Technology in Mathematics Education

A Descriptive Study of the Availability and Uses of
Calculators and Computers in Public High School Mathematics Classes
in the State of Virginia

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(ABSTRACT)

The purpose of this descriptive study was to investigate the availability and distribution of calculators and computers for the mathematics classes in public high schools across the State of Virginia; examine professional development activities used by teachers to prepare for the use of calculators and computers in the classroom; explore factors that may guide and influence mathematics teachers in the use of calculators and computers; examine the familiarity and degree of influence assigned by teachers to documents advocating technology use in mathematics education; determine in which SOL courses – Algebra I, Geometry, Algebra II, Math Analysis, Calculus, Discrete Mathematics, Probability & Statistics, and Computer Mathematics – calculators and computers are being used, as well as the frequency and type of usage; and explore the ways in which teachers have incorporated the use of calculators and computers into mathematics courses, as well as the problems overcome and successes which have resulted.

The study surveyed the mathematics department heads from 80 public high schools from school divisions located throughout the State of Virginia through the use of a self-administered mail questionnaire. From these questionnaires, the data gathered about calculator and computer availability, factors influencing teachers' professional development, and actual usage in SOL courses were analyzed to provide a picture of the current state of technology use in the high school mathematics programs of these high schools. Results from this study indicate that: (1) Through funding provided by the State of Virginia, adequate quantities of graphing calculators and computers exist for use by students in mathematics classes; (2) the widespread use of graphing calculators in the classroom is being driven by the Standards of Learning for Virginia Public Schools; computer use is more limited, despite the availability of computers in classroom and lab settings; and (3) teachers are reported as wanting more professional development activities designed for incorporating calculator and computer use into the classroom, but have taken only limited advantage of existing opportunities, preferring to use self-training and school or division in-service activities to satisfy their needs.

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Chapter 1

Introduction

As we rapidly approach the twenty-first century, concerns are being raised as to how the United States will meet new challenges in education while reforming or eliminating instructional processes which are no longer valid or useful (Mathematical Sciences Education Board, 1990). Worries exist over student performances in mathematics and science within all grade levels. Comparisons of test scores between students in the United States with those in Europe and Japan have placed issues of public education at the forefront of the minds for many in the American Public (Bailey & Chambers, 1996).

In responding to these concerns, many disciplines within public education are undergoing various levels of reform as educators search for ways to improve education (Strassenburg, 1996). In particular, the increased use of technology – especially computer technology – in educational processes has been incorporated as a way to improve educational opportunities, while enhancing student performance (Picciano, 1994). Current reforms in mathematics education in the State of Virginia are being fueled by documents such as the Curriculum and Evaluation Standards for School Mathematics, published by the National Council of Teachers of Mathematics in 1989, and the Standards for Learning for Virginia Public Schools (1995). Documents such as these suggest a greater emphasis be placed on enabling students to reason and think critically, solve authentic problems, and make more productive use of instructional time to enrich their educational experiences (Lavigne & Lajoie, 1996). In order to achieve such changes, teachers should move away from traditional teacher-centered classroom practices, such as lectures and drill and practice activities, into a more student-centered context that allows students to work collaboratively and cooperatively to develop learning skills (Kilpatrick & Davis, 1993). Technology, especially computer and calculator technology, is seen as a way of providing the tools needed to enable the transition, while serving as a catalyst for further change in high school mathematics education (Owens & Waxman, 1995).

Technology in education is not a new issue nor a recent phenomenon (Eisele & Eisele, 1990). However, technology in the form of computers and calculators has changed dramatically over the past fifteen years. These technology tools have gotten smaller, more powerful, and, perhaps most importantly, less expensive (Sorensen, 1996). In addition to the computational power and symbolic manipulation capabilities of computers and calculators, these tools also provide exciting new ways of sharing data, information, and ideas (Kitchens, 1996). Through the use of computer and calculator technology, the modern mathematics classroom is no longer necessarily restricted to the chalkboard and the physical walls surrounding the students (Sorensen, 1996).

Over the past several years, the State of Virginia has expressed a strong interest in making use of technology in all aspects of K - 12 education. With the 1995 publication of Standards of Learning for Virginia Public Schools, the State Board of Education provided "reasonable targets and expectations for what teachers need to teach and students need to learn" (p. iii), and set expectations within the mathematics curriculum that "the use of technology must be an integral part of teaching and learning" (p. 3). Embedded in these standards, particularly in the mathematics standards, are expectations that teacher and students will use appropriate technology to enhance the learning process and assist in problem solving for courses such as Algebra I, Geometry, Algebra II, Math Analysis, Calculus, Discrete Mathematics, Probability and Statistics, and Computer Mathematics.

The State has further emphasized the importance of technology use in education with the January 1998 approval of the proposed Technology Standards for Instructional Personnel (1997). These standards were developed to ensure instructional personnel are capable of demonstrating competency in the use of technology consistent with the requirements established for students in 1995 by the Standards of Learning for Virginia Public Schools, (SOLs). In addition, these regulations require school divisions to certify all newly-hired instructional personnel as meeting these standards, while providing division-wide training to enable current instructional personnel to meet these standards by the beginning of the 2002 - 03 school year.

