framework of the learning environment is crucial to the success of such implementation (Nakhleh, 1994). Trumper (1997) argued that improvement in learning science concepts through the used of microcomputer-based laboratories results from both the technology and appropriate curriculum materials. Student involvement in the experiment at hand need not be diminished by the use of a computer. Instead, with the use of appropriate activities, student involvement can be increased. Thorton (1987) and Solomon, Bevan, Frost, Reynolds, Summers and Zimmerman (1991), described an experiment in which position-time graphs and velocity-time graphs were being produced by students as they physically move and trace their own movement with a motion detector.

There are many types of commercially available interface systems. The focus of this internship was the use of the Vernier interface due to its availability in schools under the jurisdiction of the Burin Peninsula School Board. Additionally, the present curriculum in the Senior High physics and chemistry courses in Newfoundland and Labrador recommends the use of the Vernier interface in the delivery of these science courses. Laboratory manuals developed by the Government of Newfoundland and Labrador (1995), through Distance Education, provide laboratory activities using Vernier that address specific objectives of both these courses. Other areas of the science

curriculum, at both the senior and junior high levels, can utilize computer interfacing to facilitate the meeting of curricular goals. Unfortunately, specific activities have not been developed to address these areas. At the junior high level, the use of computer interface is recommended to meet objectives throughout the curriculum in all grade levels.

The Vernier system meets the requirements suggested by Graef (1983), in that it enables laboratory data to be processed by a computer. Sensors capable of detecting various phenomena are available as part of the Vernier system to capture data. This analog data can then be converted into digital signals recognized by the computer. Finally, Vernier software allows the user to analyse the data collected. Risley (1988), in reviewing Vernier software, noted that the package is versatile and promotes high interaction with student control.

Currently, the majority of schools in the Burin Peninsula School District utilize a DOS based version of the software. This software includes four programs; Motion Plotter, Graphical Analysis, Precision Timer and Multipurpose Lab Interface Program. However, Vernier has also developed a Windows-based version of the Multipurpose Lab Interface Program which is more user friendly than the older DOS version.

Professional Development Support

The use of microcomputers in science teaching, as discussed above, has great potential to improve the education of students. This potential can be realized if teachers are successful integrating this technology with their educational goals and curriculum. The introduction of innovations into a school system does not ensure their

implementation into programs (Hope, 1997). Locally, The Technology in Learning Environments (Government of Newfoundland and Labrador, 1996) document noted that the inservice of teachers is not keeping up with the fast pace at which technology is being introduced. Many will argue that, although school systems have spent tremendous amounts of money on computer hardware and software, the area of teacher inservice training has been largely neglected (Wallinger, 1997; Willis, 1997). McKenzie (1998a) argued that the most significant explanation for the failure of technologies in schools is the lack of investment in teacher learning. The lack of inservice training is seen as a contributing factor to the limited use of microcomputers in science classrooms (Germann & Barrow, 1996; Lehman, 1985). The theme throughout this internship was the provision of support to teachers that promotes the integration of computer interfacing into the science curriculum. Fox, Hershman and Peard (1994) suggested that both middle and high school teachers need support and training in the use of computer interfacing for experimentation.

Merely using technology is not sufficient, its importance as an educational innovation lies in its potential to change the nature of teaching and learning through integration (Willis, 1993). Meaningful integration of technology into the curriculum may be possible if teachers are provided adequate support (Persky, 1990). The issue of effective inservice training has been addressed in the literature. Borchers, Shroyer and Enochs, as cited in Haney and Lumpe (1995), contended that effective staff development includes training, continuous support and implementation help and addresses the needs of each particular teaching environment.

Research recognized the importance of support and inservice that meets individual teachers' concerns and needs. Unfortunately, support often fails to address the varying backgrounds of teachers (Moursund, 1998). Wedman, Heller and Strathe (1986) argued that those who provide inservice must be attentive to the heterogeneous nature of teachers experiences. The success of such support systems is dependent on the attention given to individual differences (Hall & Loucks, 1981). The vital role that teachers play in staff development is identified by Haney and Lumpe (1995), who contended that teachers' beliefs about science teaching must be identified throughout any training. Harty and Enochs (1985) identified that inservice programs should reflect the involvement of teachers in all areas including needs assessment, planning, designing and implementation. Furthermore, a knowledge of teachers use and understanding about technology is essential to the planning of support training (Atkins & Vasu, 1998). Such knowledge allows providers of inservice training to address necessary issues and thereby provide more effective training. McKenzie (1991) suggested that input from teachers can increase the likelihood that inservice activities will match the needs of teachers.

Ingvarson and MacKenzie (1988), in reference to Fullan, identified the absence of follow up sessions after workshops to be a significant problem in professional development. Agreement that the impact of inservice education depends on the degree of follow up support teachers receive was provided by Zammit (1992). Baird, Ellis and Kuerbis (1989) questioned whether science teachers who received inservice training on the implementation of computers in their classrooms used the computers when they returned and if they continued to use them at times after training. Ongoing support

during the adoption of an innovation should, and can, be provided through a number of means including school-based consultants and electronic support (Willis, 1993). A slow and deliberated approach to the integration of technology into teacher practice was explored by Brown and Henscheid (1997). These authors note that patience for change is necessary. Although a school system is often pressured to bring about change quickly, it may be necessary to realize that real change can only occur over the long term. Without providing follow up, teachers don't get a chance to put their knowledge to use and often lose interest or forget what they have learned at inservice sessions (Guskey, 1986; Wallinger, 1997). Wallinger (1997), in referencing Kinnaman, contended that teachers need time to learn and get comfortable with both the technical and curricular aspects of technology.

Individual teacher concerns that are not addressed at a group inservice, often due to the variation in teachers who take part, can be addressed during one-on-one inservice and steps can be taken to build on the educator's current level of knowledge (Moursund, 1998; Wallinger, 1997). O'Brien (1992) promoted the utilization of coaching. Small groups or individual training/coaching sessions are more conducive environments for addressing individual needs and concerns. Ellis (1989) noted that a peer coaching component is not often incorporated into support systems although research indicates it is critical to the success of training. Williams (1993) suggested that peer instruction or coaching promotes learning more significantly than large group lecture sessions. Training of this type over several sessions allows teachers to build on existing knowledge in a systematic way and promotes the incorporation of this knowledge into classroom

practices (Baird, Ellis & Kuerbis, 1989; Showers, 1985). Promotion of a systematic process was echoed by Hall and Loucks (1981). Inservice structured in this way can minimize unrealistic expectations and allow teachers to get comfortable with specific aspects of an innovation before moving on to subsequent issues. Additionally, these coaching sessions provide better opportunities for teachers to be involved in hands on training. Baird, Ellis and Kuerbis (1989), cited that such training is beneficial to teachers and promotes positive attitudes toward that application of computers in education. Coaching sessions can allow follow up from group inservice that promotes the transfer of new skills from the session to the classroom (Ellis, 1990; McKenzie, 1991). When these sessions take place in the teacher's regular environment feelings of comfort are facilitated (Gilmore, 1995). Furthermore, Ellis and Kuerbis (1992), argued that when fellow teachers serve as coaches or consultants, a comfortable atmosphere is created.

One-on-one sessions provide opportunities for teachers to both observe and actively participate in activities. These interactions can promote the establishment of effective working relationships between the coach and the teacher (MacArthur, Pilato, Kercher, Peterson, Malouf & Jamieson, 1995). One-on-one sessions also allow trainers to deal with the changing needs of teachers, as well as each unique situation. Wallinger (1997) contended that teachers need to be persuaded that technology will improve teaching and learning if they are to incorporate it into their curriculum.

By utilizing activities that reflect the goals of the learning, the teachers are submerged in a meaningful context. Williams (1993) argued that skills learned in such context are more likely to be transferred. McKenzie (1998b) suggested that, for the busy

teacher, brief sessions in comfortable, small group settings are ideal. During these times specific issues can be addressed. He also argued that any support systems must focus on learning rather than training. Learning in adults is facilitated by participation in activities that match a person's interests and needs.

Measuring Changing Concerns of Teachers

The research discussed above identifies the importance of individual teachers' needs and concerns to the effective implementation of an innovation. Hope (1997) contended that the implementation of an innovation is a change process. The successful implementation of an innovation necessitates an understanding of this change process from the teachers' perspective.

The Stages of Concern Questionnaire (SoCQ), based on the Concerns-Based Adoption Model, has been identified as an instrument to measure changes in concerns as individuals strive to implement an innovation (van den Berg, 1993). This questionnaire was developed by Gene Hall and colleagues at the Research and Development Center for Teacher Education, University of Texas (Hall, George & Rutherford, 1977). Information obtained from these questionnaires can provide understanding of how individuals respond to innovations and how inservice programs may change responses. The focus is on individuals' concerns about an innovation. Feelings, preoccupations, thoughts and considerations, relevant to individuals involved in the implementation of an innovation, are identified as concerns. The instrument consists of 35 items that measure seven levels of concern as shown in Table 1 below. Individuals respond to each item of the

questionnaire by using an eight-point Likert scale.

Hall (1979) provided suggestions that would facilitate the movement of teachers from early stage concerns to later stage concerns. These interventions were aimed at recognizing an individual's concerns as significant and then providing support to resolve such concerns.

The versatility of this measurement instrument was voiced by Broyles and Tillman (1985) who contended that the instrument can be used for individuals at varying levels of an innovation (nonuser to expert) and for any type of innovation. Further research indicates the SoCQ has been used in the study of many innovations, including those related to the use of microcomputers in education (Wedman, 1988).

James (1981) and James and Hall (1981) promoted the use of the SoCQ by those who wish to facilitate the implementation of innovation into the science curriculum. The use of the SoCQ, as well as other components of the Concerns Based Adoption Model, allows for a better understanding of the implementation process which will facilitate implementation efforts. Additionally, Broyles and Tillman (1985) used the SoCQ to determine the effect of various inservice components (presentation, example, application, feedback) on changes in teachers' concerns. Analysis of the results of this study indicated that the time spent on each component of inservice reflected the concerns expressed by teachers, as measured by SoCQ. For example, when more time was spent on providing feedback, participants showed increases in concerns at the management stage. The findings of this study suggested that the content of inservice sessions greatly influences the movement of teachers through the various stages of concern.

Table 1

Levels of Concern Stages

Stage	Title	Stages of Concern Description
Self-Concerns		
0	Awareness	Concern is absent; unaware of innovation.
1	Information	Concerned about not knowing enough; want general, high level information.
2	Personal	Concerned about effect innovation has on personal role.
Task Concerns		
3	Management	Concerned about managing innovation when implemented; will it create an unmanageable organization structure?

Stage	Title	Stages of Concern Description
Impact Concerns		
4	Consequence	Concerned about impact innovation will have on students; will they be better off from it?
5	Collaboration	Concerned about ability to work with others during implementation
6	Refocusing	Concerned about altering innovation either to improve it or change it

Germann and Sasse (1997, p.407)

The use of the SoCQ to evaluate the effectiveness of inservice on the use of microcomputers in educations was explored by Wedman, Heller and Strathe (1986). The authors of this study used their findings to caution that inservice activities may not necessarily lead to successful implementation of a program. Analysis of pre- and post-questionnaires indicated that management concerns did not increase after the inservice. The implication is significant in that these findings indicate that transfer from inservice to the classroom should not be assumed by those who provide inservice.

Cicchelli and Baecher (1987) reported that the use of the SoCQ to plan inservice activities was successful in bringing about significant changes in teachers concerns

toward microcomputers. Their findings indicated that significant increases in impact concerns (Stages 4, 5 and 6) were realized.

Further support for the use of the Stages of Concern Questionnaire was provided by a study on the implementation of teacher technology workstations by Hope (1997). This study illustrated the significance of measuring teachers' concerns to the provision of effective support and training. The concerns of the sixteen participating teachers measured in a pretest of the SoCQ guided the support that was provided to teachers. This support, in turn, resulted in the movement of teachers to higher levels of the stages of concern continuum. Similar findings were reported by Germann and Sasse (1997) in a study about the use of microcomputers in science teaching. Teachers who participated in this study moved from early stage concerns (self and task) measured at the beginning, to higher stage concerns (impact) at the end.

Summary

A review of the literature on the use of computer interfacing in science education clearly supported the use of this technology as an effective teaching methodology. Compared to traditional laboratory techniques, computer interfacing may provide an environment for more meaningful and in-depth learning and understanding since the student is relieved of the tedious work of data collection. It allows for experimentation of phenomena that otherwise would be limited or impossible. Research suggested that computer interfacing easily allows students to manipulate variables and repeat experiments efficiently and accurately as they attempt to answer questions that have

surfaced during their inquiry. The implication is that students may be motivated to complete independent investigations.

Also evident in the literature review was a cautionary note to teachers. To be effective, computer interfacing must be thoughtfully integrated into the curriculum rather than being an additional component of a course. The computer itself should not be the central point of the scientific investigation. Instead the goal should be increased student involvement.

Many studies indicated that appropriate attention to teacher inservice has not been present with the advent of technology use in schools. Most educational institutions invest far more financial resources into the acquisition of hardware and software, rather than support for teachers in the use of this equipment. Additionally, when support is provided it is often in an unfamiliar environment and includes little teacher involvement.

Effective professional development involves continued support over time with due attention to the individual needs of the educators involved. Teachers require professional development that allows them to understand how a particular technology contributes to the learning and teaching process. An ongoing support system allows teachers to implement an innovation in a systematic manner and to resolve their concerns as they progress.

In order to measure changes in teachers' concerns as they attempt to integrate the Vernier interface into the science curriculum a pre-existing measurement device was required. The Stages of Concern Questionnaire was identified as an applicable instrument to meet this requirement. This instrument has been cited as a valid and

reliable means to measure changes in concerns associated with the implementation of an innovation. It has been successfully used in many areas of educational and particularly with professional development and microcomputer innovations.

CHAPTER THREE

METHODOLOGY

The research component of this internship gathered data from teachers regarding the use of the Vernier interface in the science curriculum and the professional development support provided by the intern. This chapter presents information on the participants, the instrument used and the professional development support provided. Within this context, a week-by-week account of the internship is given.

The Instruments

The following instruments were used at the beginning of the internship: (a) The Stages of Concern Questionnaire (SoCQ) (Hall, George & Rutherford, 1977) (Appendix F); and (b) A demographic form developed by the intern (Appendix G). Following the completion of the internship, the SoCQ was again administered, as well as a follow-up questionnaire on the support provided by the intern (Appendix H).

The Stages of Concern Questionnaire was used to determine teachers concerns. It consists of 35 statements. Respondents were asked to read and respond to each statement regarding their concerns at the time of administration, using an 8-point, Likert scale. The innovation represented in the statements was clearly identified as the integration of the Vernier interface into the science curriculum. A cover letter describing the questionnaire and the appropriate method to complete it was included with both the pre- and post-questionnaires.

Individual responses were grouped into seven raw scale scores and an overall total score that was converted into percentile scores provided in the SoCQ manual. These percentile score were used to create graphic profiles of each of the participants on both the pre- and post-measures.

The demographic form included 10 questions that requested information of each of the following:

1) Professional background;

2) The current teaching assignments;

3) General computer use;

4) Computer availability;

5) Vernier interface use;

6) Perceived barriers to individual integration of the Vernier interface;

7) Previous inservice on the use of Vernier; and

8) Participants perceptions of the type of support that would be most beneficial to the individual.

This information was useful in planning the support offered to individual participants throughout the internship. This data also contributed to the analysis of the changes in concerns measured in individual participants.

The post SoCQ questionnaire was accompanied by an evaluation form of the support provided during the internship. Participants were asked to indicate the extent of their participation in the internship activities. Also included were twelve statements aimed at determining the value of the support provided throughout the internship.

Participants were asked to respond to these statements using a five-point scale. The form also included two open-ended questions regarding the support provided. In order to encourage responses that were honest, open and critical, the identification of the participants remained unknown to the intern on this form. The intent of the information was to allow the intern to critically reflect on and evaluate the support provided throughout the internship.

Participants

The participants of this study were junior and senior high science teachers with the Burin Peninsula School Board. Twenty-five teachers participated in at least one aspect of the internship. Of these teachers, eight did not complete questionnaires and four failed to return complete questionnaires. Therefore a total of 13 teachers was included in the sample.

The teaching experience of these individuals varied from 0-5 years of teaching to 21-25 years. Table 2 provides the distribution of teaching experience for the participants. With respect to the past experiences of these teachers in the use of the Vernier interface, 54% indicated they had previously used this technology, while 46% had not. When questioned on previous support they had received on the use of Vernier, 67% responded that they had attended a prior inservice.

Participants were asked about the availability of computers in their science laboratories prior to the internship. Sixty-two percent, or eight respondents, noted the absence of any computers available in the science lab. Three participants indicated the

presence of one, two and four computers, while two noted that six computers were available in their science laboratory.

Participants were asked to identify factors that were perceived as barriers to the integration of the Vernier interface into science courses. The most common response was "inadequate time to prepare" (36%), followed by lack of available equipment (27%). Lack of skills and inadequate support each accounted for 16% of the responses given. None of the participants indicated that they felt lack of student interest was a contributing factor, while only one respondent identified "personal lack of interest" as an obstacle. The frequency of participants responses to the perceived barriers is provided in Table 3.

Table 2

Distribution of Teaching Experience (n = 13)

Years	Frequency	Percent
0 - 5	3	23
6 - 10	4	31
11 - 15	3	23
16 - 20	0	0
21 - 25	3	23

Table 3

Perceived Barriers to the Personal Integration of the Vernier Interface into the Science
Curriculum (n = 13)

Barrier	Frequency	Percent
Personal lack of interest	1	3
Lack of skills	5	16
Inadequate time to prepare	11	36
Lack of available equipment	7	23
Inadequate support	5	16
Lack of student interest	0	0
Equipment not set up in lab	1	3
Software/hardware problems	1	3

Note. Participants were free to respond to more than one item.

The Professional Development Support

The support provided to the participants throughout the course of the internship encompassed many areas. A detailed description of the activities implemented by the intern was provided in Chapter One. In general, the activities were aimed at providing support for the following:

1) The acquisition of necessary equipments for science labs;

2) The setup of this equipment;

3) Technical support for the use of the equipment;

4) Understanding of the role of computer interfacing in science education;

5) Direction on the integration of this technology into the science curriculum; and

6) The provision of resource materials to facilitate successful integration.

It is important to note that the activities each participant partook were unique to each individual. Participation ranged from the mere request for direction and resources on the use of Vernier in a particular subject area to the involvement in group, and individual sessions, as well as classroom visitations.

At the onset of the internship, the lack of available equipment in science labs was perceived by participants as an important barrier to their integration of the Vernier interface into the science courses taught. In an attempt to overcome this barrier, the acquisition of necessary equipment was a major focus of the internship. Teachers indicated that sessions on the use of this technology would be most beneficial if carried out with their own equipment in the school's science lab. Therefore most sessions were completed after the acquisition and setup of the necessary equipment. Since this process

was time consuming, it resulted in little time near the end of the internship to carry out multiple sessions with participants.

The development of resource materials was accomplished all throughout the internship. The internship proposal indicated a desire by the intern to design an online resource for teachers. This goal was realized during the internship. Additionally, at the request of a number of teachers, an activity booklet was developed. These laboratory activities provide resources for both junior and senior high science courses. Although the activities do no encompass all the possible areas where the Vernier interface can be used based on the current curriculum for Newfoundland and Labrador, it does provide a variety of investigations in a ready-to-use format for teachers and students.

Weekly Account of the Internship

Provide below is a synopsis of the events that occurred and projects implemented during the internship.

Week 1   (September 8 - September 11)

- Visits were made to the 10 senior high schools allowing contact to be made with principals and teachers. In-depth discussions regarding the internship ensued with some participants.

- Information present at the Board Office regarding the inventory of Vernier interface equipment was organized.

Week 2   (September 14 - September 18)

- Questionnaires were finalized to be sent to participants. Personal letters were prepared for each teacher that referenced the previous weeks meeting and expressed the intern's enthusiasm to be working with the participants.

- Possibilities for the destination of 25 computers were explored and final decisions made.

- Initiated search for available resources on the internet

- Intermediate science curriculum was examined for potential application of the Vernier interface.

- Computers present in one school's science lab were checked, and the equipment calibrated.

- Labs requiring the use of a motion detector were tested in a school science lab.

Week 3   (September 21 - September 25)

- Computers available in one school were moved to the science lab, checked and the equipment calibrated.

- Visited two schools for more discussion with teachers regarding their concerns and the equipment requirements for each school necessary to meet these needs.

- Meet with distance education students in one school.

- Labs requiring the use of a temperature probe were testing a school science lab.

- Continued internet searches of available resources.

- Setup database for the organization of data collected during the internship.

- Began the creation of a web page.

Week 4   (September 28 - October 2)

- Development of laboratory activities began.

- Four classroom visits were made.

- Follow-up visits to four schools were made to discuss requirements and plan ways to meet these needs.

- Accompanied and assisted the Itinerant Teacher for Technology with a teacher inservice on Windows 95.

- Assisted distance education students in Physics 3204 and 2204 with laboratory activities.

Week 5   (October 5 - October 10)

- Continued work on the development of the activity booklet, including the testing and write-up of these activities.

- Planned group sessions with teachers in one school and carried out this session.

- Expanded the design of the web page.

- Assisted distance education students with a laboratory activity.

- Met with the principal of the College of the North Atlantic in an attempt to determine the availability of resources for the construction of photogate kits.

Week 6   (October 13 - October 16)

- Continued to explore avenues for the construction of the photogate kits.

- Held a one-on-one session with a teacher where equipment was demonstrated and the potential of computer interfacing discussed. Also, at the request of the participant, a physics lab was conducted which the teacher wished to complete

with students.

- Continued web page development and search of available resources.
- Complete lab with distance education students.

Week 7 (October 19 - October 23)

- Visited distance education student in one school, assisted them with some technical problems they were experiencing and completed a laboratory activity with one group.
- Accompanied the Itinerant Teacher for Technology to two schools that were not participating in the internship due to their grade population.
- Finalized plan for the construction of the photogate kits with the cooperation of two instructors from the College of the North Atlantic.
- Investigated the use of two additional sensors in an effort to design activities for their use.
- Explored and tested the Windows version of MPLI.
- Completed a laboratory activity with a distance education student.
- Follow-up discussion with a teacher who had participated in a one-on-one session with the intern and then used the Vernier interface with students.

Week 8 (October 26 - October 30)

- Conducted two one-on-one sessions with a participant on the use, calibration and trouble shooting of the Vernier interface. The initial session involved a discussion of the merits of computer interfacing and its place in the curriculum. The subsequent session focussed on the demonstration and calibration of the

equipment with the use of specific activities.

- Continued the testing of activities that were being developed.

- Meet with instructors at the College of the North Atlantic to discuss a contract that would protect them from liability with the construction of the photogates and the responsibilities of those involved.

- Assisted the Itinerant Teacher for Technology with a classroom activity for Grade Four students on the use of Corel Word Perfect.

Week 9   (November 2 - November 6)

- Attended a department head meeting at the school board office.

- Computers arrived from Computers for Schools and arrangements were made for their delivery to the schools.

- Set up four computers in the science labs of two schools.

- Continued development of web page and its uploading to the internet.

Week 10   (November 9 - November 12)

- Completed lab with distance education students.

- Set up six computers in the science lab of one school.

- Followed up on previous requests to get photogate kits sent to the board office for construction.

- Spent two days in St. John's at Memorial University of Newfoundland to continue research.

Week 11   (November 16 - November 20)

- Delivered photogate kits to instructor at the College of the North Atlantic.

- Assisted Program Specialist for Senior High with the development of a list of necessary resources for computer technology courses in the senior high. Explored the availability and costs of these resources from various supply companies.

- Explored the possibility for teacher inservice on the integration of the Vernier interface.

- Set up four computers in the science lab of one school.

- Completed laboratory activity with distance education students.

Week 12   (November 23 - November 27)

- Participated in a Strategic Planning Inservice for board personnel.

- Attended a presentation by consultants with the Department of Education on the Pathways Document.

- Conducted group sessions with teachers in two schools.

- Assisted with classroom activity for Grade Six students.

- Continued the testing and development of activities for resource booklet.

- Conducted a one-on-one session with a participant on the use of the Vernier interface in physics and chemistry.

- Completed laboratory activity with distance education students.

- Conducted a group session with two participants in one school.

- Continued work on the resources for computer technology courses

Week 13   (November 30 - December 4)

- Completed lab with distance education students.

- Tested out laboratory activities that had been developed.

- Conducted one-on-one follow-up session with a participant.

- Carried out a physics laboratory with a participant and students in one school

- Conducted a group session with three teachers in one school where equipment was demonstrated, calibrations carried out and integration discussed.

- Continued the development of activity booklet and web page.

- Assisted with a classroom visit for elementary students.

- Carried out a junior high laboratory activity with a participant and students.

Week 14   (December 7 - December 11)

- Continued work on resources that were being developed.

- Assisted with a classroom visit on the use of Corel Presentations in junior high.

- Checked technical problems distance education students were having.

- Installed and checked Vernier cards and sensors in one school.

- Attended an inservice in Carbonear on "Connections" given by a consultant from the Department of Education.

Week 15   (December 13 - December 18)

- Finalized resources and prepared activity booklet for distribution to teachers in the district.

- Had two classroom visitations where the Vernier interface was being used by Chemistry students.

- Completed report on the computers that had been donated by Computers for Schools.

- Received and distributed the constructed photogates that had been completed at the College of the North Atlantic.

- Assisted a distance education student with a physics lab.

- Accompanied the Itinerant Teacher for Technology on a classroom visit on the use of Corel Presentations with elementary students.

- Spend one day consulting with the teacher who was replacing me during my leave.

- Last day was spent cluing up at the office.

Summary

Every effort was made to encourage all teachers to participate in the internship activities. Although only senior high physics and chemistry teachers were the focus initially, junior high science teachers in schools where the Vernier interface was available were also invited to participate. The Stages of Concern Questionnaire was chosen due to its application in the measure of changing teacher concerns in education, and particularly in innovations that involved a technology component. This instrument was deemed to be reliable and valid. The next chapter presents the findings of the data collection and an in-depth analysis of these results.

CHAPTER FOUR

RESULTS AND ANALYSIS

This chapter reports the results of the data collected during the internship. An analysis of these results follows which examines participants most intense levels of concern, comparisons based on years of teaching experience and previous use of the Vernier interface. Within these contexts, pre- and post-measures are analysed. Participants' perceptions of the internship are also presented.

Percentile Scores

Each raw score for the pre- and post-measures was converted into a percentile score provided in the Stages of Concern manual. The analysis presented here involves these percentile scores, rather than the raw scores. These percentile scores reveal relative intensities of each of the stages in comparison to one another. Higher and lower intensities are not absolute. A 60th percentile for one participant may represent the most intense stage, however for another participant this percentile may indicate a stage of little concern.

Highest Concern Stage

Hall, George and Rutherford (1977) indicated that the simplest interpretation of the SoCQ is to identify the highest stage score. Table 4 shows the highest stages scores for participants on both the pre- and post-measures of the SoCQ. As can be seen in

Table 4, 85% of the participants indicated their greatest concerns were lower level self-concerns, specifically awareness and information concerns, on the pre-measure. High scores on the Information stage reflect the participants desire to know more about the Vernier interface system and its integration into the science curriculum. Only two participants scored highest on concerns with management issues. Both of these participants indicated that they had previously used the Vernier interface. High scores at this stage reflect concerns with time and preparation, as well as how to fit the innovation into classroom structures. Of the three participants who scored highest on the Awareness stage, two were non-users. This stage can represent different meanings based on the participants previous experience with the integration of the Vernier interface into the science curriculum. For non-users a peak score at the Awareness stage represents concern about the innovation in question, however for a user this high score indicates a lack of concern about the innovation. Table 4 also indicates that none of the participants scored highest on the upper stages of concern, described collectively as impact concerns, on the pre-measure.

Results from the second administration of the SoCQ, also provided in Table 4, illustrate a shift to higher levels of concerns for 38% of the participants. However, 54% of the sample still indicated that self-concerns were significant to them. Another interesting finding in Table 4 is that consequence concerns were not foremost in the minds of participants on either the pre or post-measure. This stage of concern encompasses concerns that relate to the impact of the innovation on students.

Table 4

Highest Concerns Stage for Pre- and Post-Measures (n = 13)

Stage	Pre-Measure		Post-Measure	
	Frequency	Percent	Frequency	Percent
0 Awareness	3	23	1	8
1 Information	8	62	4	31
2 Personal	-	-	2	15
3 Management	2	15	1	8
4 Consequence	-	-	-	-
5 Collaboration	-	-	4	31
6 Refocusing	-	-	1	8

All of the participants who scored highest on the Awareness stage in the pre-measure had moved on to other concerns in the post-questionnaire. This suggests that their concerns at the Awareness stage were resolved sufficiently. While one of these participants moved on to the next highest stage, two had advanced to higher stages of personal and refocusing concerns. The majority of participants scored highest on the information stage of the pre-measure. Of these eight participants, five advanced to higher

stages, two appeared not to have resolved their concerns at this stage and one participant showed increased concerns at the awareness level in the post-measure. This regression to a lower stage of concern may indicate that this previous user of the Vernier interface experienced a lack of concern about this innovation, as is representative of peak scores at the Awareness stage by users.

Second Highest Stage Score

Additional interpretations of the result of the SoCQ were provided by examining both the highest and second highest scores. These results are provided in Table 5. Teacher self-concerns are prominent in the second highest score of the pre-measure. Also indicated is the concern of two participants, one who had previously used the Vernier interface, with collaborative issues. Rating this stage as second highest may be indicative of the participants' willingness and desire to work with colleagues. Both of these individuals had less than 10 years of teaching experience.

Post-measures revealed that the second highest scores were distributed among all but one of the stages of concern. Although the post-measure revealed highest and second highest scores at the Refocusing stage that were expectantly absent on the pre-measure, lower levels of concern are still evident for many participants.

A close look at the pre- and post-measures of the second highest scores of individual participants showed that eight participants, or 62%, progressed from lower to higher concerns. Again this demonstrated resolution of concerns to a sufficient level that allowed the participants to progress to higher level concerns. Interestingly, four

Table 5

Percentage of Highest and Second Highest Concerns of Participants by Stage of Concern

for Pre- and Post-Measures (n = 13)

| | Pre-Measure | | Post-Measure | |
Stage	Highest	Second Highest	Highest	Second Highest
0 Awareness	23	31	8	15
1 Information	62	15	31	23
2 Personal	-	23	15	15
3 Management	15	15	8	15
4 Consequence	-	-	-	-
5 Collaboration	-	15	31	8
6 Refocusing	-	-	8	23

participants scored second highest on a lower level of concern on the post-measure.

There were no clear patterns within this group with respect to teaching experience,

previous use of the Vernier interface or their ability to advance to higher levels with

respect to their most intense concern level. The only participant who showed no change

in the second highest score had not previously used the innovation and was successful in

advancing from the Awareness stage to the Collaboration stage on the highest concern

score. These scores exhibited the participant's interest in working with colleagues, while still attempting to resolve concerns about the general awareness of the Vernier interface.

Group Means

Graphic profiles of the stages of concern percentile scores provided a means to follow changes in pre- and post-measures of the SoCQ. Figure 1 presents a graph of pre- and post-means of the participants. The pre-questionnaire results exhibit a characteristic pattern of mean scores for the stages of concern prior to the implementation of an innovation, in this case the integration of the Vernier interface. Mean scores on the post-measure decreased for the lower concerns (awareness, information, personal and management) and increased for higher concerns (refocusing). These findings are further indicative that the participants had progressed to higher stages of concern after participation in the internship activities.

Although the increase in refocusing concerns on the post-measure was promising, the change was small. The most significant change exhibited in the mean scores was a 23-point decrease in the Information stage between the pre- and post-measures. Minimal changes were realized on both the Consequence and Collaboration stages.

Figure 1

Pre- and Post-Measures of Mean Percentile Scores for Participants
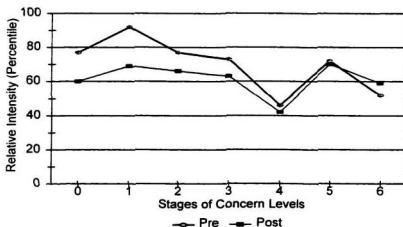
Group Means and Teaching Experience

In an attempt to identify any patterns in concerns based on teaching experience, mean profiles were generated which separated participants into groups. These profiles are presented in Figure 2 (pre-measure) and Figure 3 (post-measure). It is evident from Figure 2 that the patterns for each of the four groups were very similar. Peak scores for all groups appeared on the Information stage. The Consequence stage scores indicated few concerns with this level. The greatest variations in the scores occurred within the highest levels of concern, at the Collaboration and Refocusing stages. A difference of 24 points was recorded for both of these stages. These mean score profiles suggest little

variation in participants' concerns based on their teaching experience at the time of the first administration of the SoCQ.

Figure 2

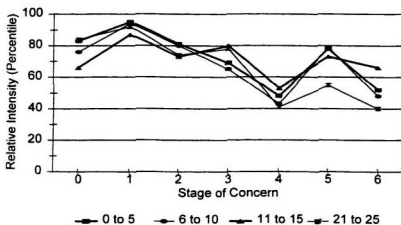Comparison Profiles Based on Teaching Experience for Pre-Measure

Figure 3 does show more variation in the concern profiles of the four groups. These greater differences indicate that the groups of participants had different concerns after participation in the internship.

Figure 3

Comparison Profiles based on Teaching Experience for Post-measure
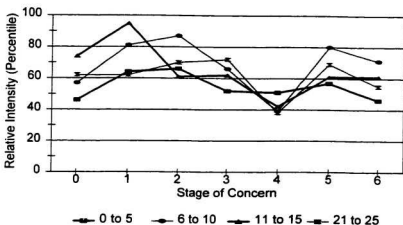
Comparisons of each group for pre- and post-measures are provided in Figure 4

(0 -5 years), Figure 5 (6 - 10 years), Figure 6 (11 - 15 years) and Figure 7 (21 - 25 years).

With respect to the participants with zero to five years of teaching experience all levels

scored lower on the post-measure with the exception of the Consequence stage. Although

these individuals seem to have reached some resolution to their lower level concerns, they

did not move on to focus on higher level concerns.

The second grouping of teachers, presented in Figure 5, showed the greatest

difference at the Refocusing stage with a 23-point increase on the post-measure.

However, these individuals showed little difference between the pre- and post-measures

of the intermediate stages of concern. This suggests that although they may have

reconciled some lower level concerns and progressed to the refocusing level, there are

still unresolved concerns that need to be addressed.

Figure 4

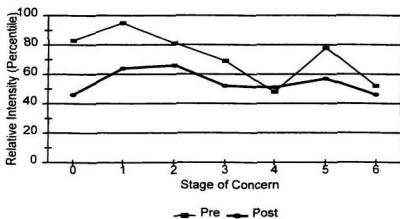Comparison Profiles of Teachers with 0 to 5 Years Teaching.
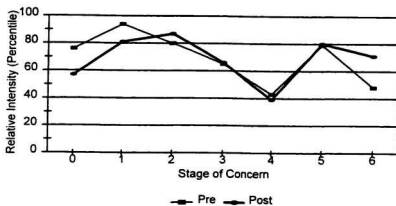
Figure 5

<u>Comparison Profiles of Teachers with 6 to 10 Years Teaching</u>.

Figure 6

<u>Comparison Profiles of Teachers with 11 to 15 Years Teaching</u>.
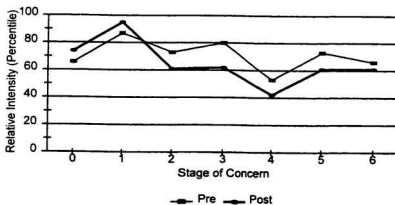
Teachers with 11 - 15 years of teaching experience provided the most unexpected results. Rather than scoring lower on the early stage of concern and higher on the upper levels on the second administration of the SoCQ, the scores of these individuals were the opposite. The profile in Figure 6 clearly shows that this group scored lower on all levels except for the Awareness and Information stages on the post-questionnaire. These individuals were both users and non-users of the Vernier interface prior to the internship and participated at varying degrees in the internship activities.

Figure 7 represents pre and post profiles of the participants with the greatest amount of teaching experience. In comparison to the other groups, these participants exhibited profiles very similar to the participants with the least amount of teaching experience on the lower levels of concern. Both groups showed decreased scores in self and management concerns. However, the more experienced group was successful in advancing to higher levels of concern unlike the 0 - 5 grouping. The profiles presented in Figure 7 best reflect the 'expected' results, suggested by the Stages of Concern manual, that participants show as they evolve through the implementation of an innovation.

Figure 7

Comparison Profiles of Teachers with 21 to 25 Years Teaching

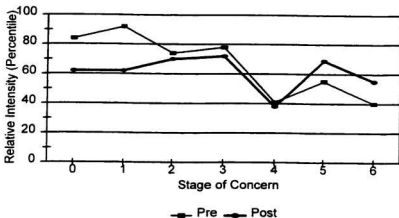## Group Means and Previous Experience with the Vernier Interface

The final analysis of the SoCQ results involved a comparison of participants who

had previously used the Vernier interface and those who had not. This information was

provided by participants on the demographic form administered prior to the

implementation of the internship activities. However, no attempt was made by the intern

to distinguish between different levels of use.

Percentile scores for users and non-users on the pre-questionnaire are provided by

Figure 8. These groups showed no difference in the intensity of their concerns at the

Consequence stage. Users appeared to have lower concerns at the Awareness stage and

Figure 8

Comparison Profiles of Users and Non-Users on Pre-Measure.
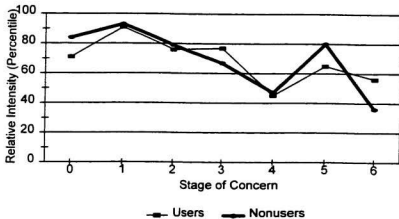
scored higher than non-users on the Refocusing stage which may represent concerns with expanding their current use of the Vernier interface. Non-users, on the other hand, appeared to have high levels of self-concerns prior to the internship.

A greater variation between the two groups on the lower levels of concern is evident on the post-measures presented by Figure 9. The non-users scored lower than the users on the first five stages of concern.

A comparison of the pre- and post-measures for non-users is shown in Figure 10. It appears as if the non-users rectified their lower level concerns and advanced to refocusing concerns. A similar profile was obtained when pre and post scores were compared for previous users, as indicated by Figure 11. It appears then that both groups

resolved lower end concerns and favoured high concerns after their participation.

However, the intensities of those concerns were different for the two groups, as evidenced

in Figure 8 and Figure 9 and discussed above.