Virginia has also taken the lead in providing funding for purchases of computer and calculator technology for school divisions ("State buys," 1997). During recent years, the State has provided millions of dollars to school divisions to be specifically used in the purchasing of technology. The expectations of how these monies were to be spent included providing a computer lab in each school; a multimedia, internet-ready computer in each classroom; and sufficient numbers of programmable, graphing calculators to provide every ninth and tenth grade student, and all eighth grade students enrolled in Algebra I, with a calculator for classroom use (Virginia Department of Education, 1995).

During this same time period, Virginia published the Regulations Establishing Standards for Accrediting Public Schools in Virginia (1997). Included in this document are revised graduation requirements for the Class of 2002 in which every graduating student will be expected to have passed an Algebra I course. With this requirement, the significance of providing adequate access to computer and calculator technology to help all students meet the requirements of the Algebra I Standards of Learning for Virginia Public Schools (1995) increases. Virginia has set high expectations of student performance through the Standards of Learning; mandated teacher competencies in using computer technology with the Technology Standards for Instructional Personnel (Supts. Memo. No. 89, 1997); provided funding for computer and calculator purchases with technology initiatives; and set stronger math requirements for the Graduating Class of 2002 under the Standards for Accrediting Public Schools (1997). Technology, in the form of calculators and computers, must be one of the many tools necessary to achieve success with all these areas.

Purpose of the Study

In order to meet these expectations for high school mathematics education, school divisions must have adequate technology in place. Teachers must possess the knowledge and willingness to use technology in the classroom. Technology must be used in a frequent and consistent fashion within mathematics courses. Given that the focus of this study is on mathematics education, the term technology will be used to represent the tools such as handheld calculators (scientific or graphing) and personal or desktop computers, as well as the uses to which these are put.

The purpose of this study is to investigate the availability and distribution of calculators and computers, and the ways in which these are being used in mathematics classes of public high schools across the State of Virginia. The study will also examine elements that provide direction, influence, support, or encouragement for teachers in the use of calculators and computers in the mathematics classroom.

In an effort to be fully inclusive, the study attempted to survey all public high schools from all school divisions across the State of Virginia. The data gathered about calculator and computer availability, factors influencing teachers' professional development, and actual usage in SOL courses – Algebra I, Geometry, Algebra II, Math Analysis, Calculus, Discrete Mathematics, Probability and Statistics, and Computer Mathematics – are analyzed to provide a picture of the current state of technology use in high school mathematics. Where appropriate, data are further broken down into categories according to school sizes and settings in order to examine potential disparities.

The findings from this study will enable school divisions, school superintendents, school board members, teachers, parents and community groups to make comparisons between what is available at the local level versus that in other schools across the state. The findings should also aid school divisions in planning purchases, developing training activities that will enable teachers to better implement technology use, and more fully incorporate the use of calculators and computers in SOL mathematics courses. At the very least, the results from this study enables a determination to be made of the effectiveness of the State of Virginia's commitment to put calculator and computer technology into the public schools. Perhaps as importantly, this study points out potential weaknesses or anomalies that should be useful in planning for future studies of this kind.

Research Questions

The research questions for this study are:

1. How many calculators (scientific and graphing) and computers are available for use in high school mathematics classes in public high schools within the State of Virginia? How are these distributed in schools based on school size and school setting? What are the average numbers of calculators and computers available per school or per teacher in this schools providing calculators and computers?

2. In what types of professional development activities have mathematics teachers participated over the past eight years in order to prepare for the use of calculators and computers in teaching activities?

3. What additional elements, in the form of individuals or groups, exist for providing directions, influence, support, or encouragement for the use of technology in mathematics classrooms?

4. What level of familiarity do teachers have with documents in which increased use of technology in the mathematics classes is advocated? What levels of influence on the actual use of technology in mathematics classes are assigned to these documents by teachers?

5. In which courses are calculators and computers used? How frequently are they being used? In what ways are they being used?

6. In what ways do the instructional and assessment practices of teachers incorporate the uses of calculators and computers? What problems have been overcome (must be overcome) in order to achieve appropriate usage of calculators and computers? What successes have resulted from calculator and computer usage?

Delimitations of the Study

As is the case with description data, the results and findings of this study apply only to those schools which have participated in the study. Although the study sought to include all public high schools, only those given permission to participate by their division superintendents were mailed questionnaires. Additionally, in order to eliminate over-representation of these schools, these questionnaires were mailed directly to the mathematics department heads of participating high schools and were to be completed by the department heads. While this reduced the chance of receiving data from any given school more than once, it also meant that all questions were answered only from the perspective of the department head. For questions dealing with availability and distributions, this should not be an issue. However, other questions dealt with usage of calculators and computers within all mathematics classes at the school and issues of support for this usage. In responding to these questions the mathematics department head either answered based on his or her observations, or actually met with departmental members to determine appropriate responses – the questionnaire did not provide data to determine which. Finally, the questions within the questionnaire were not exhaustive, and closed-response format was used wherever possible – making coding for later analysis much easier, but reducing the diversity of the answers.