Figure 9

Comparison Profiles of Users and Non-Users on Post-Measure.
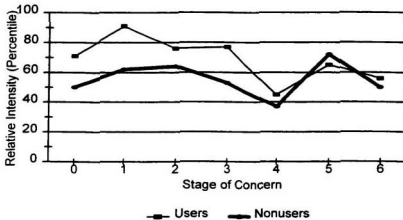
Users *Nonusers*

Figure 10

Comparison Profiles of Non-Users for Pre- and Post-Measures.
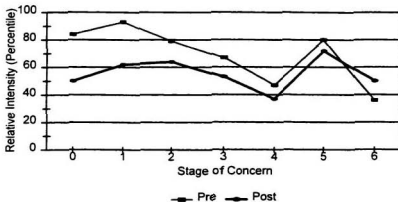
Figure 11

Comparison Profiles of Users for Pre- and Post-Measures.
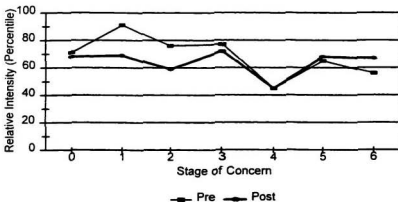
Professional Development Support Evaluation

The results of the support evaluation were highly positive. Table 6 shows the 12 statements participants were asked to respond to and provides a summary of the findings. All of the participants agreed that the intern was approachable, addressed participant concerns, was punctual and acted in a professional manner. Eighty-six percent of the participants perceived the support provided as valuable and 93% suggested that the internship facilitated their use of the Vernier interface. When asked if participation in the internship was worthwhile, 93% of the participants agreed and 86% viewed the internship as worthwhile to them as a teacher.

An open-ended question which asked the participants to identify the most valuable support received during the internship summoned a variety of responses. Many identified the technical assistance as most valuable. Others commented on the assistance provided when working with students, resources provided by the intern and the increased confidence they felt in working with the Vernier interface.

Table 6

Percentage Responses to the Evaluation of Professional Development Support (n = 13)

Statement	NA	SD	D	A	SA
Intern was approachable.	-	-	-	7	93
Intern addressed my questions during sessions.	-	-	-	21	79
Intern keep appointments and was prompt.	-	-	-	21	79
Intern provided valuable support.	7	-	7	14	72
Intern attempted to address my needs.	7	-	-	14	79
Intern responded to and acted upon requests I made for support.	21	-	-	7	72
Intern facilitated my use of the Vernier interface.	7	-	-	28	65
Intern acted in a professional manner.	-	-	-	7	93
The internship was helpful to me as a teacher.	7	-	7	21	65
Intern showed interest in my concerns and contributions.	7	-	-	-	93
I took advantage of the support provided by the internship.	14	-	7	29	50
Participation in the internship was a worthwhile experience.	-	-	7	21	72

Summary

Knowledge of the concerns participants had prior to the implementation of the internship activities allowed the intern to provide support that attempted to address these concerns. The instrument used revealed different stages of concern for participants. A follow up administration of this instrument permitted the intern to follow any changes that occurred in participant concerns after they had participated in the internship.

The mean percentile scores of the participants revealed a decrease in the concerns of teachers at the lower levels on the stages of concern continuum. Additionally, an increase in concerns at the highest stage (refocusing) was indicated. Comparison of the participants with respect to teaching experience disclosed little variation among the groups on the first administration of the SoCQ. More disparity was evident on the post-measure. The group that most closely demonstrated a developmental nature in changing concerns was made up of teachers with 21 to 25 years of teaching experience. This group comprised 23% of the sample which is fairly representative of the distribution of participants as shown in Table 2.

Analysis of the data collected within the context of previous experience with the Vernier interface found that both groups resolved lower end concerns and moved on to those at the highest level. Greatest differences in these groups were found in the relative intensities on the post-measure, with non-users scoring significantly lower than users on self and management concerns.

Participants' perceptions of the internship indicated that overall it was considered to be a positive experience. The support provided by the intern appears to have been

appreciated by and useful to participants.

Throughout the profiles presented above, there are distinct occurrences of relatively low scores on stage four, the Consequence stage. Concerns at this stage focus on the impact of the innovation on students. High concerns would be indicative of the participants' interest in the relevance of the Vernier interface for students, student outcome evaluations and ways to increase student performance. The low scores on this stage suggested that the support provided to teachers should focus on lower end concerns until they have be reconciled to significant degree to allow movement to subsequent stages. The participants of the internship appeared to require time to familiarize themselves with the interface before they focus their attention on how it will affect their students.

The data collected was very comprehensive and informative. From this information a number of issues concerning the internship and its goals can be addressed. The following chapter will discuss these implications.

CHAPTER FIVE

SUMMARY AND RECOMMENDATIONS

This chapter will give an overview of how the internship goals were accomplished, as well as the research findings. Conclusions are drawn and recommendations proposed in reference to the experiences of the internship. Finally, a personal reflection of the internship is presented.

Accomplishment of the Internship Goals

In an attempt to ensure that the internship provided a valuable experience, a number of goals were developed prior to its initiation. These goals are stated in Chapter One. The attainment of these goals was facilitated by the implementation of various internship activities. This section addresses these goals and discusses the degree to which they were accomplished, as well as the activities that contributed to their fulfilment.

Professional and Personal Goals

Preparation for sessions with teachers, developing laboratory activities and setting up the necessary equipment all provided tremendous experience with the Vernier software and hardware. Throughout these undertakings new obstacles were encountered. Solving these problems was helpful to both the intern and the participants, since the solutions could be shared. Additionally, this experience granted opportunities for the intern to explore new uses for the various sensors and also allowed the time required to investigate sensors that had not previously been used by the intern. Through these

activities, applications of this technology to various areas of the science curriculum became evident. This will, and has, allowed the intern to use the Vernier interface with greater breadth.

The teaching practices of colleagues were observed during classroom visits throughout the internship. During these times, a participant's method of dealing with various classroom issues was demonstrated. The participants shared their ideas and practices, in the use of the Vernier interface, as well as other classroom concerns. In many of these visits, information regarding a useful resource book or a software package was gained. In one case, a teacher's recognition of the importance of student independence in the laboratory was evident. This teacher was experiencing great success and satisfaction with how the students had developed into independent workers and thinkers. These visits reinforced some of the feeling held by the intern and additionally contributed to the reflection and rethinking of some of the intern's practices.

The graduate program experienced over the past three years exposed the intern to many theories and philosophies regarding education in general, as well as the use of technology in the classroom. Of particular importance to this experience was the potential of computers in education. There are many views of the role of computers in education. In some cases their role has been criticized greatly. On the other hand are those who feel that the computer is an answer to all educational problems. The personal philosophy of the intern lies somewhere in between these two extremes and was reinforced by the internship experience. The word potential appears to be the key. The placement of computers in a classroom does not address the issue. Instead the way in

which the computer, or any other technology, is used should be the focus. The computer may motivate students, facilitate an understanding of concepts, promote cooperation and group work, and contribute to problem solving skills. However, all this depends on the context in which the technology is used. Both teachers and students require support in learning how to maximize the potential offered by technology.

An improved understanding of the issues involved with the integration of technology into the curriculum was identified as a goal. A number of issues arose with regard to integration, through experiences with the Vernier interface, as well as other technologies. Through sessions with teachers it was evident that they required resources that would facilitate their integration of interface technology. Although many had interest in developing their own uses of the Vernier interface, available time was perceived as an obstacle. Teachers wanted resources that would allow them to meet the curriculum objectives of their science courses. In response to this, an activity booklet was developed and made available to teachers in the district.

An understanding of the support required by teachers for the integration of the Vernier interface grew during the internship. Many of the teachers welcomed opportunities that would allow them to broaden their experience. However, many of these same teachers expected support from the district. The participants of this internship showed interest and enthusiasm in their attempts to increase their knowledge of the Vernier interface. This was very promising. However, the support required by educators must be present. The objective of support programs should be to first illustrate and demonstrate how a technology can be used within the present curriculum. With such

direction many educators may expand their uses of technology.

Research into the area of effective inservice methods, and the reading that followed, greatly expanded the intern's professional knowledge in this area. It is one thing to know what you as an individual are comfortable with. It is another to realize that such preferences are shared by others. The sessions offered to teachers, as well as discussions with them throughout the internship, strengthened the suggestions put forward in the literature. The effectiveness of one day inservice was questioned in the literature. Some participants suggested that although such experiences were helpful, additional training was often required. The situation present in one's own school does not always resemble that which was experienced at a workshop. Additionally, inservice should promote involvement by educators. The one on one sessions offered during this internship reflected this. In early sessions, an introductory oration was given by the intern. However, this was modified to a much shorter version and much of the information was provided by handouts. This permitted more time for practical experience with the Vernier interface. Another issue that seemed evident in the sessions was that teachers like to come away from an inservice with a resource that they can take back to their classrooms and use. The activity booklet helped to address this area, although it was not available until the end of the internship.

The last goal identified was in the area of improved leadership skills that could promote the intern's future undertaking of technological initiatives within the classroom or school. The practical experience of the internship provided opportunities for the intern to serve as a facilitator, and in some aspects as leader. The intern gained tremendous

confidence in this role throughout the internship. These experiences gave the intern assurances that such future endeavours were also surmountable. Prior to the internship, a request to conduct an inservice sessions would have been shied away from. Throughout this experience it became evident that the intern did have ideas and recommendations that were worthwhile and useful. Sharing of these ideas is much easier now.

The accomplishment of the goals identified under the professional and personal area was very fulfilling to the intern. It is probably easiest to identify and realize the individual gains of the internship experience. These goals contributed greatly to the confidence of the intern, not only as a teacher, but also as an educator who has something valuable to offer colleagues. It is also very probable that this experience will yield future professional opportunities for the intern in the area of professional development and technology integration.

Technology Integration Goals

A number of goals were identified within the realm of technology integration. Overall success in this area will depend on the sustained use of this technology by participants. Although feedback from teachers and observations made by the intern were promising, continued evolution of this technology will depend on future support provided. Promotion of the use of computing interfacing was a major goal of the internship and all the activities implemented attempted to address this goal. For participants who had not previously used the Vernier interface system, the initial introduction to this technology heightened interest and enthusiasm. For others who had previously utilized the technology, a renewed interest was strengthened. Therefore, the

promotion of the Vernier interface was a success. In order to support teachers continued learning in this area, an on line resource was developed. Participants were encouraged to use this forum to help them overcome any future obstacles they encountered. It is the intent of the intern to continue the development, maintenance and expansion of this site. It is believed that this medium will continue to contribute to the realization of this goal.

Sessions with teachers and the activity booklet both aided in providing direction in the use of computer interfacing. To accomplish this goal, participants were first given an overview of the potential of the Vernier interface. Discussions evolved that addressed where and when this technology was most beneficial. Next, the use of the equipment for specific curriculum areas was demonstrated by the intern and carried out by the participants. In order to address areas for which there were no available activities, a resource was developed that was ready to use by teachers in the classroom. The intent was to provide teachers with activities they requested. Additionally, it is hoped that exposure to a broad range of activities will inspire teachers to develop their own activities in the future.

Initial classroom visits allowed the intern to determine the availability of computers in the science labs of schools. Teachers were made aware of the possible set ups for such equipment. Schools were encouraged to use an arrangement that was most convenient for them. The majority of schools choose to have the computers and equipment placed in the science labs. Agreements were reached with the technology teachers who could also access the equipment in the science lab. Other schools decided to have the computers placed on mobile carts that could be moved to any location in the

school where they were needed. Another school chose to keep the equipment in the technology room and science teachers would access it there. Accessibility to the equipment was a major concern, especially in larger schools where the demand was greater. Another concern was the space required by placing the computers in the science lab. Schools that choose this option decided that four to six computers would be appropriate. In schools where computers were available, the equipment was set up and checked by the intern. Those that did not have computers received an average of four computers when they became available. Through these actions the initial set up and organization of the computers was accomplished.

The opportunities for teacher inservice were not realized to the degree anticipated prior to the internship. First of all, a one day inservice proposed to take place early in the fall was at first postponed and finally cancelled due to the lack of available substitute days. Therefore inservice was carried out only during teachers preparation time and after school. These attempts were further diminished by scheduling problems. Although the intern was available after school hours, teacher schedules did not always permit such opportunities. This is the greatest regret experienced by the intern. In an attempt to maximize the benefits for teachers, other areas were explored, namely the development of a laboratory activity resource.

Solutions to obstacles identified by participants were addressed throughout the internship. The first was the procurement of computers for the science labs and the subsequent set up of this equipment. Additionally, a means of constructing the photogate kits was established and carried out. The activity booklet addressed the concern of

available laboratory activities for a variety of areas in the science curriculum at both the junior and senior high levels. Unfortunately, the obstacle identified by the majority of teachers, inadequate time to prepare, was not directly addressed by the internship. It is hoped that the support provided will alleviate this problem somewhat by requiring less time of teachers in the future for the preparation involved with the use of the Vernier interface.

Throughout the internship, the cooperation and interaction of teachers was to be promoted. It is questionable whether such relationships were nurtured between teachers of different schools, since the internship did not provide situations where these teachers worked together. It was evident that teachers within schools who attended group sessions were open to working with one another. These collegial relationships were intact due to the willingness and previous actions of these educators. The internship cannot be credited with developing such relationships. However, the intern encouraged such interactions with the use of the Vernier interface. It should be suggested that the intern benefited most from the interactions with the participants. These interactions were beneficial to the use of computer interfacing. More importantly however, they have allowed the intern to develop relationships that will continue to be advantageous. The web page was seen as a possible means to promote interaction. Its present form demands that teachers make contact with the intern and from there questions, ideas and concerns would be posted to the site. One way in which this site could be improved to better promote interaction is to allow teachers to directly submit their queries or suggestions and also view and comment on those made by other teachers. In this manner, teacher

interactions can occur independently of the intern. Such an environment may be more open and interactions would not require that individuals are available at the same time in order to communicate.

As suggested earlier in this section, the initial visits to schools allowed the intern to determine the needs of individual schools with respect to technical support and equipment requirements. To address these needs the availability of resources within the community was explored. This resulted in the acquirement of computers, construction of photogate kits and the repair of damaged interface cards. Additionally, teachers were made aware of sensors available at the board office and the purchase of additional sensors was initiated by the intern.

The degree to which the technology integration goals were met was more difficult to determine, especially for those that involve participants' future use of the Vernier interface. A number of issues were, without doubt, addressed. Schools now have the necessary equipment available to them where it was deemed to be most suitable for all teachers involved. New users have been introduced to this technology and previous users reacquainted with its potential. The internship provided direction and support for the integration of the Vernier interface into the science curriculum.

<u>Research Goals</u>

The value, as perceived by teachers, of the support provided through the internship was determined by feedback from the participants through discussions, observations and the evaluation form provided to teachers after the conclusion of the internship. Based on this information, it is reasonable to assume that the majority of

teachers felt that the internship provided valuable support. The continued participation of teachers may also illustrate its perceived value. It would be misleading to suggest that all teachers benefited equally. However, the majority of teachers were positive in their feedback.

Although individual sessions were not evaluated through formal means, the evaluation form given at the end of the internship was aimed to assess the support provided. Teacher perceptions indicated that the support was conducted in a professional manner by the intern. Individual concerns were addressed through support which was individualized to meet specific needs.

It is the opinion of the intern that a discrepancy between the intent of the inservice training and what was actually achieved does exist. This conclusion is based on the shift in the time devoted to various activities throughout the internship. The amount of time expected to be spent on inservice sessions with teachers was much less that anticipated. Instead, more time was spent acquiring and setting up the necessary equipment. It is believed that these adjustments were necessary based on the requests and concerns voiced by participants. Therefore, the impact of the internship on the true integration of the technology into the science curriculum was less than anticipated. The contributions of the internship activities dealt more with exposing the teachers to the Vernier interface and attempting to foster its use. The activity booklet provided a means for teachers to use the technology within the present curriculum. The participants' success with continued integration will be determined by their future endeavours with the Vernier interface.

The internship attempted to determine any change in the use of the Vernier

interface system by participants. Follow up sessions with teachers indicated that some participants had used the interface in their classrooms. Other participants have indicated that their use of the technology has progressed and they have experienced success in its use with science fair projects. The limitations of the internship did not allow a determination of continued use of the Vernier interface by participants, which would be possible with a lengthier longitudinal study.

The experience of the internship allowed the intern to suggest possible future needs to address the concerns of teachers. The data collected within the research component provided this opportunity. Overall, it was evident that continued support would be necessary. It is suggested that teachers' concerns will change as they continue to explore the use the Vernier interface. Continued support should address these evolving concerns. Future endeavours in this area might attempt to more specifically address differences in teachers based on their previous use of the Vernier interface and also to attempt to separate concerns involved in the many dimensions of such an innovation.

The research component of the internship measured changes in teachers' concerns through the administration of the Stages of Concern Questionnaire. Participants' responses, prior to and after the internship, to statements of this instruments were compared and analysed. A general trend was identified in the group means that teachers moved from lower end concerns to those at higher stages. Additional analysis suggested that teachers may continue to experience self concerns as they continue to encounter novel dimensions of the innovation.

The research component of the internship was reflected in the research goals

developed. Through the use of Stages of Concern Questionnaire, as well as discussions with and feedback from the participants, the intern was able to identify and respond to initial concerns. These concerns were instrumental in planning the support required by the individual participants. Changes in these concerns were discovered through comparisons of pre and post measures of the instrument. This information would also be useful in the development of future support initiatives.

Discussion

The intent of the internship was to provide support to teachers in an attempt to promote the integration of the Vernier interface into the science curriculum. The research component focussed on teacher concerns regarding this technology. The assumption was that teachers' concerns were developmental in nature and would change over the course of the internship. It was believed that participants' concerns about the Vernier interface system would impact on its successful integration into the science curriculum.

The SoCQ identified the concerns of participants prior to the implementation of the internship activities. An identification of these concerns was a necessary step in understanding participants' emotions regarding the Vernier interface. Furthermore, this information guided the support provided by the intern and the activities implemented. The support provided was specific to individual teacher concerns and needs. It included providing information on the Vernier interface, procuring and setting up equipment, demonstrating the interface system, developing resource materials and assisting teachers with its use in the classroom. These interventions are believed to have contributed to

participants resolution of self-concerns and movement to higher level concerns.

Conclusions

The conclusions must be interpreted based on the assumptions about the validity and genuineness of participants' responses to the instruments used to collect data. Additionally, it is important to note that the participants' involvement in the internship was varied. That is to say, there was no defined 'treatment' that all the participants received. The data collected during this internship may not be representative of the group of science teachers in the district. With a limited number of teachers responding, the sample may be biased. Those teachers that did participate and respond to the questionnaire may be those who were more enthusiastic about the use of computer interfacing. Finally, due to the small sample size, it is unlikely that these conclusions can be generalized to other groups.

In light of the above, the following conclusions are proposed:

1.   In general, concerns of teachers regarding the integration of the Vernier interface into the science curriculum were developmental in nature. They should be expected to vary over time and change as experience with the technology changes. The importance of this expectation was noted by James (1981), who contended that a developmental pattern is characteristic in an implementation process when support is provided that allows individuals to first resolve their lower end concerns.

2.   Technology innovations are not static in nature. Advancements in technology occur at a phenomenal rate. In education this translates into ever-changing

software and hardware that can be used within subject disciplines. While the adoption of the Vernier interface system may appear simple and straightforward, it is an ongoing commitment. Even users of this technology will re-encounter lower end concerns as this interface program changes or is replaced by other systems. A users exploration of new and different uses of the innovation will also contribute to them experiencing self-concerns. This may explain the intensity of these levels of the stages of concern evident in the results obtained.

3.   Although the support provided during the internship appears to have facilitated and promoted the use of the Vernier interface, there are still numerous concerns that need to be addressed. Continued support in this area is a necessity. Further interventions may help maintain teachers' interest in becoming more knowledgeable about this innovation and its role in the classroom. One would be remiss to conclude that all concerns had been dealt with. Low scores on the Consequence stage were found for many participants. James and Hall (1981) noted similar results and suggested that the impact of an innovation on students should not be a focus during the initial stages of an innovation adoption. Educational change does not occur quickly. Instead, it may require years. This short term internship, then, would probably be perceived as a significant first step in the integration of the Vernier interface. This suggestion is supported by the post mean percentile scores of the participants. These scores indicated that although teachers had an increase in intensity of concerns at the Refocusing stage, earlier concerns were equally intense.