Interview sessions for interested participants had been planned. It was felt that these interviews would add to the depth of knowledge and provide insights in ways that a survey questionnaire could not. However, only ten of the 80 respondents indicated any interest in participating in interviews. When contacted at a later date, close to the end of the 1997 – 98 school year, only two of the ten were willing to be interviewed. The others were unable due to time constraints. Limited dialog concerning the study has been continued with these two participants by way of postal and electronic mail. No data from these correspondences have been included in the results of the study.

Chapter 2

Literature Review

In preparing for this study, literature representing a variety of topics was reviewed. To set the context of technology use in mathematics education, literature concerning reform movements in mathematics education was examined. Issues involving technology use in education, and the role of technology in mathematics reform, were explored through current literature. Standards documents calling for reform in mathematics education and establishing guidelines for what teachers should teach and students should learn were read to determine the level of technology advocated for use. Articles in books and journals expressing the need for professional development activities for teachers learning to use calculators and computers, and how these should be incorporated into the classroom, were included as part of the literature review. Finally, previous studies and research concerning the use of technology in education – particularly computer technology – were examined.

Mathematics Reform

One place to begin a study of technology in mathematics education is through examining the reforms and changes which have taken place over the past 40 years in mathematics education. Many of the courses currently taught at the high school level came about as a result of changes proposed during the 1950s by the Commission on Mathematics of the College Board Examination (Usiskin, 1995). In addition to calling for increased emphasis on mathematics and science education, this commission proposed the sequence of Algebra I, Geometry, Algebra II, Advanced Mathematics, and Calculus courses that is so commonly used for high school students in Virginia.

Although the content of high school mathematics has not changed dramatically, the approach toward teaching mathematics has. As expressed by the National Council of Teachers of Mathematics, and echoed by Glidden, a professor of Education at West Chester, the emphasis has gradually shifted from the mechanics of computation to the understanding processes of the students, with calculators and computers being used to perform routine computations (Glidden, 1996; NCTM, 1989). As part of this change, as observed by Kitchens, the Director of the Center for Instructional Services at Texas Christian University, the roles of the teacher and student are being redefined – teachers are seen as facilitators and co-learners with the students in the education process (1996). This shifting from teacher-centered instruction to student-centered environment has placed greater importance on the active participation of the students working in a collaborative environment with teachers to promote a deeper level of understanding (Mathematical Sciences Board, 1990; Wilcox & Zielinski, 1997). Within these settings, problems involving "real world" situations are taking the place of those problems which were designed to provide students practice in computational and manipulative skills (Ross, 1996). According to Cuoco (1995), a former high school mathematics teacher with 24 years of teaching experience who is now employed by the Education Development Center, students are being asked to work collaboratively to develop awareness and understanding of problems of a more complex nature, while using technology to assist in determining solutions. Specifically, technology is seen as providing the tools, in the form of calculators and computers, that enable this transition (Simonson & Thompson, 1997).

In reviewing national survey data from 15,000 tenth-grade students on the use of technology, Owens and Waxman (1995) concluded that while technology provides the tools, it may also be acting as a catalyst to bring about additional changes in mathematics education. It has been suggested that it is the availability of this technology that is driving the current reform in mathematics (Keitel, Kotzmann, & Skovsmose, 1993). Others credit the changes in technology as providing a part of the influence for reform, with other equally-important components coming from the social and economic needs of the American society, as well as the results of years of research about learning from the field of cognitive psychology (Schifter, 1996).

In studying educational reform movements of the past, Sarason (1991) notes that for any reform movement to be successful, it must satisfy the requirements of those involved. This is never an easy task to accomplish. Teachers alone, have several hurdles to overcome in accepting many of the current changes suggested for mathematics reform – changes in values, attitudes, and methods that may be at odds with what has previously been used and judged as successful (Schifter & Fosnot, 1993; Wertheimer, 1995); and teachers represent only one of the groups of stakeholders involved in this transformation process. Even with the full support of all involved, reform does not come easy – the complexity and inertia of the American school system are too great to be easily changed (Mathematical Sciences Education Board, 1990).

Technology Use in Education

Over the years technology has been employed most often to furnish ways in which information could be presented and exchanged (Kitchens, 1996). Projection devices, recording devices, and video devices represent a few of the tools which have resulted from technology and have been incorporated into education as a media for information exchange – making possible the delivery of information in ways other than traditional lecture and text formats (Roblyer, Edwards, & Havriluk, 1997). In this context, calculator and computer technology represent the latest of the informational technologies being used as a media for information exchange as described by Barker and Dickerson (1996), respectively the Dean for Teacher Education and Technology and the Director of the Center for the Application of Information Technologies of Western Illinois University.