4.   The results indicated that for some participants lower end concerns were

still significant after the internship. This may be explained by the many dimensions encompassed by the integration of the Vernier interface into the science curriculum. That is to say, the innovation itself is multifaceted. Successful adoption of the innovation warrants due attention to technical aspects of the equipment, instructional practices, student interactions and achievement, curriculum issues and time management concerns. Notably, this list is not complete. However, it does demonstrate the magnitude of issues that may be of concern to teachers. For example, it is plausible to suggest that while a participant may have resolved information concerns regarding technical aspects, this same type of concern may not be reconciled in terms of curriculum issues. Germann and Sasse (1997) found a similar regression to lower end concerns of teachers involved in a two year program aimed at integrating the use of computers into the curriculum.

5.   School districts need to designate more resources to inservice support rather than software and hardware. Obviously, the availability of the equipment is a necessary first step, as witnessed during this experience. However, once hardware and software demands have been met the focus must be on teacher support. All too often this area is neglected in favour of the procurement of faster computers and more advanced interface systems (Wallinger, 1997; Willis, 1997).

6.   The activities implemented during the internship addressed some of the perceived barriers of participants that affected their use of the Vernier interface. Equipment and technical issues were addressed and it is anticipated that this will alleviate some of the preparation demands of teachers. However, the area of inadequate time to prepare most likely will remain unchanged. Teacher workloads seem to be ever

increasing. It is to be expected that integration of the Vernier interface into the science curriculum may not be the only innovation that participants were involved in at the time of the internship. Constantly changing curriculum and policies place high demands on teacher time.

Recommendations

The results of this internship can benefit those who would provide future support in this area. Some of the recommendations may also be applicable to other technology programs that are being integrated into specific curricular areas. Once again, it is important to note that the sample size of the participants of this internship was small. All recommendations should be considered with due attention to this limitation of the internship. Based on the results and conclusions of this experience, the following recommendations are offered:

1. Teachers attempting to integrate an innovation such as the Vernier interface into the curriculum can be expected to require general information about the innovation and personal support for its successful integration. This suggestion is supported by Hope (1997) who found that the implementation of an innovation was promoted by the successful resolution of lower end concerns. The degree to which self-concerns were addressed by training affected teachers' abilities to move on to higher level impact concerns. The importance of addressing general information about an innovation was also noted by Wedman (1988) who argued that inservice about unfamiliar applications should be designed to address lower end concerns such as those at the Information stage.

2.   Inservice programs presented to potential users of the Vernier interface should be extended over time, with small group of individuals in familiar settings rather than a one day and large group inservice where little individual participation is promoted. The preference for ongoing support systems over one day professional development sessions was noted by Gilmore (1995). Many others argued that ongoing support is the key to a successful professional development program (Baird, Ellis & Kuerbis, 1989; Guskey, 1986; Wallinger, 1997; Zammit, 1992).

3.   Those who provide support for teacher should be cognizant of the varying and changing concerns and needs of individual teachers. Support programs should be planned in the context of these needs and concerns so that more constructive attempts to rectify concerns can be realized. Support should also change to meet the changing needs of teachers. As noted by Moursund (1998) professional development support does not usually give due attention to teacher's individual needs. Others, including Wedman, Heller and Strathe (1986) and Hall and Loucks (1981), argued that the success of support programs is rooted in the attention given to individual differences. Baird, Ellis and Kuerbis (1989) found that support programs that are individualized and build on existing needs in a systematic way allowed teachers to better incorporated new skills and ideas.

4.   Districts which have the MS-DOS based version of the Vernier interface should designate financial resources for teacher support in this area, as opposed to spending any available money on newer versions of this or any other interface. Although this version may not be as fast or user friendly as newer ones, it offers obvious advantages. It is currently available in the schools, it can run on low end computer

systems and teachers are seeing some progress in their use of this current system. This is not to suggest that upgrades should be totally dismissed. However, during times of financial constraints, such as the present, this suggestion is justified. Investment in initiatives that promote the development of knowledge and expertise of educators should be favoured over the purchase of the best equipment that may never be used, at least to its maximum advantage. Zammit (1992) also noted that it is often much easier to get approval for the purchase of new equipment rather than to pay for professional development training. Unfortunately, the acquisition of such equipment does not ensure it will be used. Additionally, teachers should not be expected to use only their own time and finances on professional development endeavours. Although it is unrealistic to expect districts to absorb all these expenses, teachers do need support in this form. Commitment by both parties would be ideal.

5. The role of teacher as coach or mentor may be underutilised. Within all school districts there are teachers who have a lot to offer their fellow colleagues. Schools and school districts should strive to promote such collegial working relationships. When working with fellow educators, teachers may feel more at ease and less vulnerable. All too often, it seems that the only real insight that can be gained is perceived to come from those in the upper most levels of the educational system. Why must we continue to overlook the human resources that are closest to us? Relationships that develop from coaching interactions can be mutually beneficial to both individuals. MacArthur, Pilato, Kercher, Peterson, Malouf and Jamieson (1995) argued that a mentoring approach to teacher professional development is an effective method to providing ongoing

contexualized support. The literature is rich with support for such approaches that use mentors or coaches (Ellis, 1989; Ellis, 1990, O'Brien, 1992; Williams, 1993).

6.   When the participants of this internship were grouped according to their previous use of the Vernier interface, the profiles revealed moderate differences in the post-measure. The information collected during the internship did not, however, identify the various levels of use by participants. James and Hall (1981) addressed differences in the concerns of users and non-users toward the implementation of a science innovation. These authors noted distinct differences in the concerns profiles based on the years of experience with the innovation. Similar distinct profiles of users and non-users were found by Cicchelli and Baecher (1987). Based on previous experience with microcomputers, participants in a study by these authors demonstrated different intensities on each of the stages of concern. It is reasonable to suggest that more insight into the differences between users and non-users would be forthcoming if future endeavours in this area attempted to determine the participants level of use.

7.   Based on the findings and experiences of the internship, a number of recommendations specific to the Burin Peninsula School Board are proposed. First of all, an ongoing support system for the integration of the Vernier interface should be continued. This support system should utilize and expand upon activities initiated during the internship. Additionally, new teachers hired by the board should be inserviced on the use of the Vernier interface system. Secondly, the board should encourage teachers to become mentors or coaches to facilitate the integration of other innovation into the curriculum. Finally, the board should explore other ways in which internship experiences

cold be beneficial to the district. It is suggested that educators should be encouraged to complete internships that are mutually beneficial to the district and the educator.

Personal Reflection

To say that the 15 week internship embarked upon during the fall of 1998 was a learning experience would be an understatement. Of course, everything did not go as previously planned. In many ways the necessary adjustments aroused many conflicting feelings. However, in other ways the changes and adaptations made to meet the needs of the participants may have contributed to its success.

The internship afforded an opportunity for many experiences that are not always available to a regular classroom teacher. We meet and converse occasionally with our colleagues in other schools through inservice and workshops, or even at the grocery store for that matter. None of this can compare with the chance to work with fellow colleagues in a friendly, comfortable environment that was experienced during this time. We have much to learn from each other. I am thankful to the participants of this internship, as well as other teachers I encountered during my school visits, for sharing with me their views, concerns, triumphs and struggles. I can only hope that they learned as much from me.

Throughout the internship certain personality traits that I am fortunate, or unfortunate, to possess were evident. One is my lack of spontaneity. I am not very comfortable doing things "on a whim". Instead I prefer a well thought out plan in the accomplishment of most activities. I can not be convinced that organization is not important. However, a degree of flexibility needs to come into play. The internship

demanded flexibility. I believe that though remaining fairly organized, I am able to take upset in my plan of action in a better light.

Conflicts are situations I tend to avoid and the thought of being in the middle of them make me queasy. There were times during the internship when I found myself in these situations. One was where teachers perceptions of what was expected of them with regard to the Vernier interface was a topic of discussion. The dilemma seemed to be whether teachers should be encouraged to use this technology or whether they were expected to use it. Another was the placement of the Vernier interface cards in computers and whether these computers would be available to both science teachers and technology teachers. I, of course, attempted to be very diplomatic. Apparent conclusions were reached in both situations. However, I still wonder if all parties were cognizant of the others views.

I have been a classroom teacher for the past 11 years. Even with its aches and pains, I do enjoy my role. When I'm in the classroom, I feel as if it is my milieu. Upon reading the journal I kept while completing the internship, it is clear that my reflections on days when I spent time working with distance education students or worked with teachers in their classrooms were very positive. These chances to "stay in touch" with the classroom were also beneficial to me upon my return to school in January. I didn't really feel as if I had been away.

I was probably unrealistic in my expectation that every teacher would be overly enthusiastic of and open to the support I was offering. Lack of participation by teachers, to which the Vernier interface was applicable, was very difficult for me. I learned to take

this in stride. However, I still wonder what I could have done differently to encourage them more. Those that did participate made this a very worthwhile experience for me, both personally and professionally. My time spent working with these individuals left me with a great sense of accomplishment.

Prior to the internship a number of goals were identified and developed. These goals were divided into three areas - personal and professional, technology integration and research. I believe that the personal and professional implications of the internship were underestimated. I gained tremendous experience with the Vernier interface. I explored new and different uses of the technology I hadn't attempted before. And yes, I have developed a personal philosophy on effective inservice. What I didn't count on was the increased confidence I would feel with respect to sharing my knowledge and ideas with others. I am overwhelmed with the discoveries I made with respect to the process of change. Change, as a process, is not to be feared or avoided, but instead should be faced head on.

My greatest regret from the internship is that more opportunities to work with teachers did not occur. As suggested in my conclusions, I believe I have just explored the tip of the iceberg in my attempts to facilitate the integration of the Vernier interface into the science curriculum. That is not to minimize the contributions made my the internship. I just wish I could have done more - another character flaw. I take great reassurance in the appreciative comments made by the participants. Nothing made my day more that receiving a comment from a participant that a session I had held was "tremendously enlightening" or hearing that students and teachers were experiencing

great success in the use of Vernier for science fair projects.

During the internship, I was based at the school board office. Being there gave me a chance to better appreciate the demands placed upon board office personnel. As a teacher, I am often guilty of thinking that no one in the educational system has such a challenging role as us out in the trenches. I've often felt disconnected from and intimidated by those at the board office. The opportunity to work with them was enlightening for me. I am now better able to understand their roles and give them the credit and respect they deserve.

The internship allowed me to become involved in activities other than those that focussed on the Vernier interface. I participated in classroom visitations and teacher inservice sessions that concentrated on other aspects of technology and the science curriculum.

To anyone contemplating an internship in their pursuit of a Masters degree, I would suggest that nothing could replace this practical experience. My advice would be to focus on what is being accomplished rather than dwelling of what did not come to pass.

REFERENCES

Adamson, G. E., Zimmerman, J. R. & Nakhleh, M. B. (1997). A computer-interfaced O2 probe: Instrumentation for undergraduate chemistry laboratories. Journal of Computers in Mathematics and Science Teaching, 16(4), 513-525.

Amend, J. R. & Furstenau, R. P. (1992). Employing computers in the nonscience-major chemistry laboratory. Journal of College Science Teaching, 22(2), 110-114.

Amend, J. R., Briggs, R. D., Furstenau, R. P., Tucker, K.A., Howald, R. A., & Ivey, B. E. (1989). Laboratory interfacing for science courses in Montana schools: A project at Montana State University. Journal of Computers in Mathematics and Science Teaching, 9(1), 95-105.

Anderson, J. (1989). Chromanal: Interactive chromatographic analysis software. Journal of Chemical Education, 66(8), A198-A201.

Atkins, N. & Vasu, E. (1998). The teaching with technology instrument: Effectively measuring where teachers are and planning for staff development. Learning and Leading with Technology, 25(8), 35-39.

Baird, W. E., Ellis, J. D. & Kuerbis, P. J. (1989). Enlist micros: Training science teachers to use microcomputers. Journal of Research in Science Teaching, 26(7), 587-598.

Brasell, H. (1987). The effect of real-time laboratory graphing on learning graphic representations of distance and velocity. Journal of Research in Science Teaching, 24(4), 385-395.

Braun, B. & Mulstay, R. (1993). Human spirometry: Computerized data acquisition in the undergraduate human physiology laboratory. Journal of Computers in Mathematics and Science Teaching, 12(1), 37-46.

Brown, G. & Henscheid, J. (1997). The toe dip or the big plunge: Providing teachers effective strategies for using technology. Techtrends, 42(4), 17-21.

Broyles, I. & Tillman, M. (1985). Relationships of inservice training components and changes in teacher concerns regarding innovations. Journal of Educational Research, 78(6), 364-371.

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

Clark, A. (1993). Investigating school physics laboratory software and hardware. Physics Education, 28(2), 87-91.

Cordes, A. (1990). Using computers in the physics laboratory. Journal of Computers in Mathematics and Science Teaching, 9(3), 53-63.

Durham, B. (1990). Wet laboratories, computers and spreadsheets. Journal of Chemical Education, 67(5), 416-420.

Ellis, J. D. (1989). An evaluation of a project for preparing science teachers to use microcomputers. Journal of Computers in Mathematics and Science Teaching, 9(1), 51-64.

Ellis, J. D. (1990). Preparing science teachers for the information age. Journal of Computers in Mathematics and Science Teaching, 9(4), 55-70.

Ellis, J. D. & Kuerbis, P. J. (1992). Implementing microcomputers in science teaching. Journal of Science Teacher Education, 3(3), 65-75.

Findlay, D. & Lamb, M. J. (1993). Microcomputers in the physics laboratory. Physics Education, 28(2), 92-96.

Finkel, J. (1975). Computer-aided experimentation: Interfacing to minicomputers. New York: NY.: John Wiley and Sons Inc..

Fontana, L. A. & Ochoa, A. (1985). What are the issues for teaching training. NASSP Bulletin, 69(480), 15-20.

Fox, J. N. & Eddy, J. K. (1990). Project ExCELS - Computer interfacing workshops for high school science teachers. Journal of Computers in Mathematics and Science Teaching, 9(3), 39-44.

Fox, J. N., Hershman, K. E. & Peard, T. (1994). ExCELS - The next step. Journal of Computers in Mathematics and Science Teaching, 13(1). 69-81.

Friedler, Y. & McFarlane, A. E. (1997). Data logging with portable computers: A study of the impact on graphing skills in secondary pupils. Journal of Computers in Mathematics and Science Teaching, 16(4), 527-550.

Germann, P. J. & Barrow, L. H. (1996). The use of computer technologies in Missouri secondary science classrooms. Journal of Computers in Mathematics and Science Teaching, 15(3), 217-236.

Germann, P. J. & Sasse, C. M. (1997). Variations in concerns and attitudes of science teachers in an educational technology development program. Journal of Computers in Mathematics and Science Teaching, 16(2/3), 405-423.

Gilmore, A. M. (1995). Turning teachers on to computers: Evaluation of a teacher development program. Journal of Research on Computing in Education, 27(3), 251-269.

Government of Newfoundland and Labrador. (1995). Student Manual: Distance Learning. St. John's, Newfoundland: Department of Education and Training.

Government of Newfoundland and Labrador. (1996). Technology in learning environments: Enabling tomorrow's learners today. St. John's, Newfoundland: Department of Education and Training.

Graef, J. (1983). The computer connection: Four approaches to microcomputer laboratory interfacing. The Science Teacher, 50(4), 42-47.

Guskey, T. R. (1986). Staff development and the process of teacher change. Educational Researcher, 15(5), 5-12.

Hall, G. E. (1979). The concerns-based approach to facilitating change. Educational Horizons, 57(4), 202-208.

Hall, G. E., George, A. & Rutherford, W. (1977). Measuring stages of concern about the innovation: A manual for the use of the Stages of Concern Questionnaire. Austin, Texas: Texas University, Research and Development Center for Teacher Education. (ERIC Document Reproduction Service No. ED 147342)

Hall, G. E. & Loucks, S. F. (1981). Program definitions and adaptation: Implications for inservice. Journal of Research and Development in Education, 14(2), 46-58.

Haney, J. J. & Lumpe, A. T. (1995). A teacher professional development framework
   guided by reform policies, teachers' needs, and research. Journal of Science
   Teacher Education, 6(4), 187-196.

Hart, F. X. (1998). A microcomputer-based phase-change experiment. The Physics
   Teacher, 36(2), 98-99.

Harty, H. & Enochs, L. G. (1985). Toward reshaping the inservice education of science
   teachers. School Science and Mathematics, 85(2), 125-135.

Heck, R. H. (1990). Secondary science teachers' attitudes about microcomputer-based
   laboratory techniques: Instructional uses and needed improvements. Computers
   in the Schools, 7(3), 71-85.

Hope, W. C. (1997). Resolving teachers' concerns about microcomputer technology.
   Computers in the Schools, 13(3/4), 147-160.

Ingvarson, L. & MacKenzie, D. (1988). Factors affecting the impact of inservice courses
   for teachers: Implications for policy. Teaching and Teacher Education, 4(2), 139-
   155.

James, R. K. (1981). Understanding why curriculum innovations succeed or fail. School
   Science and Mathematics, 81(6), 487-495.

James, R. K. & Hall, G. E. (1981). A study of the concerns of science teachers
   regarding an implementation of ISCS. Journal of Research in Science Teaching,
   18(6), 479-487.

Krause, D. (1988). The computer-based laboratory. Journal of Chemical Education, 65(10), 875.

Lehman, J. (1985). Survey of microcomputer use in the science classroom. School Science and Mathematics, 85(7), 578-583.

MacArthur, C. A., Pilato, V., Kercher, M., Peterson, D., Malouf, D. & Jamison, P. (1995). Mentoring: An approach to technology education for teachers. Journal of Research on Computing in Education, 28(1), 46-62.

MacIsaac, D. (1990). Why use computers to teach physics labs. Retrieved September 1998 from the World Wide Web: http://www.phy.nau.edu/~danmac/whyMBL.html.

Matlock, D. B. & Safford, D. C. (1989). Beyond the black box: Using the microcomputer as a multipurpose analytical instrument. Journal of College Science Teaching, 18(5), 313-317.

McKenzie, J. (1991). Designing staff development for the information age. From Now On, 1(4). Retrieved September 1998 from the World Wide Web: http://www.fno.org/fnoapr91.html

McKenzie, J. (1998a). Secrets of success: Professional development that works. From Now On. Retrieved September 1998 from the World Wide Web: http://www.fno.org/eschool/secrets.html

McKenzie, J. (1998b). Adult technology learning: Creating learning cultures with just-in-time support. From Now On. Retrieved September 1998 from the World Wide Web: http://www.fno.org/eschool/adult.html

Mokros, J. R. & Tinker, R. F. (1987). The impact of microcomputer-based labs on children's ability to interpret graphs. <u>Journal of Research in Science Teaching, 24</u>(4), 369-383.

Moursund, D. (1998). Professional development: An eight-level scale. <u>Learning and Leading with Technology, 25</u>(4), 4-5.

Nachmias, R. & Linn, M. C. (1987). Evaluations of science laboratory data: The role of computer-presented information. <u>Journal of Research in Science Teaching, 24</u>(5), 491-506.

Nakhleh, M. B. (1994). A review of microcomputer-based labs: How have they affected science learning? <u>Journal of Computers in Mathematics and Science Teaching, 13</u>(4), 368-381.

National Science Teachers Association. (1992). An NSTA position statement: The use of computers in science education. Retrieved September 1998 from the World Wide Web: http://www.nsta.org/handbook/computer.htm.

Norton, P. (1992). When technology meets the subject-matter disciplines in education. Part two: Understanding the computer as discourse. <u>Educational Technology, 32</u>(7), 36-46.

O'Brien, T. (1992). Science inservice workshops that work for elementary teachers. <u>School Science and Mathematics, 92</u>(8), 422-426.

Persky, S. E. (1990). What contributes to teacher development in technology? <u>Educational Technology, 30</u>(4), 34-38.

Powers, M. H. (1986). Interfacing commodore microcomputers with a laboratory device: A thermometer probe. Journal of Computers in Mathematics and Science Teaching, 5(2), 47-51.