The meaning and purpose of technology in education is not always clear (Gentry, 1991). Over the years, at least two predominate descriptions of technology for education have developed. The field of educational technology came into being during the 1930s and 40s as increased awareness of educational methods focused on technology as a media through which information could be delivered for mass instruction, as well as individualized and group learning (Percival, Ellington, & Race, 1993; Roblyer, Edwards, & Havriluk, 1997). Instructional technology represents a more recently developed field –

resulting in part from the launching of the Soviet space satellite, Sputnik (Johnsen & Taylor, 1991). According to Seels and Richey (1994), instructional technology is "the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning" (p. 1). Instructional technology emphasizes the development of the entire learning process, as well as the experiences and tools through which these may be provided, while educational technology focuses on the ways in which information may be delivered. (Gentry, 1991).

In mathematics education, technology is often viewed as a provider of learning devices and tools – calculators and computers – which may be used in the classroom (Simonson & Thompson, 1997). As these tools have gotten more powerful, smaller, and less expensive, they have become more readily available for students and teachers, this usage has increased – often resulting in the perception that technology use has increased simply because more tools are being used (Sorensen, 1996).

Based on a nationwide survey of 608 teachers in grades 4 through 12, Sheingold and Hadley (1990) found that with the use of calculators and computers in education, teachers were better equipped to act as facilitator-coach and provide individualized guidance to students, while further promoting the movement away from teacher controlled lecture environment into student controlled learning environments. In a similar nationwide survey of 550 teachers in grades K through 12, Honey and Henriquez (1993) found that students, and teachers, may be provided with opportunities to move beyond the physical confines of the classroom for sharing information with others, without excessive costs or delay. As expressed by Dwyer, Ringstaff, and Sandholtz (1991), based on their studies of the Apple Classrooms of Tomorrow (ACOT) project, expectations of what students are capable of accomplishing may increase, and more material may be covered in a shorter period of time, when using the tools of technology.

Standards Documents

In 1989, the National Council of Teachers of Mathematics published the first of a series of documents advocating changes in mathematics education, the Curriculum and Evaluation Standards for School Mathematics. This document contains a set of standards for the mathematics curricula of North American schools for grades K - 12 and suggestions for the evaluation of the quality of the curriculum and student achievement (NCTM, 1989). These standards provide a vision and broad framework of ideals which local school divisions can interpret and adapt to suit their needs.

Embedded in these standards is a call for increased use of technology in mathematics education. In particular, this document presents the level of availability expected for tools of technology such as calculators and computers. In the Curriculum and Evaluation Standards (1989), the beliefs are expressed that: (a) Appropriate calculators should be available to all students at all times; (b) a computer should be available in every classroom for demonstration purposes; (c) every student should have access to a computer for individual and group work; and (d) students should learn to use the computer as a tool for processing information and performing calculations to investigate and solve problems (p. 8).

Some teachers believe that following the changes proposed by the Curriculum and Evaluation Standards (1989), especially those calling for increased use of technology, may result in students being unable to perform simple calculations and unwilling to learn the basic algorithms used in mathematics education (Middleton & Goepfert, 1994). However, the intent expressed by this document was not to replace the basic skills and knowledge of computational algorithms. Instead, appropriate use of calculators and computers should help extend the students' capabilities in performing calculations and solving problems (NCTM, 1989).

To provide additional guidelines, the NCTM published two more standards documents – Professional Standards for Teaching Mathematics (1991) and Assessment Standards for School Mathematics (1995). These documents provide further support for teachers dealing with changes in mathematics education brought about in the shift from a teacher-centered to a student-centered atmosphere. The Professional Standards for Teaching Mathematics provide guidance for the kinds of teaching environments, actions, and activities needed in order to realize the changes suggested in the original NCTM Standards document (NCTM, 1991). The Assessment Standards for School Mathematics provide criteria against which teachers can judge their own assessment efforts (NCTM, 1995). While neither of these documents is centered about the use of technology, they provide guidance for teachers using technology in mathematics education.

The State of Virginia has recently developed its own set of standards for use in grades K - 12. The Standards of Learning for Virginia Public Schools (1995), often referred to as the Virginia SOLs, are more inclusive than the NCTM Standards (1989, 1991, 1995), providing specific content topics for mathematics education, as well as science, English, and history. Like the NCTM Standards, the Virginia SOLs are designed as a minimum standard for content and do not prescribe instructional strategies nor assessment methods. The mathematics standards assume that students will continue to develop traditional mathematics skills, as well as enhance skills through the use of technology. An excerpt from these 1995 Virginia SOLs indicates the place of technology within the framework of mathematics education:

> Students today require stronger mathematical knowledge and skills to pursue higher education, to compete in a technologically oriented workforce, and to be informed citizens. Students must gain an understanding of fundamental ideas in arithmetic, measurement, geometry, probability, data analysis and statistics, and algebra and functions, and develop proficiency in mathematical skills. In addition, students must learn to use a variety of methods and tools to compute, including paper and pencil, mental arithmetic, estimation, and calculators. Graphing utilities, spreadsheets, calculators, computers, and other forms of electronic information technology are now standard tools for mathematical problem solving in science, engineering, business and industry, government, and

> practical affairs. Hence, the use of technology must be an integral part of teaching and learning. However, facility in the use of technology shall not be regarded as a substitute for a student's understanding of quantitative concepts and relationships or for proficiency in basic computations (p. 3).

The State of Virginia has continued its goal of incorporating technology into education through the development and adoption of technology standards for instructional personnel (Supts. Memo. No. 89, 1997). Originally proposed in July 1996, these standards were developed to serve as guidelines for school divisions to use to as entry-level markers for measuring technology proficiencies of all instructional personnel. Modeled after guidelines for competencies and skills for education developed by the International Society for Technology in Education, the State's Technology Standards for Instructional Personnel are an effort to ensure that teachers possess the skills and competencies necessary to use technology in an educational setting. Included in these are expectations that each local school division will determine, develop, and provide the necessary in-service activities that will enable teachers to meet these technology standards.

To further aid the incorporation of technology into school divisions across the State, Virginia's Department of Education published the Six-Year Educational Technology Plan for Virginia (1995). Designed to build upon an existing base of technology – including calculators, computers, and satellite dishes and receiving equipment – this plan provides five goals for the guidance of technology use. These goals include: (a) integration of voice, video, and data networks capable of providing communications at the school, division, state, and national levels; (b) improvement of teacher and student access to technological resources in classrooms and other learning centers; (c) establishment of training programs and incentives to enhance teaching and learning through the use of educational technologies; (d) access to technologies that provide for the full maintenance, reporting, and analysis of student and administrative data; and (5) development for a system of on-going evaluation of technology initiatives to establish a benchmark for measuring the success of state and local school educational technology (p. 3).

In order to effectively implement the strategies presented in the Six-Year Educational Technology Plan for Virginia, the State presented an implementation plan in March 1997. This plan, An Implementation Plan for the Six-Year Educational Technology Plan for Virginia (1997) provides information on the strategies, projects, and offices involved in the Six-Year Plan, and an explanation of what is being performed and the level of involvement. While not as specific as to the skills which students are expected to possess, nor the competencies that teachers are required to develop, the Six-Year Education Technology Plan for Virginia does establish standards to be met for technology use across the public school divisions of Virginia.

To further promote the development of technology use in a controlled and meaningful fashion, the State required each school division to develop and maintain a local technology plan (Supts. Memo. No. 37, 1994). These plans are expected to: (a) present a vision of what is to be achieved with technology use; (b) establish goals for technology use consistent with the vision; (c) document current technology components and uses, along with explanations of use based on the vision and goals of the division; (d) propose evaluation methods and processes for determining the degree of implementation and the level of success; and (e) identify methods and strategies which will be used to assure all staff are comfortable using technologies as identified by the <u>Standards of Learning for Virginia Public Schools</u>, as well as the local school division. The plans are expected to serve as guidelines for the purchasing of technology, implementation of technology into the curriculum, and development of strategies for professional development activities to help support teachers using technology. In August 1997, local technology plans were rated by the State of Virginia and used to provide information for state and federal funding – such as Goals 2000 grant awards – for technology projects within the school divisions (Supts. Memo. No. 82, 1997).

<u>Professional Development for Teachers</u>

The influence of technology on education is profound (Hache, 1997). In their efforts to validate instruments for use in teacher education, Delcourt and Kinzie (1993), of McGill University and The University of Virginia, found that for this influence to be a positive factor in instruction, teachers must be willing to embrace the use of technology, as well as devote the time and resources needed to become comfortable using the technology. Hoffman (1997), Assistant Professor of Educational Technology at San Diego State University, emphasizes that teachers must be willing to commit time and effort in learning how to use technology in the classroom, and resources – including professional development activities – must also be available from the schools and divisions in which these teachers work.

In the not too distant past, Wetzel, a Professor of Education at Arizona State University West Campus, found that professional development activities for technology use often consisted of providing the tools – calculators and computers – along with limited in-service activities designed to give the basics of the operations of the tools (1996). According to Wild (1996), of Edith Cowan University in Perth, Australian, an assumption is being made that the teachers need to know how to use the tools of technology without first knowing <u>why</u> they need the tools, and <u>what</u> they are going to do in the classroom with the tools. In the rush to purchase and distribute the tools, schools and divisions may often overlook the importance of providing professional development activities that will allow the teachers to understand why they need the tools, what they will do with the tools, and how to use the tools (Olson, 1992).

These professional development activities may be costly in terms of money and time – and school divisions may not be willing to invest in training over equipment. A 1990 statewide survey of California public schools indicated that out of ten million dollars appropriated for educational technology, only about seven percent was designated for staff development (Main & Roberts, 1990). With a lack of adequate preparation and resources, teachers may be unlikely to move rapidly towards embracing the use of technology. A 1995 study conducted by the United States Congress' Office of Technology Assessment reported that a majority of teachers felt insufficiently trained to adequately use computer technology resources, a majority of schools lacked on-site or division personnel to coordinate or assist with the use of technology, and that teachers wanted more hands-on training opportunities with convenient access to support personnel and equipment (OTA, 1995).