Price, C. L. (1989). Microcomputer applications in science. Journal of Science Education, 1(2), 30-33.

Risley, J. S. (1988). Courseware review: Vernier software: Precision timer II. The Physics Teacher, 26(6), 402-403.

Roth, W. M. (1989). Experimenting with temperature probes: Computers and hands-on activities do go together, if you know how. Science and Children, 27(3), 52-54.

Scaife, J. (1993). Datalogging: where are we now? Physics Education, 28(2), 83-86.

Showers, B. (1985). Teachers coaching teachers. Educational Leadership, 42(7), 43-48.

Solomon, J., Bevan, R., Frost, A., Reynolds, H., Summers, M. & Zimmerman, C. (1991). Can pupils learn through their own movement? A study of the use of motion sensor interface. Physics Education, 26(6), 345-349.

Stein, J. S. (1987). The computer as lab partner: Classroom experience gleaned from one year of microcomputer-based laboratory use. Journal of Educational Technology Systems, 15(3), 225-236.

Thompson, S. R., Seligmann, P. F. & Cava, F. J. (1993). A pH and computer approach to measuring respiration rate. The American Biology Teacher, 55(1), 46-48.

Thornton, R. K. (1987). Tools for scientific thinking - Microcomputer-based laboratories for physics teaching. Physics Education, 22(4), 230-238.

Thorton, R. K. & Sokoloff, D. R. (1990). Learning motion concepts using real-time microcomputer-based laboratory tools. American Journal of Physics, 58(9), 858-867.

Trumper, R. (1997). Learning kinematics with a V-scope: A case study. Journal of Computers in Mathematics and Science Teaching, 16(1), 91-110.

Trumper, R. & Wiener, A. (1994). Investigation of coupled harmonic oscillations with a V-scope. Journal of Computers in Mathematics and Science Teaching, 13(4), 445-463.

van den Berg, R. (1993). The concerns-based adoption model in the Netherlands, Flanders and the United Kingdom: State of the art and perspective. Studies in Educational Evaluation, 19(1), 51-63.

Wallinger, L. M. (1997). Developing technology training for teachers. Kappa Delta Pi Record, 34(1), 18-19.

Wedman, J. F. (1988). Variations in teachers' concerns about different applications of educational computing. Educational and Psychological Research, 8(1), 51-60.

Wedman, J. F., Heller, M. O. & Strathe, M. I. (1986). Changes in teachers' concerns about educational computing. Computers in the Schools, 3(2), 63-71.

Weller, H. G. (1996). Assessing the impact of computer-based learning in science. Journal of Research on Computing in Education, 28(4), 461-485.

Westling, B. D. & Bahe, M. E. (1986). Interface it yourself. The Science Teacher, 53(8), 45-47.

Williams, B. (1993). Barriers to new technologies. Part Two: Skill fixation in staff development. From Now On, 4(2). http://www.fno.org/FNOOct93.html#Barriers.

Willis, E. M. (1997). Technology: Integrated into, not added onto, the curriculum experiences of pre-service teacher education. Computers in the Schools, 13(1/2), 141- 153.

Willis, J. (1993). What conditions encourage technology use? It depends on the context. Computers in the Schools, 9(4), 13-32.

Wilson, J. M. & Redish, E. F. (1989). Using computers in teaching physics. Physics Today, 42(1), 34-41.

Winders, A. & Yates, B. (1990). The traditional science laboratory versus a computerized science laboratory: Think carefully before supplanting the old with the new. Journal of Computers in Mathematics and Science Teaching, 9(3), 11-15.

Zammit, S. A. (1992). Factors facilitating or hindering the use of computers in schools. Educational Research, 34(1), 57-66.

APPENDIX A

Request to Complete Internship

June 16, 1998

Mr. Michael Siscoe
Executive Director
Burin Peninsula School Board
Marystown, NF.
A0E 2M0

Dear Mr. Siscoe.

As you are already aware, I am interested in completing an internship with the cooperation of the Burin Peninsula School Board. This internship is a partial and final requirement for a Masters in Education from Memorial University of Newfoundland.

Please accept this as a formal request to complete this internship, as required by University regulations. I have enclosed the approved guidelines for the completion of this route. I also request permission to use Mr. Greg Coombes, Mr. Graham Wood and yourself as contact people.

During this summer I will be developing a comprehensive proposal that will detail the goals and objectives of this field placement. Dr. Dennis Sharpe has agreed to act as the University Supervisor, upon approval of the completed proposal. Additionally, School Board personnel will be contacted regularly to ensure that the proposal meets with their expectations.

It should be noted that final approval lies with the University. I anticipate that all such required components will be completed by early August. Additionally, a copy of the proposal will be made available to all participating individuals so that any revisions or concerns can be addressed prior to the initiation of the internship.

Please contact me if you have any questions or concerns. I am confident that the proposed field placement will be a meaningful and worthwhile experience for all participants.

Yours truly,

Cynthia Pope
cc: Mr. Greg Coombes
    Mr. Graham Wood

APPENDIX B

Letter of Approval to Complete Internship

Burin Peninsula School Board

P. O. Box 4000
Marystown, NF
A0E 2M0

Telephone: (709) 279-2870
Fax: (709) 279-2177

July 7, 1998

Associate Dean of Graduate Studies
Department of Education
Memorial University of Newfoundland
St. John's, NF

Please be advised that Cynthia Pope has this office's approval to complete in the District an internship as partial requirement for her Masters in Teaching and Learning.

If you require any further information, please contact this office.

Sincerely yours,

Mike Siscoe
DIRECTOR
MS/bp

APPENDIX C

Ethics Approval

▦ Memorial
University of Newfoundland

Faculty of Education
Graduate Programmes & Research

September 1, 1998

Ms. Cynthia Pope
P.O. Box 1665
Marystown, NF
A0E 2M0

Dear Ms. Pope:

After reviewing your proposal, the Ethics Review Committee is satisfied that it meets the guidelines of the University and Faculty. We wish you all the best in your work.

Sincerely,

Tina Hunt

for T. Seifert
Ethics Review Committee

cc   Dr. Dennis Sharpe

APPENDIX D

Letter to Principals

Dear Principal:

I am a Master of Education student at Memorial University. With the cooperation of the Burin Peninsula School Board, I am completing an internship focussing on the integration of Vernier software into the Senior High science curriculum. I am requesting your permission to visit your school and carry out a number of activities.

Your school's participation will involve science teachers of Physics and Chemistry courses. These teachers will participate in interviews, a Board approved inservice, classroom visitations, as well as the completion of questionnaires. Teachers in your school will be asked to participate and it will be made very clear that he or she can stop participation at any time. This internship will be ongoing from September to December. All visits to your school will be at the convenience of participating teachers.

All information gathered in this study is strictly confidential and at no time will individuals be identified. I am interested in addressing individual teacher concerns of how they can most effectively integrate Vernier software into the science curriculum. Participation is voluntary and you may withdraw your school at any time. This study has received the approval of the Faculty of Education's Ethics Review Committee. The results of the research will be available upon request.

If you are in agreement with having your school participate in this study please sign below and return one copy to me at the Board Office. The other copy is for your files. If you have any concerns or questions please do not hesitate to contact me at the Board Office (279-2870) or home (279-2892). If at any time you wish to speak with a resource person not associated with the study please contact the Associate Dean, Graduate Programs and Research.

I look forward to working with you and your teachers.

Yours sincerely,

_____

Cynthia Pope

I _____ (Principal) hereby give permission for the participation of _____ (School) in a study on the integration of Vernier software into the science curriculum. I understand that participation is entirely voluntary and that participation can be terminated at any time. All information is strictly confidential and no individual will be identified.

_____   _____

Date   Principal

APPENDIX E

Letter of Intent to Teachers

Dear Teacher:

I am a Master of Education student at Memorial University. With the cooperation of the Burin Peninsula School Board, I am completing an internship focussing on the integration of Vernier software into the Senior High science curriculum. I am requesting your commitment to participate in my research study. This participation will include the completion of questionnaires, interviews, inservice and classroom visitations.

All information gathered in this study is strictly confidential and at no time will individuals be identified. I am interested in addressing individual teacher concerns of how they can most effectively integrate Vernier software into the curriculum. Participation is voluntary. This study has received the approval of the Faculty of Education's Ethics Review Committee. The results of the research will be available upon request. This internship will be ongoing from September to December. All visits to your school will be at your convenience.

It is my goal that your participation will help you to integrate Vernier software into your science curriculum. Questionnaires and interviews will allow me to determine your personal concerns which can be addressed though the course of the internship. You are free to discontinue your participation at any time and also to refrain from answering any questions.

If you are in agreement with participating in this study please sign below and return one copy to me at the Board Office. The other copy is for your files. If you have any concerns or questions please do not hesitate to contact me at the Board Office (279-2870) or home (279-2892). If at any time you wish to speak with a resource person not associated with the study please contact the Associate Dean, Graduate Programs and Research.

I look forward to working with you.

Yours sincerely,

_____
Cynthia Pope

I _____(Teacher) hereby agree to participate in a study on the integration of Vernier software into the science curriculum. I understand that participation is entirely voluntary and that participation can be terminated at any time. All information is strictly confidential and no individual will be identified.

_____   _____

Date   Teacher

APPENDIX F

Stage of Concern Questionnaire

Integration of Vernier interface into the science curriculum

Concerns Questionnaire

ID#_____   Date _____

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the innovation adoption process. The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various innovation to many years. Therefore, a good part of the items may appear to be of little relevance or irrelevant to you at this time. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale, according to the explanation at the top of each of the following pages.

For example:

0 1 2 3 4 5 6 ⑦   This statement is very true of me at this time.

0 1 2 ③ 4 5 6 7   This statement is somewhat true of me now.

0 ① 2 3 4 5 6 7   This statement is not at all true of me at this time.

⓪ 1 2 3 4 5 6 7   This statement seems irrelevant to me.

Please respond to the items in terms of your **present** concerns or how you feel about your involvement or potential involvement with the integration of Vernier interface into the science curriculum. Since this questionnaire is used for a variety of innovations, specific reference to the **integration of Vernier interface into the science curriculum** does not appear. However, phrases such as "the innovation", "this approach" and "the new system" all refer to the Vernier interface. Remember to respond to each item in terms of your **present** concerns about your involvement or potential involvement with the integration of Vernier interface into the science curriculum.

Thank you for taking time to complete this task.

0 1 2 3 4 5 6 7   1) I am concerned about students' attitudes toward this innovation.

0 1 2 3 4 5 6 7   2) I now know of some other approaches that might work better.

0 1 2 3 4 5 6 7   3) I don"t even know what the innovation is.

0 1 2 3 4 5 6 7   4) I am concerned about not having enough time to organize myself each day.

0 1 2 3 4 5 6 7   5) I would like to help other staff in their use of the innovation.

0 1 2 3 4 5 6 7   6) I have a very limited knowledge about the innovation.

0 1 2 3 4 5 6 7   7) I would like to know the effect of reorganization on my professional status.

0 1 2 3 4 5 6 7   8) I am concerned about conflict between my interests and my responsibilities.

0 1 2 3 4 5 6 7   9) I am concerned about revising my use of the innovation.

0 1 2 3 4 5 6 7   10) I would like to develop working relationships with both our staff and other colleagues using this innovation.

0 1 2 3 4 5 6 7   11) I am concerned about how the innovation affects students.

0 1 2 3 4 5 6 7   12) I am not concerned about this innovation.

0 1 2 3 4 5 6 7   13) I would like to know who will make the decisions in the new system.

0 1 2 3 4 5 6 7   14) I would like to discuss the possibility of using the innovation.

0 1 2 3 4 5 6 7   15) I would like to know what resources are available if we decide to adopt this innovation.

0 1 2 3 4 5 6 7   16) I am concerned about my inability to manage all the innovation requires.

0	1	2	3	4	5	6	7
Not true of me now		Somewhat true of me now				Very true of me now	

0 1 2 3 4 5 6 7   17) I would like to know how my teaching or administration is supposed to change.

0 1 2 3 4 5 6 7   18) I would like to familiarize other departments or persons with the progress of this new approach.

0 1 2 3 4 5 6 7   19) I am concerned about evaluating my impact on students.

0 1 2 3 4 5 6 7   20) I would like to revise the innovation's instructional approach.

0 1 2 3 4 5 6 7   21) I am completely occupied with other things.

0 1 2 3 4 5 6 7   22) I would like to modify our use of the innovation based on the experiences of our students.

0 1 2 3 4 5 6 7   23) Although I don't know about this innovation, I am concerned about things in the area.

0 1 2 3 4 5 6 7   24) I would like to excite my students about their part in this approach.

0 1 2 3 4 5 6 7   25) I am concerned about time spent working with nonacademic problems related to this innovation.

0 1 2 3 4 5 6 7   26) I would like to know what the use of the innovation will require in the immediate future.

0 1 2 3 4 5 6 7   27) I would like to coordinate my efforts with others to maximize the innovation's effects.

0 1 2 3 4 5 6 7   28) I would like to have more information on time and energy requirements by this innovation.

0 1 2 3 4 5 6 7   29) I would like to know what other teachers are doing in this area.

0 1 2 3 4 5 6 7   30) At the time, I am not interested in learning about this innovation.

0 1 2 3 4 5 6 7   31) I would like to determine how to supplement, enhance or replace the innovation.

	0	1		2	3	4	5		6	7

Not true of me now   Somewhat true of me now   Very true of me now

0 1 2 3 4 5 6 7   32) I would like to use feedback from students to change the program.

0 1 2 3 4 5 6 7   33) I would like to know how my role will change when I am using the innovation.

0 1 2 3 4 5 6 7   34) Coordination of tasks and people is taking too much of my time.

0 1 2 3 4 5 6 7   35) I would like to know how this innovation is better than what we have now.

APPENDIX G

Demographic Form

Please circle an appropriate response or write your response.

1) Teaching Experience   0-5 6-10 11-15 16-20 21-25 26-30 30+

2) Major area of undergraduate study

Biology	Chemistry
Physics	Earth Science
Mathematics	Other_____

3) Science courses currently teaching

Chemistry 2202	Chemistry 3202
Physics 2204	Physics 3204

4) General computer use: Please indicate your use of each of the following in your classroom.

word processing	Extensive	Regular	Occasional	Seldom	Never
spread sheets	Extensive	Regular	Occasional	Seldom	Never
graphics programs	Extensive	Regular	Occasional	Seldom	Never
Internet (research)	Extensive	Regular	Occasional	Seldom	Never
E-mail	Extensive	Regular	Occasional	Seldom	Never
simulations	Extensive	Regular	Occasional	Seldom	Never
drill and practice	Extensive	Regular	Occasional	Seldom	Never
tutorials	Extensive	Regular	Occasional	Seldom	Never
interfacing	Extensive	Regular	Occasional	Seldom	Never

5) General computer availability: How many computers are available in

your school's computer lab   _____

your school's science lab   _____   your classroom _____

6) Vernier interface use: Please indicate which areas of the Chemistry and Physics curriculum that you have use Vernier interface.

Physics 2204

    Introduction

    Mechanical Energy

    Wave Energy

    Light Energy

    Energy Considerations in House Design and Construction

    The Physics of Music

    The Physics of Photography

    Laser Physics

Physics 3204

    Vector Kinematics

    Dynamics

    Electrostatics

    Current Electricity

    Magnetism, Electromagnetism, Electromagnetic Induction

    Oceanography

    Nuclear Physics

    Electronics

Chemistry 2202
   Matter and Energy in Chemical Change
   Matter as Solutions and Gases
   Quantitative Relationships in Chemical Changes
   Chemical Bonding in Matter
Chemistry 3202
   Organic Chemistry
   Thermochemical Changes
   Equilibrium, Acids and Bases in Chemical Changes
   Electrochemical Changes

Other Courses (please specify)
   _____
   _____

7)   Which of the following would you perceive as barriers to your personal integration of
     Vernier software into the science courses you teach? (Check all those that apply).
     Personal lack of interest   _____

     Lack of Skills   _____

     Inadequate time to prepare   _____

     Lack of Available equipment   _____

     Inadequate support   _____

     Lack of Student interest   _____

     Other (please specify)   _____

8)   Have you attended any inservice sessions that dealt with Vernier interface before? Yes
     No

9)   In terms of the support offered to you through this internship, what do you perceive as
     being your **MOST** important request?
     _____
     _____
     _____
     _____
     _____

10) **Other comments:**
     _____
     _____
     _____
     _____

APPENDIX H

Support Evaluation

Integration of Vernier interface into the Science Curriculum

1) *Participation*: Please indicate with a check mark which of the following activities you participated in during the course of this internship.
   1) group session with intern
   2) one-on-one session with intern
   3) class activity with intern
   4) used Vernier interface in classroom since meeting with intern
   5) used activities provided by intern
   6) visited website developed by intern
   7)

2) *Evaluation of support*: Please indicate your response to each statement by circling the appropriate response using the scale below:
   NA - not applicable
   SD - strongly disagree
   D - disagree
   A - agree
   SA - strongly agree

1) Intern was approachable.	NA SD D A SA
2) Intern addressed my questions during sessions.	NA SD D A SA
3) Intern keep appointments and was prompt.	NA SD D A SA
4) Intern provided valuable support.	NA SD D A SA
5) Intern attempted to address my needs.	NA SD D A SA
6) Intern responded to and acted upon requests I made for support.	NA SD D A SA
7) Intern facilitated my use of the Vernier interface.	NA SD D A SA
8) Intern acted in a professional manner.	NA SD D A SA
9) The internship was helpful to me as a teacher.	NA SD D A SA
10) Intern showed interest in my concerns and contributions.	NA SD D A SA
11) I took advantage of the support provided by the internship	NA SD D A SA
12) Participation in the internship was a worthwhile experience.	NA SD D A SA

3 *Comments*
   a. What was the most valuable support you received during the internship?
      _____
      _____

   b. What concerns did the internship fail to address?
      _____
      _____

   c. Other comments
      _____
      _____

Please return this survey in the small, enclosed envelope

APPENDIX I

Activity Booklet Developed for Teachers

Integrating Vernier Interface into the Science Curriculum

Activities

Developed by: Cindy Pope (1998)

INTRODUCTION

The activities in this book were designed as part of an internship focusing on the integration of the Vernier interface into the science curriculum. Some of these activities were adapted from other sources to better meet the objectives of the Newfoundland curriculum.

Any suggestions for the improvement of these activities would be greatly appreciated. If you modify any activities and find they work better please share these ideas. A disk copy of this resource is included to allow easy modification of the activities. These activities were written using Corel WordPerfect. All the activities included here are also available on the internet. Therefore, modifications can be made so that all teachers can easily access them.

The activities are designed for the DOS version of Vernier, since this is the version most schools are currently using. However, they can be easily adapted to the Windows version. Please feel free to copy this resource and share it with any of your colleagues.

WEB SITE

You are invited to visit a web site, also developed as part of this internship, at

This site provides information about the use of Vernier in the science curriculum, a troubleshooting section and other sites related to microcomputer-based laboratories. This site will be maintained after the conclusion of this internship. You are encouraged to send comments and/or regarding the information provided by this site. Your participation in this will promote the site and hopefully help it evolve into a useful resource for science teachers.

Table of Contents

Calibration of a Temperature Probe

Introduction:

In order to ensure that the temperature readings measured by a temperature probe are accurate, the temperature probe must be calibrated. The Vernier interface measures differences in voltages and converts these differences to electrical signals. These signals are then expressed in units that specify temperature or in degrees Celsius. Calibration sets reference points that associate a particular voltage reading with a known temperature. Once a calibration has been completed it can be saved as a file in the same manner you save a file that contains a document you've completed in a word processing program. When the temperature probe is used in the future the calibration file will be loaded into the program from the computers memory.