Within the State of Virginia, professional development for teachers using technology has become a major issue. The increased availability of funds to be used for providing professional development activities (Supts. Memo. No. 120, 1996), and the increased expectations for teachers being able to use technology in the classroom (Supts. Memo. No. 94, 1996; Supts. Memo No. 89, 1997) have resulted in more attention on professional development activities. As stated in the Six-Year Educational Technology Plan for Virginia (1995):

> Ultimately, teachers are responsible for the appropriate use of technology in the classroom. The successful integration of technology depends largely upon the existence of a well-developed teacher training and technical assistance program. The training must be ongoing and linked to current needs. ... Good training programs produce local technology coordinators and technical support staff (p. 26).

In June 1997, the State conducted a survey of technology coordinators from school divisions throughout the State (Supts. Memo. No. 38, 1997). The purpose of this survey was to determine the scope of technology training required and how that training could best be provided. As a result of this survey, the State began a series of monthly workshops designed to develop the skills of local division trainers, who in turn would act to develop the skills of division instructional personnel at the local level (White, 1998). While a single component, this serves as an indication of the value the State of Virginia is beginning to place on professional development activities designed to enable teachers to use technology.

But the value of any professional development activity is ultimately determined by the teachers. Teachers who are interested in using technology will find ways to obtain the development activities they desire (Hache, 1997). Such opportunities are widely available, ranging from self-training activities involving one or more individuals to formalized settings for college credits. For teachers who have not yet indicated interest in using technology, some level of incentive may need to be provided, as well as support from administrators and time for which these opportunities to occur (Taylor, 1994).

Recent Research on Technology Use

Over the past decade, numerous studies have been done with respect to technology use in education – especially computer technology. In particular, Quality Education Data, a data marketing company that has tracked educational technology across the United States since 1981, has provided schools with breakdowns of information on the numbers of school divisions with computers, the numbers of public schools with computers and the average numbers of students per computer through surveys conducted frequently during the 1990s (1992, 1994, 1997). Over the past two decades, the number of school districts using computers has grown from under 6,000 to over 16,000 as of the 1995 - 96 school year. The numbers of public schools having computers available for use has increased from 14,000 to 83,000, while the average number of students per computer has decreased from 125 students per computer to 9 students per computer.

Studies designed to determine the numbers of teachers who were using computers in the classroom, and the ways in which the computers have been used, have been conducted by government organizations such as the United States Congress Office of Technology Assessment (1995) and by individuals such as Honey and Henriquez (1993). These nationwide studies show that a substantial number of teachers have little or no use of computers for instructional purposes, and that students were reported as using computers less than two hours per week. However, these studies also indicate that teachers who have incorporated the use of technology into the classroom use computers in multiple ways which allow them to present more complex materials to students, providing more individualized attention to students, and allowing the students to work independently.

At a statewide level, the State of Virginia has used surveys to determine the effectiveness of providing funding for purchases of computer equipment by school divisions (Virginia Department of Education,1995). Superintendents' Memo. No. 49 (1997) included a questionnaire seeking information on availability and usage of graphing calculators and scientific probes at local school division levels – ultimately resulting in the purchase of 20 million dollars worth of graphing calculators and scientific probes ("State buys," 1997). The State has begun conducting studies to determine areas of need for professional development activities to help teachers incorporate technology into the classrooms (Supts. Memo. No. 38, 1997).

The State of Virginia also commissioned Quality Education Data to conduct an additional survey on technology use. This survey, the Virginia School Technology Survey (1997), was to be completed at individual school sites, as well as at the division level. Aspects of the questionnaire sought to identify training and use plans; Internet accessibility; technology hardware including computers, peripherals such as printers and multimedia equipment; and graphing calculators. At this current time, the results of this survey have not been made available.

The State of Virginia is continuing to seek information about the ways in which technology is being used in education across the State. As of July 10, 1998, the Department of Education is soliciting sealed proposals on-line at http://www.pen.k12.va.us/Anthology/VDOE/News/ETS99/ets_99rf.html for a study designed to "assess the status of educational technology available, and usage in each public school in the Commonwealth" (p. 1).

Chapter 3

Methodology

Design of the Study

The purpose of any descriptive study is to collect data about a population which can be organized and summarized in fashions which allow others to make sense of the results (Ott, 1993). One of the most widely used techniques for gathering data for descriptive studies is the survey – it provides a means of gathering information that can describe both the nature and extent of a specified set of data ranging from tallies and frequencies to attitude and opinions (Isaac & Michael, 1990). Surveys may be used to describe populations, determine differences in groups within populations, or explore little known aspects of populations. Such descriptive surveys may also be used to collect cross-sectional data which is fixed at one point in time to provide a base reference for future studies (Fink[b], 1995).

Data collection tools for surveys include the interview and the questionnaire (Ary, Jacobs, & Razavieh, 1990). Interviews allow greater flexibility and more control of the questions, while questionnaires can be designed to be self-administered and mailed to a larger group of subjects in more diverse locations. Concerns exist regardless of the format being used. Misinterpretation of questions or statements may result in incorrect or inappropriate responses and participants may not respond well to questions which seem too long, too confusing, too sensitive, or considered not interesting (Bourque & Fielder, 1995).

Other concerns in the design of a survey exist with respect to the reliability and validity of the tool. Design reliability is affected by random error, measurement error and internal consistency, while the overall validity is determined by content and criterion validity (Litwin, 1995). Content validity may be judged by individuals having competence in the areas being surveyed and representative of the participants in the survey. Criterion validity may be determined by actual observation to determine whether the subjects' responses match actual behaviors. The overall validity of any survey can be greatly affected by the importance of the topics to the respondents, as well as the degree of anonymity provided (Ary, Jacobs, & Razavieh, 1990).

Descriptive studies often do not require complex statistical analysis (Ary, Jacobs, & Razavieh, 1990). Data gathered from self-administered questionnaires are typically analyzed using simple statistical tools such as tally or frequency counts; measures of central tendencies; measures of dispersion; and cross-tabulation correlation between categorical or nominal data (Fink[a], 1995).

For this study, a questionnaire designed to be self-administered was developed (see Appendix A), using guidelines suggested in The Survey Kit by Fink (1995), in order to collect data from mathematics department heads from public high schools in Virginia. The questionnaire was pilot-tested by a group of experienced mathematics teachers in order to establish clarity, ease of use, and validity of content. Revisions were made based on recommendations received during the pilot-testing period. The final questionnaire contained 30 questions with the majority of these being in closed-response format. Several questions used table format so that a large quantity of data could be recorded quickly in a minimum of space. Three free-response questions were provided to allow the participants the opportunities to express results using their own words.

Upon receipt of a completed questionnaire, the responses were examined to determine the level of completeness of the answers and compliance with the questions. Once verified, the data were recorded onto an electronic spreadsheet template. Descriptive statistics in the form of tallies, frequencies, and percentages were calculated. These results were aggregated to determine answers for the original research questions.

Settings/Participants

The settings consisted only of public high schools within the State of Virginia. At the time of the study, according to the 1996 – 97 Virginia Educational Directory, there were 278 public high schools. No private high schools were included in this study, primarily because funding provided by the State for purchases of calculators and computers was not readily available to them. For similar reasons, and due to more specialized student populations, jointly operated vocational-technical centers and regional academic Governor’s Schools were not included in this study.

The majority of the public high schools in Virginia provide services for students in grades nine through twelve. Some of the schools support students over a broader range of grades, often combining middle school grades 6 - 8 with high school grades 9 - 12. A small number of schools service the entire range of students K - 12. Most school divisions support at least one high school. However, a few divisions sponsor jointly controlled or consolidated high schools that merged students from two divisions.

The participant selection process began with the letter of transmittal sent to each public school division superintendent within the State of Virginia (see Appendix B). These letters were mailed during the first week of November 1997. In this letter, a request was expressed for the superintendents to would respond as quickly as possible, so that for those divisions granting permission, survey packets could be mailed to mathematics department heads during the early portion of December.

By December 12, 1997, responses had been received from 81 of the public school divisions. Seventy-one of these had elected to allow high schools within the divisions to be included in the study. Four had denied permission to conduct the research. Three school divisions sent notifications that their high schools were operated jointly with other school divisions, and that the requests for participation had been directed to those school divisions. Three divisions had returned additional forms which were required before the request could be acted upon – these also noted that permission to participate was not automatically given after completion of the forms, nor would the turn-around time be rapid; a delay of six to twelve weeks should be expected before the results of the request would be known. A follow-up phone call to one of the divisions for additional information resulted in the expressed opinion that permission to participate would not be granted even after completion of the forms. An email message to a second division resulted in a similar response – that school division rarely participated in research conducted by graduate students, and such a request would probably be denied. Due to the expected delay and the likelihood of negative responses, these forms were not completed and returned to the school divisions.

Efforts to elicit further responses from the remaining school divisions, by way of an electronically mailed copy of the original letter, were not successful. These email letters were sent to the superintendent's VaPEN email accounts. Only two additional responses resulted – both of these a denial of permission for participation.

The actual participants for this study were the mathematics department heads from those 139 high schools (50% of all high schools) in which permission had been granted to extend an invitation for participation in the study. The choice of department heads was a deliberate one. These teachers are often veteran teachers who should be able to respond to questions concerning the availability of calculators and computers for mathematics use at their schools and should be able to gather specific information about technology usage from other members of the department. By targeting the department heads, it was assured that only one survey would be completed and returned from each participating school. There would be little chance of counting the same school more than once, reducing concerns about over-sampling for a given school.

The questionnaires were mailed to the mathematics department heads at these 139 high schools. Participation – completion of the survey – was completely voluntary on the part of the mathematics department heads. In all, a total of 80 completed questionnaires, or 58% of the original number mailed, were returned.

The Questionnaire

The survey tool for this study was a self-administered mail questionnaire. A closed-response questionnaire design was used to provide an easy format for completion, while reducing the possibilities for misinterpretation. The closed-format response format also provided an easy mechanism for structuring categories that could be easily tallied during data analysis.