Materials:

a 100 mL beaker of warm water
a 100 mL beaker of cold water
a thermometer
temperature probe
MPLI box

Procedure:

1. Connect the temperature probe to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MPLI interface program. (At c prompt type cd mpli [E] and then mpli again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Select inputs.[E]
6. Select input A and turn off inputs B and C using the space bar.
7. Press enter three times to return to **Main Menu.**
8. Select calibration.[E]
9. Select **z** - input calibration data [E]
10. Select input A [E]
11. A message will ask you if you are sure you want to proceed with a calibration. Type **Y** [E].
12. Type **temperature** (as the measure) [E]
13. Type Deg C (as the units) [E]
14. Place the thermometer and the temperature probe into one of the beakers. Watch the voltage reading and wait until it stabilizes. Press [E] when the value is stable. Type in the temperature reading on the thermometer to the nearest tenth of a degree [E].

15. Place the thermometer and the temperature probe into the other beaker. Watch the voltage reading and wait until it stabilizes. Press [E] when the value is stable. Type in the temperature reading on the thermometer to the nearest tenth of a degree [E].
16. When requested, type **your name** [E].
17. Type **Y** when asked if you want to save the file [E].
18. Type the filename _____ [E].
19. Press **enter** until you return to the main menu.
20. Turn off the computer and detach the probe and MPLI box from the computer. Dry the temperature probe and store away properly. In future labs you may load this calibration file from memory so that it can be used to measure data.

Questions:
(1) What is meant by the term calibration?
(2) Why is it necessary to calibrate instruments, such as thermometers and temperature probes?
(3) Why were two different temperatures used to calibrate the temperature probe? How do these temperatures relate to those used to calibrate a standard thermometer?
(4) How accurate do you think your calibration of the temperature probe was? What factors (errors) in the experiment would contribute to the accuracy of your calibration?

Calibration of a Student Force Sensor

Introduction:

In order to ensure that the force readings measured by a student force sensor are accurate, the sensor must be calibrated. The Vernier interface measures differences in voltages and converts these differences to electrical signals. These signals are then expressed in units that specify force or in newtons. Calibration sets reference points that associate a particular voltage reading with a known force. Once a calibration has been completed it can be saved as a file in the same manner you save a file that contains a document you've completed in a word processing program. When the student force sensor is used in the future the calibration file will be loaded into the program from the computers memory.

Materials:

student force sensor
500 g (0.500 kg mass)
MPLI box

Procedure:

Part A. (Calibration)

1. Connect the force sensor to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MP interface program. (At c prompt type **cd mp** [E] and then **mp** again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Under **Other Options Menu** select motion detector input, use the space bar to turn this off so that the current setting reads none.
6. Select force transducer input, use the space bar to select Channel A.
7. Select calibrate force transducer [E]
8. At warning note type **Y** for yes, indicating you want to proceed with the calibration.
9. When requested for new force units type **N** (for newtons). This may already be done. [E]
10. Grasp the force sensor in your hand so that the side with the hooks is parallel to the floor. Keep the sensor steady and wait for the voltage reading to stabilize. When it is stabilized press enter.
11. Hand a 500 g mass from the hook. Again wait for the reading to stabilize, then press enter. When asked for input force, type **4.9** [E]
12. At **Other Options Menu** select return to main menu [E]
13. The force sensor has now been calibrated. To test out the force sensor continue with the procedure below, otherwise exit the program, turn off the computer and detach the MPLI box and the force sensor. Store away properly.

Procedure:

Part B (Experimenting with forces)

14. At **Main Menu** select monitor/graph in real time [E]
15. At **Graph Style Options** use the space bar to turn on background grid of dots, line connecting points, and specify graph title [E]
16. When prompted type **Force vs Time** as a graph title [E]
17. At **Real Time Graphing - Scaling** screen make sure that the force is on and distance, velocity and acceleration are off. Select time of run and change time to 1:00 [E]. Then select start graph [E].

Measuring vertical forces

18. Hold the force sensor as before and begin data collection by pressing enter. Do not touch the hooks of the force sensor initially. Then push down on the hooks. Notice the change in the graph when force was applied. Release the downward pressure and then push up on the hooks. Notice the difference in your graph. When the computer has finished taking data press enter.
19. At **Graph Follow-up Options Menu** select repeat data collection - no changes.

Measuring horizontal forces

20. Hold the force sensor so that the side containing hooks is perpendicular to the floor. Do not touch the hooks of the force sensor initially. Then push left on the hooks. Notice the change in the graph when force was applied. Release this pressure and then push right on the hooks. Notice the difference in your graph. When the computer has finished taking data press enter.
21. When finished return to the main menu and quit the program. Turn off the computer and disconnect the MPLI box and the force sensor. Store all materials away properly.

Analysis:

(1) What was the force (in newtons) when no pressure was applied to the sensor? What does this tell you about your calibration?

(2) Force is a vector quantity, meaning it has both magnitude (or size) and direction.
   A. How did your graph change when you pushed down and then up on the hooks? What do the negative and positive values indicate?
   B. How did your graph change when you pushed left and then right on the hooks? What do the negative and positive values indicate?

Calibration of a Motion Detector

Method One: Specifying Temperature

Materials:
Vernier MPLI
motion detector
thermometer

Procedure:

1) Connect the MPLI box to the computer. Connect the motion detector to Channel A of the MPLI box. Turn on the computer.

2) Load the Motion Plotter program - at the c prompt type **cd mp** [E], then **mp** [E].

3) At **Main Menu**, select other options [E].

4) At **Other Options Menu** use the space bar to set the motion detector input to channel A and ensure that the force transducer input reads none.

5) At **Other Options Menu** select calibrate motion detector [E].

6) A warning message will appear on the screen cautioning you that this option will recalibrate the motion detector. Type **y** to indicate you wish to proceed.

7) At next screen you will be asked to select method. Select enter temperature [E].

8) You will be prompted for the current room temperature in degrees Celsius. Enter the appropriate value, as measured on your thermometer, using the keyboard [E].

9) The screen will now display the adjusted speed of sound [E].

10) At the **Other Options Menu** you can select save configuration file. This file will be stored in the computer's memory and loaded each time you use the motion plotter program.

11) You will be warned that this action will replace the current configuration file. Type **y** if you wish to proceed.

12) Enter your name when prompted by the computer [E].

13) You will now be returned to the **Other Options Menu**. Select return to main menu [E].

14) Either quit the program or proceed with an activity.

Method Two: Distance Comparison Method

Materials:
Vernier MPLI
motion detector
meter stick or measuring tape

Procedure:
1) Connect the MPLI box to the computer. Connect the motion detector to Channel A of the MPLI box. Turn on the computer.
2) Load the Motion Plotter program - at the c prompt type **cd mp** [E], then **mp** [E].
3) At **Main Menu**, select other options [E].
4) At **Other Options Menu** use the space bar to set the motion detector input to channel A and ensure that the force transducer input reads none.
5) At **Other Options Menu** select calibrate motion detector [E].
6) A warning message will appear on the screen cautioning you that this option will recalibrate the motion detector. Type y to indicate you wish to proceed.
7) At next screen you will be asked to select a method. Select enter distance [E].
8) Place the motion detector firmly on a flat surface. Hold a large book or piece of cardboard in front of you and stand a known distance from the motion detector. The computer will display the distance as read by the motion detector. Press enter and the computer will prompt you to enter a distance. Enter the appropriate value, as measured on your meter stick, using the keyboard [E].
9) Repeat step 22 for a different distance.
10) Please note that the range of the Motion Detector is between 0.4 to 6 meters.
11) At the **Other Options Menu** you can select save configuration file. This file will be stored in the computer's memory and loaded each time you use the motion plotter program.
12) You will be warned that this action will replace the current configuration file. Type y if you wish to proceed.
13) Enter your name when prompted by the computer [E].
14) You will now be returned to the **Other Options Menu**. Select return to main menu [E].
15) Either quit the program or proceed with an activity.

Endothermic Reaction (Teacher Demonstration)

Purpose: To illustrate that heat is absorbed during an endothermic chemical reaction.

Materials:
Vernier MPLI
temperature probe
125 mL erylenmeyer flask
30 g barium hydroxide
15 g ammonium thiocyanate (or 10.5 g ammonium chloride or 15 g ammonium nitrate)
small wooden block (optional)
stopper (with slit)

Procedure:
1. Connect the temperature probe to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MPLI interface program. (At c prompt type cd mpli [E] and then mpli again)
3. Press enter to go to **Main Menu**.
4. Select other options. [E]
5. Select inputs.[E]
6. Select input A and turn off inputs B and C using the space bar.
7. Press enter three times to return to **Main Menu**.
8. Select calibration.[E]
9. Select load calibration file. [E] twice
10. Use the down arrow key to select the calibration file _____. [E]
11. Press enter two times to return to **Main Menu**. Select graph in real time. [E]
12. Select the following options under the **Graph Options Menu** by using the space bar to turn them on: Background grid of dots, line connecting points and specify graph title.
13. Specify graph title: type temperature vs time. [E]
14. Enter minimum anticipated input: -30. [E]
15. Enter maximum anticipated position: 30. [E]
16. Select yes indicating you want to store data in memory. [E]
17. Move cursor to the indicated position and change time to 0-00:03:00.. [E]
18. Indicate the number of readings required by entering 45. [E]
19. Insert the probe into the stopper. Measure out 15 g of ammonium thiocyanate into the flask. Position the probe so that it is about 0.5 cm above the bottom of the flask. Press enter to begin data collection and monitor the temperature of the ammonium thiocyanate for 30 - 40 seconds. Then add 30 g of barium hydroxide into the flask. Swirl the erlenmeyer flask and observe the graph displayed on the monitor.

20.   Press enter once the temperature has stabilized or when the three minutes have passed.
21.   Press enter to exit graph.
22.   Select print graph under the **Graph Follow Up Menu**. [E]
23.   Select printer type and make sure the type of printer corresponds to the printer you will be using.
24.   Select start printing.
25.   When finished return to the **Main Menu** and exit the program.

Note:
For a visual effect, the flask could be placed on a block of wood with water on the top. When the flask is placed on the water, it freezes as the endothermic reaction progresses.

Analysis

1.   What is meant by the term endothermic reaction?
2.   What happened to the erlenmeyer flask as the reaction progressed?
3.   Where did the necessary energy needed for the reaction to proceed come from?
4.   In this chemical reaction, would energy be classified as a reactant or a product? Explain why.

Rates of Evaporation

Purpose: To observe temperature changes during evaporation and to compare evaporation rates of various liquids.

Materials:
Vernier MPLI
temperature probe
small samples of the following liquids:
Mineral oil
Nail polish remover
Perfume
Rubbing alcohol
test tubes and holder

Procedure:

1. Connect the temperature probe to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MPLI interface program. (At c prompt type cd mpli [E] and then mpli again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Select inputs. [E]
6. Select input A and turn off inputs B and C using the space bar.
7. Press enter three times to return to **Main Menu.**
8. Select calibration.[E]
9. Select load calibration file. [E]
10. Use the down arrow key to select the file _____. [E]
11. Press enter to return to **Main Menu.** Select graph in real time. [E]
12. Select the following options by using the space bar to turn them on: Background grid of dots, line connecting points and specify graph title. [E]
13. Specify graph title: type temperature vs time. [E]
14. Enter minimum anticipated input: 12. [E]
15. Enter maximum anticipated input: 30. [E]
16. Select yes indicating you want to store data in memory. [E]
17. Move cursor to the indicated position and change time to 0-00:02:00.. [E]
18. Indicate the number of readings required by entering 45. [E]
19. Insert the temperature probe into mineral oil.
20. Begin monitoring the temperature by pressing enter. Monitor the temperature of mineral oil for approximately 15 seconds. This will be the initial temperature. After 15 seconds remove the probe from the liquid. With as little motion as possible, lay the probe on the counter top, with the tip of the prove, extending

about 5 cm over the edge of the counter. The tip of the probe must not rest on the counter. The computer will continue to monitor the temperature for the remainder of the two minutes.

21. After two minutes press enter to terminate data collection. [E]
22. Press enter until you are back at the **Main Menu**.
23. Select display/print data table. [E]
24. Select display data table. [E]
25. Using the arrow keys scroll down to the end of the data table. Record the maximum and minimum values for temperature in the table. Determine the time elapsed from the time you removed the probe to the time the probe returned to room temperature. Record this time in your table.
26. Press enter to return to main menu.
27. Press enter until you return to **Main Menu**.
28. Select plot graph.
29. Under **Graph Options Menu** make sure background grid of dots, line connecting points and specify graph title are selected. [E]
30. Type temperature vs Time for graph title. [E]
31. Select automatic scaling - origin at 0 for the next two screens.
32. Select print graph under the **Graph Follow Up Menu**. [E]
33. Select printer type and make sure the type of printer corresponds to the printer you will be using.
34. Select start printing.
35. When finished return to the **Main Menu**.
36. Rinse the temperature probe with water and dry with a paper towel.
37. Repeat steps 4 -37 of the procedure for each of the other liquids.
38. When you have finished, rinse the probe with water and dry with a paper towel before storing it away.
39. When finished the experiment return to the **Main Menu** and exit the program

Analysis:

1) From the graph and data table determine the maximum and minimum temperatures for each liquid used . Calculate the change in temperature for each set of data collected.

Substance	t_2 (°C)	t_1 (°C)	Δt ($t_2 - t_1$)(°C)	time (seconds)
Mineral Oil				
Nail Polish Remover				
Perfume				
Rubbing Alcohol				

2) If a liquid has a small change in temperature, this indicates a large amount of energy is needed to evaporate a given amount of liquid, hence it must have a high heat of vaporization. Can you suggest why there were differences in the heat of vaporization for the substances used in this lab?

Phase Changes (Freezing and Melting of Water)

Introduction:
Freezing temperature is the temperature at which a substance turns from a liquid to a solid. Melting temperature is the temperature at which a substance turns from a solid to a liquid. In order to freeze a liquid, energy must be removed. On the other hand, to melt a substance energy must be added to it.

Purpose: To determine the relationship between the freezing and melting temperatures of water.

Materials:

Vernier MPLI	temperature probe
450 mL beaker	10 mL graduated cylinder
ice	ring stand and utility clamp
stirring rod	one test tube
salt	

Procedure:

Part One: Freezing

1. Connect the temperature probe to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MPLI interface program. (At c prompt type cd mpli [E] and then mpli again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Select inputs.[E]
6. Select input A and turn off inputs B and C using the space bar.
7. Press enter three times to return to **Main Menu.**
8. Select calibration.[E]
9. Select load calibration file. [E]
10. Use the down arrow key to select the calibration file _____ . [E]
11. Press enter two times to return to **Main Menu.** Select graph in real time. [E]
12. Select the following options under the **Graph Options Menu** by using the space bar to turn them on: Background grid of dots, line connecting points and specify graph title. [E]
13. Specify graph title: type temperature vs time. [E]
14. Enter minimum anticipated input: -20. [E]
15. Enter maximum anticipated input: 30. [E]
16. Select yes indicating you want to store data in memory. [E]
17. Move cursor to the indicated position and change time to 0-00:15:00.. [E]
18. Indicate the number of readings required by entering 45. [E]

19. Put about 100 mL of water and 5 to 6 ice cubes into a 400 mL beaker. Put 5 mL of water into a test tube and use a utility clamp to fasten the test tube to a ring stand. The test tube should be clamped above the water bath. Place the temperature probe into the water inside the test tube.

20. Begin monitoring temperature by pressing enter. Lower the test tube into the ice-water bath. After the test tube has been lowered, add 5 spoons of salt to the beaker and stir with a stirring rod. Continue to stir the ice-water bath.

21. Continuously move the probe during the first 10 minutes of Part One. Keep the probe in, but not above, the ice as it forms. After 10 minutes stop moving the probe and allow it to freeze into the ice. As necessary, add more ice cubes to the ice-water bath.

22. When 15 minutes have passed the data collection will stop. Keep the test tube submerged in the ice-water bath.

23. Examine your data to determine the freezing point of water.

24. Press enter to exit graph.

25. Select print graph under the **Graph Follow Up Menu.** [E]

26. Select printer type and make sure the type of printer corresponds to the printer you will be using.

27. Select start printing.

28. Return to the **Main Menu** and repeat steps 11 - 18.

29. Press enter to begin data collection. Raise the test tube and fasten it in a position above the ice-water bath. Do not move the temperature probe during this part of the activity.

30. Discard the ice water in the beaker and replace it with 250 mL of warm water. After 10 minutes, lower the test tube and its contents into the warm water bath.

31. When 15 minutes have passed the data collection will stop.

32. Examine your data to determine the melting point of water.

33. Repeat steps 24 - 27 to print your graph.

34. Return to the **Main Menu** and quit the program. Turn off the computer. Disconnect the MPLI box and the temperature probe.

Analysis:

1) What was the freezing temperature of the water sample?
   What was the melting temperature of the water sample?
   How do these temperatures compare?

2) What happened to the water temperature during freezing? During melting?

3) Phenyl salicylate has a freezing temperature of 42 degrees Celsius. Using graph paper, sketch and label a freezing curve for phenyl salicylate. On the same graph, but using a different colour, draw the melting curve for phenyl salicylate.

4) Write equations for each of the phase changes that occurred during this experiment including an energy component as either a reactant or a product.

Phase Changes (Melting and Evaporation)

Purpose: To observe temperature changes and plateaus during phase changes.

Materials:
Vernier MPLI
temperature probe
250 mL beaker
ice
hot plate

Procedure:
1. Connect the temperature probe to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MPLI interface program. (At c prompt type cd mpli [E] and then mpli again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Select inputs.[E]
6. Select input A and turn off inputs B and C using the space bar.
7. Press enter three times to return to **Main Menu.**
8. Select calibration.[E]
9. Select load calibration file. [E] twice
10. Use the down arrow key to select the calibration file _____. [E]
11. Press enter two times to return to **Main Menu.** Select graph in real time. [E]
12. Select the following options under the **Graph Options Menu** by using the space bar to turn them on: Background grid of dots, line connecting points and specify graph title. [E]
13. Specify graph title: type temperature vs time. [E]
14. Enter minimum anticipated input: -5. [E]
15. Enter maximum anticipated input: 110. [E]
16. Select yes indicating you want to store data in memory. [E]
17. Move cursor to the indicated position and change time to 0-00:20:00.. [E]
18. Indicate the number of readings required by entering 45. [E]
19. Turn on the hot place and place a beaker containing ice on the hot plate. Insert the temperature probe into the ice.
20. Begin monitoring temperature by pressing enter. Continue stirring the ice/water mixture as you monitor temperature.
21. Once water is boiling press enter to terminate the data collection.[E]
22. Examine your data to determine when phase changes (melting and evaporation) were occurring.

23. Press enter to exit graph.
24. Select print graph under the **Graph Follow Up Menu.** [E]
25. Select printer type and make sure the type of printer corresponds to the printer you will be using.
26. Select start printing.
27. When finished return to the **Main Menu** and exit the program.

Analysis:

1) What is the significance of the 'plateaus' in the graph?
2) Explain what is happening in terms of potential and kinetic energy during each of the following sections of the graph:
   A. Initial plateau.
   B. Rise from approximately 7 degrees Celsius to approximately 100 degrees Celsius.
   C. Second plateau.
3) Using your knowledge of phase changes, potential energy and kinetic energy extrapolate the graph if you continued to boil the water until the beaker was dry and captured the gas being produced.
4) Write equations for each of the phase changes that occurred during this experiment including an energy component as either a reactant or a product.
5) What is the boiling point of water? Did your water boil at exactly that point? If not, could you suggest some possible reasons for this discrepancy?

The Relationship Between Force and Mass (using MP)

Introduction:
Quite often people assume that mass and weight are the same. This is an incorrect assumption. Although the mass of an object remains the same, regardless of location, its weight can change. The weight of an object depends on the force of gravity that is present at an location. Therefore even though your mass would be the same on Mars as it is here on Earth, your weight would be different on the two planets.

Materials:
student force sensor
500 g (0.500 kg mass)
MPLI box
other known mass (Part B)

Procedure:
Part A. (Calibration)

1. Connect the force sensor to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MP interface program. (At c prompt type **cd mp** [E] and then **mp** again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Under **Other Options Menu** select motion detector input, use the space bar to turn this off so that the current setting reads none.
6. Select force transducer input, use the space bar to select Channel A.
7. Select calibrate force transducer [E]
8. At warning note type **Y** for yes, indicating you want to proceed with the calibration.
9. When requested for new force units type **N** (for newtons). This may already be done. [E]
10. Grasp the force sensor in your hand so that the side with the hooks is parallel to the floor. Keep the sensor steady and wait for the voltage reading to stabilize. When it is stabilized press enter.
11. Hang a 500 g mass from the hook. Again wait for the reading to stabilize, then press enter. When asked for input force, type **4.9** [E]
12. At **Other Options Menu** select return to main menu [E]
13. The force sensor has now been calibrated. To test out the force sensor continue with the procedure below, otherwise exit the program, turn off the computer and detach the MPLI box and the force sensor. Store away properly.

Procedure:

Part B (Mass and Force)

14. At **Main Menu** select monitor/graph in real time [E]
15. At **Graph Style Options** use the space bar to turn on background grid of dots, line connecting points, and specify graph title [E]
16. When prompted type **Force vs Time** as a graph title [E]
17. At **Real Time Graphing - Scaling** screen make sure that the force is on and distance, velocity and acceleration are off. Select time of run and change time to 0:40 [E]. Then select start graph [E].
18. Hold the force sensor so that the side containing the hooks is parallel to the floor. Hang a known mass from the hook and press enter. When the graph stabilizes press enter (this will not take the entire 40 seconds). Record the force and mass in a table similar to the one in the analysis section of this handout. [E]
19. At **Graph Follow-up Options Menu** select repeat data collection - no changes.[E]
20. Repeat Steps 18 and 19 for each mass you have available.
21. When finished return to the main menu and quit the program. Turn off the computer and disconnect the MPLI box and the force sensor. Store all materials away properly.

Analysis:

(1) Complete the table below:

Force (N)	Mass (g)	Mass (kg)	Ratio (Force/Mass)

Average Ratio: _____

Calculate the average ratio for each of your readings.

(2) The accepted value of g is 9.8 N/kg. Often a value of 10 is used to simplify calculations. How does your average compare to 9.8?

(3) Given the formula $F = mg$, calculate the force (in newtons) of a 55 kg person.

Extension Activities:

(3)   *Construction of a line graph using Graphical Analysis Program*

1.   At C prompt, type **cd ga** [E] and then type **ga** [E].
2.   At **Main Screen**, select input new data [E].
3.   When prompted, type **mass** for horizontal axis label [E].
        type **kg** for units [E]
        type **Force** for vertical axis label [E].
        type **N** for units [E].
4.   The computer should now display a screen for the inputting of data. Enter each mass and corresponding force that you measured. Press enter after each entry. When finished entering data press esc to exit.
5.   At **Main Screen** select plot graph.
6.   At **Graph Style Options**, turn on grid on graph, line connecting points, statistics and specify graph title using the space bar [E].
7.   Type **Force vs Mass** for title. [E]
8.   Select automatic scaling - axis starts at 0 (for horizontal axis) [E].
9.   Select automatic scaling - axis starts at 0 (for vertical axis) [E].
10. When graph is displayed, check the m value at the top of the screen. Compare this to your average ratio calculated.
11. At **Graph Follow-up Options Menu** you can select print graph to print a copy of your graph.
12. Make sure that the settings for the printer are suitable to the printer you are using. Then select start printing [E].
13. Using your graph and your knowledge of interpolation and extrapolation, predict the force values for each mass given below:

        _____   _____   _____

14. Record your predicted values.
15. Return to the **Main Screen** of the Graphical Analysis Program. Select numerical analysis [E].
16. Under **Numerical Analysis Menu** select extrapolate/interpolate [E].
17. Enter the first mass you were asked to predict the force of. [E]
18. The computer now displayed the interpolated or extrapolated value. How does this compare to your prediction?
19. Repeat steps 16 - 18 for each mass given in step 13.
20. When finished, return to the **Main Screen** and quit the program. Turn off the computer.

Note to teacher: Depending on the data values collected by the students, it may be necessary to have the computer construct a line of best fit or regression line in order to determine the slope.

(4)   *Construction of a bar graph using Graphical Analysis Program*

Note to teacher: If students are doing both graphs, they can omit steps 1 - 5 below since they have already entered their data.

1.   At C prompt, type **cd ga** [E] and then type **ga** [E].
2.   At **Main Screen**, select input new data [E].
3.   When prompted, type **mass** for horizontal axis label [E].
     type **kg** for units [E]
     type **Force** for vertical axis label [E].
     type **N** for units [E].
4.   The computer should now display a screen for the inputting of data. Enter each mass and corresponding force that you measured. Press enter after each entry. When finished entering data press esc to exit.
5.   At **Main Screen** select plot graph.
6.   At **Graph Style Options**, turn on grid on graph, bar graph and specify graph title using the space bar [E].
7.   Type **50** for size of each bar. [E]
8.   Type **Force vs Mass** for title. [E]
9.   Select automatic scaling - axis starts at 0 (for horizontal axis) [E].
10. Select automatic scaling - axis starts at 0 (for vertical axis) [E].
11. The graph should now be displayed. When you have finished viewing the graph press enter.
12. At **Graph Follow-up Options Menu** you can select print graph to print a copy of your graph. [E]
13. Make sure that the settings for the printer are suitable to the printer you are using. Then select start printing [E].
14. When finished, return to the **Main Screen** and quit the program. Turn off the computer.

The Relationship between Force and Mass (using MPLI)

Introduction: Quite often people assume that mass and weight are the same. This is an incorrect assumption. Although the mass of an object remains the same, regardless of location, its weight can change. The weight of an object depends on the force of gravity that is present at an location. Therefore even though your mass would be the same on Mars as it is here on Earth, your weight would be different on the two planets.

Purpose: To explore the relationship between force and mass

Materials: Multipurpose Lab Interface Box   support stand
Student Force Sensor   clamp
masses (50 g, 100 g, 200 g, etc.)
string

Procedure:
1. Connect the MPLI box to the computer and connect the student force sensor to channel A of the MPLI box.
2. Turn on the computer and start the Vernier Software Multipurpose Lab Interface Program. (This is a DOS program, therefore you cannot be in windows when you access this program.
3. When the startup screen appears, press **enter** to continue. This will bring you to the **Main Menu**.
4. At the **Main Menu** select other options [E].
5. At the **Other Options Menu** select inputs [E].
6. Make sure that Input A is turned on and Inputs B and C are turned off. To do this use the arrow keys to move to the Input and use the space bar to switch between on and off.
7. Press **enter** until you return to the **Main Menu**.
8. At the **Main Menu** select calibration [E].
9. At the **Calibration Menu** select load calibration file and press enter twice.
10. Use the arrow key to select the file **sfs_din.cal** file [E].
11. At this point you may get an red box warning you of an error in the calibration file. This will not affect your measurements. Select yes to continue [E].
12. Press enter until you return to the **Main Menu**.
13. At the **Main Menu** select monitor input vs keyboard entry [E].
14. Type **mass** for the new label for the independent variable [E].
15. Type **kg** for the new units for the independent variable [E].
16. Attach the student force sensor to a ring stand using a clamp or hold in securely in your hand.
17. Accept the 0 offset [E].

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18. You are now ready to collect the force vs mass data. If two people are in your group, one should take control of the keyboard and one change the mass that is hanging from the force sensor.

19. When the readings on the screen stabilize press the space bar and enter the mass at 0 kg [E].

20. Hang a 50 g mass from the force sensor. When the force reading has stabilized press the space bar. Type 0.050 kg for the mass [E].

21. Repeat step 20 for masses of 0.100 kg, 0.150 kg, 0.200 kg etc.

22. When you have completed all of the readings press esc.

23. Press enter when you are asked if you are finished taking data.

24. Press enter to return to the **Main Menu**.

25. Select Display Data Table [E].

26. Use the values on the data table to complete the force and mass columns on the table provided in the analysis section of this activity.

27. Press enter to return to the **Main Menu**.

28. Select Plot Graph [E].

29. Turn on the following options using the space bar: background grid of dots, line connecting points, statistics and specify graph title [E].

30. When prompted for a graph title, type **force vs mass** [E].

31. Select horizontal scaling: automatic scaling, axis starts at 0 [E].

32. Select vertical scaling: automatic scaling, axis starts at 0 [E].

33. Examine the graph provided. Note the m value shown at the top of the screen. This is the slope of the line and should be around 10 [E].

34. At **Graph Follow Up Options Menu**, select Print Graph [E]

Analysis:

(1) Complete the table below:

Force (N)	Mass (kg)	Ratio (Force/Mass)

Average Ratio: _____

Calculate the average ratio for each of your readings.

(2)   The accepted value of g is 9.8 N/kg. Often a value of 10 is used to simplify calculations. How does your average compare to 9.8?

(3)   Given the formula $F = mg$, calculate the force (in newtons) of a 55 kg person.

Force and Simple Machines

Introduction:

Simple machines allow us to do work in an easier manner. This includes allowing us to exert less effort than would ordinarily be necessary or by allowing us to change the direction of a force. There are a variety of simple machines that you have or will studied. In this activity you will investigate the use of an inclined plane and a pulley.

Purpose:

To investigate the mechanical advantage of simple machines

Materials:

MPLI box
student force sensor
pulleys (and ring stand if required)
string
a 500 g or 1000 g mass
an inclined plane
meter stick

Procedure:

Part A. (Calibration)

1. Connect the force sensor to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MP interface program. (At c prompt type **cd mp** [E] and then **mp** again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Under **Other Options Menu** select motion detector input, use the space bar to turn this off so that the current setting reads none.
6. Select force transducer input, use the space bar to select Channel A.
7. Select calibrate force transducer [E]
8. At warning note type **Y** for yes, indicating you want to proceed with the calibration.
9. When requested for new force units type **N** (for newtons). This may already be done. [E]
10. Grasp the force sensor in your hand so that the side with the hooks is parallel to the floor. Keep the sensor steady and wait for the voltage reading to stabilize. When it is stabilized press enter.
11. Hand a 500 g mass from the hook. Again wait for the reading to stabilize, then press enter. When asked for input force, type **4.9** [E]
12. At **Other Options Menu** select return to main menu [E]
13. The force sensor has now been calibrated.

Part B (Force and Simple Machines)

14. At **Main Menu** select monitor/graph in real time [E]
15. At **Graph Style Options Menu** use the space bar to turn on background grid of
     dots, line connecting points, and specify graph title [E]
16. When prompted type **Force vs Time** as a graph title [E]
17. At **Real Time Graphing - Scaling** screen make sure that the force is on and
     distance, velocity and acceleration are off. Select time of run and change time to
     0:40 [E]. Then select start graph [E].
18. Hold the force sensor so that the side containing the hooks is parallel to the floor.
     Place the weight on a level surface (floor or bench top). Attach the force sensor to
     the weight using the hooks available on each object and lift the mass a distance of
     0.300 m. When this height is reached, hold the mass and force sensor steady.
     When the graph stabilizes press enter (this will not take the entire 40 seconds).
     Record the force and mass in a table similar to the one in the analysis section of
     this handout. The force measured here represents the effort (in Newtons)
     necessary to lift the mass.[E]
19. At **Graph Follow-up Options Menu** select repeat data collection - no
     changes.[E]
20. Repeat Steps 18 and 19 for each situation below:
     D. Set up a pulley system using only one pulley and lift the mass the same
         height (0.300 m). Measure the force necessary and record your results.
     E. Set up a pulley system using two or more pulleys and lift the mass the
         same height (0.300 m). Measure the force necessary and record your
         results.
     F. Arrange an inclined plane so that its vertical height is 0.300 m. Place the
         mass at the end of the plane, attach a piece of string around the mass and
         pull the mass up the inclined plane. Please note that the height the mass
         rose is still 0.300 m. Measure the force necessary and record your results.
21. When you have finished taking all necessary data, return to the **Main Menu**, exit
     the program, turn off the computer and disconnect the MPLI box and the force
     sensor. Store all materials away properly.

Part C (additional activity)

22. Repeat each setup for various masses (200 g, 500 g, 1000 g, etc.)
23. Record your information in the data table below.

Analysis: *(Part B)*

1) Complete the table below and calculate the mechanical advantage of each setup.

Setup	Mass (kg)	Load/Weight(m * 9.8) (N)	Effort (N)	Mechanical Advantage (load/effort)
No Simple Machine				
One Pulley				
Two Pulleys				
Inclined Plane				

2) Which machine allowed you to exert the least amount of effort?

3) Why is the difference in the mechanical advantage calculated for the setup during which you did not a simple machine and the setup for only one pulley not significantly different?

4) If there isn't a significant increase in mechanical advantage when one pulley is used. what is the advantage of this type of machine. (Think about how the force (effort) was applied).

Analysis *(Part C)*

5) Complete the tables below:

A. No Simple Machine

Mass (kg)	Load/Weight (m * 9.8) (N)	Effort (N)	Mechanical Advantage
		Average:	

B. One Pulley

Mass (kg)	Load/Weight (m * 9.8) (N)	Effort (N)	Mechanical Advantage
		Average:	

C. Two Pulleys

Mass (kg)	Load/Weight (m * 9.8) (N)	Effort (N)	Mechanical Advantage
		Average:	

D. Inclined Plane

Mass (kg)	Load/Weight (m * 9.8) (N)	Effort (N)	Mechanical Advantage
		Average:	

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The Effect of Friction on Force

Introduction:

In order for work to be done two conditions must be met. First of all, a force must be exerted and secondly the object must move. When an object is pushed across a surface, work is done since these two conditions are met. In order to move an object the force exerted (effort) must overcome forces acting against it. In other words there must exist an unbalanced force. You have or will study forces that act on various objects. When you attempt to push a large desk across the classroom floor, you must exert a force that is greater than all forces (including air resistance, friction, the weight of the object) acting against you. In this activity you will explore how different surfaces affect the effort required to move an object across them.

Purpose:

To investigate the effect of friction on force and calculate the work done in moving an object.

To investigate the effect of lubricants on friction.

Materials:

MPLI box
student force sensor
bricks (or other objects)
string
various surfaces (cardboard, carpet, wood, linoleum)
water and oil
meter stick

Procedure:

Part A. (Calibration)

1. Connect the force sensor to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MP interface program. (At c prompt type **cd mp** [E] and then **mp** again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Under **Other Options Menu** select motion detector input, use the space bar to turn this off so that the current setting reads none.
6. Select force transducer input, use the space bar to select Channel A.
7. Select **calibrate force transducer** [E]
8. At warning note type **Y** for yes, indicating you want to proceed with the calibration.
9. When requested for new force units type **N** (for newtons). This may already be done. [E]

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10. Grasp the force sensor in your hand so that the side with the hooks is parallel to the floor. Keep the sensor steady and wait for the voltage reading to stabilize. When it is stabilized press enter.

11. Hand a 500 g mass from the hook. Again wait for the reading to stabilize, then press enter. When asked for input force, type **4.9** [E]

12. At **Other Options Menu** select return to main menu [E]

13. The force sensor has now been calibrated.

Part B (Friction and surfaces)

14. At **Main Menu** select monitor/graph in real time [E].

15. At **Graph Style Options Menu** use the space bar to turn on background grid of dots, line connecting points, and specify graph title [E]

16. When prompted type **Force vs Time** as a graph title [E]

17. At **Real Time Graphing - Scaling** screen make sure that the force is on and distance, velocity and acceleration are off. Select time of run and change time to 0:40 [E]. Then select start graph [E].

18. Tie a piece of string around the brick and tie other end of the string to the hooks of the student force sensor. Place the brick on the surface being tested and using the meter stick, measure off a distance of 1.0 m. When you are ready to begin collecting data press enter and pull the brick across the surface (along the distance of 1.0 m). Attempt to get the brick moving at a constant rate.

19. From your graph, determine the force (along the horizontal part) when the object was moving at a fairly constant rate. Record this value in a table as provided in the analysis section.

20. Press enter to return to **Graph Follow-up Options Menu** select repeat data collection - no changes.[E]

21. Repeat Steps 18 and 19 for each surface you are testing.

22. When you have finished taking all necessary data, return to the **Main Menu**, exit the program, turn off the computer and disconnect the MPLI box and the force sensor. Store all materials away properly.

Part C (Reducing Friction)

23. You can repeat steps 18 and 19 above for each of your surfaces, after you have applied a lubricant (such as water or oil) to reduce friction.

24. Record your data in a table as provided in the analysis section below.

Analysis:*(Part B)*

1) Complete the table below and calculate the work done.

Surface	Force (N)	Distance (m)	Work (Nm)
Wood			
Cardboard			
Carpet			
Linoleum			

2) Which surface required the greatest amount of effort? The least amount of effort?

3) Explain why the surface itself affects the amount of work done.

4) Paul was in his garage one day and attempted to move a large tool box across the floor. Paul pushed with all the effort he could and the tool box didn't move a centimeter. His friend Sue came by and she said to Joe, "My Joe, you are working very hard there now aren't you?". Joe responded, "Actually Sue I'm not doing any work right now.". Was Joe "doing work" in a scientific sense? Explain why or why not.

5) Complete the table below, which will indicate the amount of effort that had to be exerted to overcome the friction in order to move the brick over each surface.

Surface	Mass of brick (kg)	Weight (N) weight =mass x 9.8	Effort Force (N)	friction (N) friction = effort - weight
Wood				
Carpet				
Cardboard				
Linoleum				

Analysis *(Part C)*

6) Complete the tables below:

A. Wood

Surface	Force	Distance	Work Done
Wood			
Wood/water			
Wood/oil			

B.Carpet

Surface	Force	Distance	Work Done
Carpet			
Carpet/water			
Carpet/oil			

C. Cardboard

Surface	Force	Distance	Work Done
Cardboard			
Cardboard/water			
Cardboard/oil			

D. Linoleum

Surface	Force	Distance	Work Done
Linoleum			
Linoleum/water			
Linoleum/oil			

7) What effect do the water and oil have on the amount of work being done? Explain.

Matching Position Time Graphs

Introduction:

Relationships exist between time, distance, velocity and acceleration. You have studied (or will study) graphs that illustrate the motion of an object. Characteristics of different graphs allow you to determine the direction the object is moving in, its speed and its acceleration. In this activity you will explore the relationship between your movement and the resulting graphs.

Purpose:

To determine the relationship between time, distance, velocity and acceleration.

Materials:

Vernier MPLI
motion detector
Graphic overlays (located in MP directory of software)

Procedure:

1) Connect the MPLI box to the computer. Connect the motion detector to Channel A of the MPLI box. Turn on the computer.
2) Load the Motion Plotter program - at the c prompt type **cd mp** [E], then **mp** [E].
3) At **Main Menu**, select other options [E].
4) At **Other Options Menu** use the space bar to set the motion detector input to channel A and ensure that the force transducer input reads none. Select averaging, press enter. Then type 17 [E].
5) Select return to main menu [E].
6) At **Main Menu** select monitor/graph in real time [E].
7) At **Graph Style Options Menu**, use the space bar to turn the following options on: background grid of dots, line connecting points and graph overlays [E].
8) At **Load Graph Overlay Menu**, use arrow keys to select the _____ file [E].
9) A warning message may appear cautioning that the force graph cannot be turned on. Press enter to bypass this message.
10) At **Real time Graphing-Scaling** select start graph.[E]
11) A graph should now appear on the screen. Study the graph and discuss with your partner what is happening. Plan your motion to match the graph.
12) Hold a book in front of your body and stand approximately 0.5 m away from the motion detector. Have your partner press enter when you are ready. Move according to the plan you developed with your partner. As you move a line will appear on the graph that traces your motion. Compare the graph you produced with the original graph. If you wish to try again press enter twice.

13) At **Graph Follow-up Options Menu**, select repeat data collection - no change. [E]. The graph should reappear. Repeat step 12 until you have a graph that is reasonably close to the original.

14) Once you have successfully matched the graph, press enter to return to **Graph Follow-up Options Menu** and select print graph. [E]

15) At **Printer Options Menu** select the appropriate printer and then select start printing. [E].

16) To match another graph, return to **Main Menu** and repeat steps 6 - 15. At step 8 select the next file as instructed by your teacher.

Analysis

1) For each graph, describe what is happening in terms of the motion of the object. Include reference to the object's direction of movement, speed and acceleration. It may be helpful to divide your graph into sections for this question.

2) What does the slope of a distance-time graph represent? What is the significance of this slope being positive or negative?

3) What does the slope of a velocity-time graph represent? What is the significance of this slope being positive or negative.?

4) What is being illustrated in the flat regions of a distance-time graph? A velocity-time graph?

5) Explain the difference in a velocity-time graph when the line is above and below zero.

Monitoring Photosynthetic Activity with a Carbon Dioxide Probe

Purpose: To monitor the effect of light on photosynthetic activity and to relate carbon dioxide levels to photosynthetic activity.

Materials

Vernier MPLI
carbon dioxide gas sensor
bottle and slit stopper
beaker filled with water
light source
freshly picked leaves

Procedure:

1.   Connect the carbon dioxide sensor to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2.   Load the MPLI interface program. (At c prompt type cd mpli [E] and then mpli again)
3.   Press enter to go to **Main Menu.**
4.   Select other options. [E]
5.   Select inputs.[E]
6.   Select input A and turn off inputs B and C using the space bar.
7.   Press enter three times to return to **Main Menu.**
8.   Select calibration.[E]
9.   Select load calibration file. [E]
10. Use the down arrow key to select the calibration file _____ . [E]
11. Press enter two times to return to **Main Menu.** Select graph in real time. [E]
12. Select the following options under the **Graph Options Menu** by using the space bar to turn them on: Background grid of dots, line connecting points and specify graph title. [E]
13. Specify graph title: Carbon Dioxide Level vs time. [E]
14. Enter minimum anticipated input: 20. [E]
15. Enter maximum anticipated input: 50. [E]
16. Select yes indicating you want to store data in memory. [E]
17. Move cursor to the indicated position and change time to 0-00:40:00. [E]
18. Indicate the number of readings required by entering 120. [E]
19. Place 3-5 small, freshly picked leaves into the bottle. Insert the gas sensor through the slit of the stopper and place it securely on the bottle. Place the bottle next to a beaker filled with water (acts as an heat shield) and place the light source next to the beaker of water (such that the beaker of water is in between the bottle and light source).

20. As you collect data. alternate having the light source on and off for periods of 10 minutes. (10 minutes light on. 10 minutes light off, repeat two times). When you are ready to begin data collection press enter.
21. At the end of 40 minutes, press enter to exit graph.
22. Select print graph under the **Graph Follow Up Menu**. [E]
23. Select printer type and make sure the type of printer corresponds to the printer you will be using.
24. Select start printing.
25. When finished the experiment return to the **Main Menu** and exit the program.

Analysis:

1) Explain the significance of the carbon dioxide levels during the times when the light was turned off and turned on.

2) Show your understanding of the process that is occurring here by relating the equation for photosynthesis to your findings.

3) What other ways could you modify this experiment to show factors that affect photosynthetic activity?

Cellular Respiration (carbon dioxide gas sensor)

Purpose: To monitor carbon dioxide levels in humans and determine the effect of exercise on these levels.

Materials:
Vernier MPLI
carbon dioxide gas sensor
Erlenmeyer flask and slit stopper
drinking straw
watch with second hand
sealant (vaseline or mono)

Procedure:

1.   Connect the carbon dioxide sensor to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2.   Load the MPLI interface program. (At c prompt type cd mpli [E] and then mpli again)
3.   Press enter to go to **Main Menu.**
4.   Select other options. [E]
5.   Select inputs.[E]
6.   Select input A and turn off inputs B and C using the space bar.
7.   Press enter three times to return to **Main Menu.**
8.   Select calibration.[E]
9.   Select load calibration file. [E] twice
10. Use the down arrow key to select the calibration file _____ . [E]
11. Press enter two times to return to **Main Menu.** Select graph in real time. [E]
12. Select the following options under the **Graph Options Menu** by using the space bar to turn them on: Background grid of dots. line connecting points and specify graph title. [E]
13. Specify graph title: Carbon Dioxide Level vs time. [E]
14. Enter minimum anticipated input: 20. [E]
15. Enter maximum anticipated input: 50. [E]
16. Select yes indicating you want to store data in memory. [E]
17. Move cursor to the indicated position and change time to 0-00:00:30.. [E]
18. Indicate the number of readings required by entering 30. [E]
19. Insert the tubing from the pressure sensor and drinking straw into the hole of the stopper. Ensure that a tight seal is formed. Vaseline or a calking compound such as Mono could be used. Secure the stopper into the mouth of a 250 mL Erlenmeyer flask. Have one member of the group sit on a chair. Then have the person blow air through the straw for a period of 30 seconds.
20. Press enter to exit graph.

21. Press enter until you are back at the **Main Menu.**
22. Select display/print data table. [E]
23. Select display data table. [E]
24. Using the arrow keys scroll down to the end of the data table. Record the maximum and minimum values for carbon dioxide in the table.
25. Press enter until you return to **Main Menu.**
26. Select plot graph.
27. Under **Graph Options Menu** make sure background grid of dots, line connecting points and specify graph title are selected. [E]
28. Type Carbon Dioxide Level vs Time for graph title. [E]
29. Select automatic scaling - origin at 0 for the next two screens.
30. Select print graph under the **Graph Follow Up Menu.** [E]
31. Select printer type and make sure the type of printer corresponds to the printer you will be using.
32. Select start printing.
33. When finished return to the **Main Menu** and repeat steps 4 - 33 except this time have the subject exercise for a period of 2 minutes before blowing into the straw.
34. When finished the experiment return to the **Main Menu** and exit the program.

Analysis:

1) From the graph determine the maximum and minimum carbon dioxide levels . Calculate the change in carbon dioxide for each set of data collected.

Condition	Maximum CO_2	Minimum CO_2	Change in CO_2
At rest			
After 2 minutes of exercise			
After 4 minutes of exercise			

2) Was the carbon dioxide change following exercise greater or less than the carbon dioxide change before exercise? Explain.

3) Show your understanding of the process that is occurring here by relating the equation for respiration to your findings.

4) What other ways could you modify this experiment to show factors that affect carbon dioxide levels?

Cellular Respiration (pH sensor)

Purpose: To monitor the change in pH of a water sample so that carbon dioxide levels can be indirectly measured and determine the effect of exercise on these levels.

Materials:
Vernier MPLI
pH probe
250 Erlenmeyer flask containing water
drinking straw
watch with second hand

Procedure:

1. Connect the pH probe to Input A on the MPLI box. Connect the MPLI box to the computer. Turn on the computer.
2. Load the MPLI interface program. (At c prompt type cd mpli [E] and then mpli again)
3. Press enter to go to **Main Menu.**
4. Select other options. [E]
5. Select inputs.[E]
6. Select input A and turn off inputs B and C using the space bar.
7. Press enter three times to return to **Main Menu.**
8. Select calibration.[E]
9. Select load calibration file. [E] twice
10. Use the down arrow key to select the calibration file _____. [E]
11. Press enter two times to return to **Main Menu.** Select graph in real time. [E]
12. Select the following options under the **Graph Options Menu** by using the space bar to turn them on: Background grid of dots, line connecting points and specify graph title. [E]
13. Specify graph title: pH vs time. [E]
14. Enter minimum anticipated input: 0. [E]
15. Enter maximum anticipated input: 14. [E]
16. Select yes indicating you want to store data in memory. [E]
17. Move cursor to the indicated position and change time to 0-00:00:30.. [E]
18. Indicate the number of readings required by entering 30. [E]
19. Place 100 mL of water into a 250 mL Erlenmeyer flask. Place the pH probe and drinking straw into the mouth of the flask and secure. Be sure that both he drinking straw and the pH probe are beneath the water level. Have one member of the group sit on a chair. Then have the person blow air through the straw for a period of 30 seconds.
20. Press enter to exit graph.

21. Press enter until you are back at the **Main Menu**.
22. Select display/print data table. [E]
23. Select display data table. [E]
24. Using the arrow keys scroll down to the end of the data table. Record the maximum and minimum values for pH in the table.
25. Press enter until you return to **Main Menu**.
26. Select plot graph.
27. Under **Graph Options Menu** make sure background grid of dots, line connecting points and specify graph title are selected. [E]
28. Type pH vs Time for graph title. [E]
29. Select automatic scaling - origin at 0 for the next two screens.
30. Select print graph under the **Graph Follow Up Menu**. [E]
31. Select printer type and make sure the type of printer corresponds to the printer you will be using.
32. Select start printing.
33. When finished return to the **Main Menu** and repeat steps 4 - 33 except this time have the subject exercise for a period of 2 minutes before blowing into the straw.
34. When finished the experiment return to the **Main Menu** and exit the program.

Analysis:

1) From the graph and data table determine the maximum and minimum pH levels . Calculate the change in pH for each set of data collected.

Condition	Maximum pH	Minimum pH	Change in pH
At rest			
After 2 minutes of exercise			
After 4 minutes of exercise			

2) What substance, or substances, are responsible for the decrease in pH in the two trials. Explain.
3) Was the pH change following exercise greater or less than the pH change before exercise? Explain.
4) Show your understanding of the process that is occurring here by relating the equation for respiration to your findings.
5) What other ways could you modify this experiment to show factors that affect pH levels?

APPENDIX J

Web Page

Welcome

Integrating the use of *Vernier* interface into the Science curriculum

❧ *Welcome* ❧

Rationale: This page was developed as part of an internship for a Masters program at Memorial University of Newfoundland by Cindy Pope, Math/Science Teacher at St. Bernard's All Grade. The intent of this page is to provide teachers with information relating to the integration of *Vernier* interface into the science curriculum.

Welcome Welcome	Frequently Asked Questions	Supplementary Activities
Introduction	Trouble Shooting	Related Sites

Click below for a direct link to the Vernier Home Page .

Vernier
SOFTWARE

Vernier Home Page

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Integrating the use of *Vernier* interface into the Science curriculum

❦ *INTRODUCTION* ❦

The Vernier Interface system provides opportunities for students to collect data related to various phenomena in a fast and efficient manner. The computer interface converts analog signals received into digital signals that can be interpreted by the computer. With the use of a built in graphics analyzer, the program can then provide students with graphical representations, customized to the needs of the student, of the collected data.

Hardware	Software	System Requirements
Installation	Advantages	Limitations

The complete package includes both hardware and software components.

Hardware:

a Vernier interface card must be installed on the computer
a Multipurpose Lab Interface Box
a game port (for use with photogate)
various sensors

Software:

Graphical Analysis (can be used to construct various types of data independent of the remainder of the interface.
Motion Plotter (used in conjunction with the motion sensor and force sensor)
Precision Timer (motion experiments with the Photogate system)
MultiPurpose Lab Interface Program (used with temperature, pressure, pH and various gas sensors)

System Requirements:

The Vernier Interface system (DOS version) can be run on low end computers such as 286 or 386. A minimum of 640K of RAM is required. If using the Windows version, the minimum requirements would be a system that can efficiently run Windows.

Installation:

The disks for the four separate programs associated with the Vernier Interface can be installed on the hard drive of your computer by creating directories for each of the four programs as

suggested below and then copying the files from the disk into the respective directory.

Motion Plotter (MP)
Precision Timer (PT)
MultiPurpose Lab Interface Program (MPLI)
Graphical Analysis (GA)

Advantages of an interface program: (from a personal perspective)
-exposes students to technology in generally and specifically to a means of using technology as a measurement device, organizer of data and analyzer of data.

- allows data to be collected more accurately and efficiently

- provides a means of measuring change that would otherwise not be available (ex. small changes in temperature that would not be detected by the use of a thermometer)

- allows data to be gathered over a long period of time (system could be left set up overnight to take readings every hour for example)

- allows students to 'see' what is happening as it occurs (ex. students can see how there movements relate to various motion graphs)

- students can focus on science involved rather than the gathering of data and are therefore capable of higher order thought processes– exposure to use in class may promote student use of an interface for independent projects such as science fairs

- allows more than one type of data to be collected (the MPLI box has three inputs which means that up to three different sensors can be used at one time.

Limitations of an interface program: (from a personal perspective)
- some experiments can be done just as or even more efficiently and effectively using 'traditional' means

- learning curve is present for both students and teachers. While the use of the interface can allow students to focus on the science involved, students will require time to get comfortable with the interface before this truly occurs. Similarly, teachers will require time to get familiar with the interface program. After such time they will be better able to decide when and where the interface is applicable to the curriculum and also explore other avenues for the use of the interface.

- there may be a lack of available equipment in some schools, as well as difficulty in getting access to the available equipment.

- teachers require time and support to explore the program

- teachers require laboratory activities that specifically address curriculum objectives for the science courses they are teaching. Physics activities for both senior high courses in the province of Newfoundland have been developed by Distance Education. Similarly, Distance Education offers some Chemistry laboratory activities that utilize MPLI. However, laboratory activities for other areas such as Biology and Junior High Science have not yet been developed.

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▣ Introduction	✓ Trouble Shooting	▮ Related Sites

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🐝 *FREQUENTLY ASKED QUESTIONS* 🐝

Q What copyright issues are of concern with the use of the Vernier interface?

A If your school has purchased the software used with the Vernier Interface, you are permitted to make back-up copies and use these copies on any computers within your school. The use of copied disks for other purposes is not permitted.

Q How do I calibrate sensors?

A Sensors can be calibrated using a two point method. Basically, two different measurements are taken so that the computer can calibrate these known measures to the related voltages. For example to calibrate a temperature probe, two known temperatures would be inputed as data. Detailed step by step procedures are available in the Vernier manual, as well as in the distance education laboratory books. If you require specific information on the calibration of any sensor, please send me an email.

Q How can I use the Graphical Analysis Program?

A   The Graphical Analysis program can be used independently without the use of any hardware components. This would be useful if students need to construct tables and graphs of data they have collected in any lab. Additionally, the data can be modified so that students can explore possible relationships between variables that might not be obvious from the data they have collected.

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🌺 *TROUBLE SHOOTING* 🌺

Q My motion detector doesn't seem to be working and I can't get it to calibrate correctly.

A
First of all, you can check the motion detector delay adjustment under the other options menu. This technique asks you to place the motion detector a known distance away from a fixed target and use the left and right arrow keys to adjust the reading until it is stable (the lower the reading the better).

If this fails, check the initmp.cfg file (go to DOS and at the MP directory type edit initmp.cfg). This is the file saved when you calibrate the motion detector. Check the reading against a file that is working correctly. I would suggest you pay particular attention to the echodelay. It should read around -0.049. Be sure to save any changes you make and reboot the computer before trying the sensor again.

Finally, if this fails, it is possible that the computer is too fast for the sensor. This is most likely if you have a higher end machine such as a pentium. If it is a 486 you could try turning off the Turbo.

Q My system doesn't seem to be working at all.

A
It is possible that your card is damaged. There have been some problems with a particular chip in these cards. The chips have been desodered and a new one replaced into a socket so that they are easier to replace if future problems develop. The Burin Peninsula School Board has had a local man repair damaged chips in the past. Please contact me for more information.

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Integrating the use of *Vernier* interface into the Science curriculum

❧ *SUPPLEMENTARY ACTIVITIES* ❧

Below are some activities that can be used in various areas of the science curriculum for the province of Newfoundland. For the Junior High Science curriculum, these activities relate to the suggested technological links in the curriculum guide. Any suggestions for improvements or modifications to these activities is greatly appreciated. If you would like to add your own activity to this list, please send an email. Although these activities are divided into various areas, there are activites applicable to more than one grade level.

Grade 7 Science	Grade 8 Science	Grade 9 Science
Chemistry	Physics	Biology

Grade 7 Science

- **Rates of Evaporation of Various Liquids using a Temperature Probe**

- **Phase Changes**

- **Calibration of a Temperature Probe**

- **The Melting and Freezing of Water**

- **Calibration of a Student Force Sensor and Exploring Force as a Vector Quantity**

- **Relationship Between Force and Mass**

- **Relationship Between Force and Mass (using keyboard entry)**

- **The Effect of Friction on Force**

Grade 8 Science

- Changes in Respiratory Rate using a Carbon Dioxide Sensor
- Changes in Respiratory Rate using a pH Sensor
- Measuring Photsynthetic Activity using a Carbon Dioxide Sensor
- Calibration of a Student Force Sensor and Exploring Force as a Vector Quantity
- Relationship Between Force and Mass
- Relationship Between Force and Mass (using keyboard entry)
- Forces and Simple Machines

Grade 9 Science

Chemistry

- Phase Changes
- Calibration of a Temperature Probe
- The Melting and Freezing of Water
- Endothermic Reaction (teacher demonstration)

Physics 🔼

- **Calibration of a Student Force Sensor and Exploring Force as a Vector Quantity**

- **Relationship Between Force and Mass**

- **Relationship Between Force and Mass (using keyboard entry)**

- **Matching Distance - Time and Velocity - Time Graphs**

- **Calibration of Motion Detector**

Biology 🔼

- **Changes in Respiratory Rate using a Carbon Dioxide Sensor**

- **Changes in Respiratory Rate using a pH Sensor**

- **Measuring Photosynthetic Activity using a Carbon Dioxide Sensor**

Resources:

The following resources are available at the Burin Peninsula School Board. These resources may help you carry out the activities below or will even be beneficial if you wish to design your own activities:

Hardware Equipment:
Heart Rate Monitor (measures flow of blood through the ear lobe)
EKG Sensor (measures voltages produced during the contraction of the heart)
Respiration Monitor Belt and (measures respiration rates)
Biology Gas Pressure Sensor (for use with Respiration Monitor Belt or by itself)
Vernier Photogate with Super Pulley Accessory (converts photogate into a smart pulley)
PC Viewer
AVER Media

Resource Books:
Exploring Physics and Math with the CBL System
Explorations in Biology for the TI-82 and TI-83 (CBL)
Explorations in Chemistry for the TI-82 and TI-83(CBL)
Explorations in Physics for the TI-82 and TI-83 (CBL)

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❧ *RELATED SITES* ❧

Below are some links to other sites related to the use of computer interfacing into the science curriculum:

Research	Other Products
Resources	Miscellaneous

RESEARCH

- **The Influence of Microcomputer-based labs on Kinetics Graphing**
- **Middle School Science and Mathematics**
- **Why use computers to teach Physics labs?**
- **Multimedia general physics** (under nextgeneration.html)
- **Real-time laboratory graphing and learning distance and velocity**
- **The Physics Teacher**
- **Undergraduate-level learning/teaching - Resource links**

OTHER PRODUCTS

- **Personal Science Laboratory (created by Team Labs)**
- **ABRA Electronics**

- Computer Based Laboratory (created by Texas Instruments)

- IBM K-12 Education

- PASCO Computer Products

RESOURCES

- Stemnet

- Team Labs Teacher Resources

- Pearce Physics

- Activities for Various Science Disciplines

- K-12 Curriculum Resources on the web

- Adaptations for Life in the Cold (Biology activity)

- Online Educational Resources

- Using Casio Calculators

MISCELLANEOUS

- Technology in Education

- Working with Mobile Computer Laboratories

- Technology in Learning Environments: Enabling Tomorrow's LearnersToday

- A Curriculum Framework for Technology Education: Living in a Technological Society

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