The questionnaire contained five parts. Part one was designed to gather demographic data concerning the school, the mathematics department, and the number and type of mathematics courses offered. The second part was designed for specific measurement of aspects of technology use within mathematics education. Questions about the numbers and kinds of calculators and computers available, influences on calculator and computer use from individuals and groups, and the frequency and uses to which these were placed were included in this section. Questions specific to teacher use of technology were also included in this section. Part three sought to provide teachers with opportunities to indicate the types of professional development activities in which they had participated, as well as on-going activities provided by the school or school division. Part four dealt with the familiarity with documents such as the NCTM Curriculum and Evaluation Standards for School Mathematics (1989) and the Standards of Learning for Virginia Public Schools (1995), as well as other similar documents. Participants were asked to express the degree of influence these documents exerted on technology use within the high school mathematics programs of the high schools. The final part of the questionnaire consisted of a free-response section. This section allowed participants the opportunities to briefly respond to the effects technology use may have produced on instructional and assessment activities. In the same section, descriptions of problems arising from technology implementation and successes resulting from technology use could be described.

The questionnaire was printed in booklet format in an effort to produce a more professional-looking instrument, as well as to produce a distinctive appearance that would not easily be overlooked on a cluttered desktop. Thirty questions were included in the booklet – twenty-two of these closed-response questions; five of the nature requiring specific numeric data; and three free-response questions allowing for brief descriptions and situation-specific responses. Fourteen of the questions were arranged in a table format, allowing for easy completion of the requested data.

Pilot-Testing. The purpose of the pilot-test was to ensure internal consistency and content validity, as well as determine the ease of completion of the questionnaire. Twelve veteran, high school mathematics teachers from a west-central school division agreed to participate in the pilot-test.

During pilot-testing all twelve teachers completed the sample questionnaire during the same time period and in the same room. No questions were asked or answered about the questionnaire, and the teachers did not share information or comments with each other during the pilot-testing session. The length of time it took each participant to complete the questionnaire was noted for future reference.

After all participants were finished, a group discussion was held to discuss areas of confusion, weaknesses in the questionnaire, and the degree to which the questions matched the original research questions. Arrangements were made to meet with each individual teacher to further discuss the questionnaire. As a result of these meetings, coupled with further suggestions from the writer's doctoral committee, the final questionnaire was reduced in length from sixty to thirty questions – primarily through the use of table formats for many responses. The foci of several questions were sharpened, and clearer instructions were included for each question.

This revamped questionnaire was given to ten of the original participants in the pilot test. Completion time was significantly reduced – all but one completed the questionnaire within fifteen minutes, while the remaining person was finished within twenty minutes. Certainly, much of the reduction in time came about from familiarity with the content. However, all agreed that the revisions produced a questionnaire that was much easier to complete. During this second session, with the aid of the participants, a table relating the research questions to survey sections and questions (see Appendix C) was developed for future use during data analysis.

Data Collection Procedures

One hundred thirty-nine high schools were granted permission by the division superintendents to have surveys sent to the mathematics department heads. This number represented 50% of all public high schools within the State of Virginia. As permission forms were received from the division superintendents, a table listing the school division and its response was developed. For those school divisions granting permission, the table included the names and addresses of all the high schools within the division. Survey packets were then mailed to the individual department heads in each of these high schools.

The original time-line had survey packets being mailed to mathematics department heads during early December 1997. However, the actual mailing of the packets did not begin until the first week in January 1998. There were three primary reasons for this delay. First, the decision was made to wait a bit longer while non-responding school divisions were being contacted concerning permission to participate. Second, the State department was just beginning to schedule purchase authorizations for those schools who had submitted calculator requests under the Technology Initiative for Graphing Calculators and Scientific Probes (Supts. Memo. No. 49, 1997). The majority of these calculators were projected to be shipped during December 1997 and January 1998. Finally, severe weather conditions across the State had resulted in many missed days of school – in the rush to catch up before the winter holidays, it was felt that department heads would not be as responsive to completing a lengthy questionnaire.

Mailings of the survey packets to the mathematics department heads of participating high schools began during the first week in January. These survey packets included a cover letter explaining the purpose of the study and stating that permission for the school to participate in the study had been granted by the division superintendent, as well as a guarantee that the survey results would be kept confidential with no marks to identify the participating high school; a second letter giving more details for the completion of the questionnaire form; a completion form to be mailed (separate from the questionnaire, and including an option to be checked if the participant desired a copy of the final results) to ensure proper record-keeping of respondent schools; the questionnaire booklet itself; and addressed, stamped mailing envelopes for the questionnaire booklet and the completion form.

No identifying marks were placed on the questionnaire booklets. However, the return envelopes were coded. This coding, along with the receipt of the completion form, allowed for a double-check process to fully ensure accuracy of record-keeping. Once the survey forms were received, they were separated from the mailing envelope. The envelopes were then used to identify responding schools. These were verified upon receipt of the separately mailed completion form.

Keeping accurate records of those schools responding was critical. The previously developed table used for recording participating schools was modified to include additional information. This consisted of return dates (questionnaire and completion form), as well as columns for recording dates of follow-up contact letters. Since no return date had been specified in the original contact letters, it was imperative that follow-up letters be used to encourage completion of the questionnaire.

Twenty-four completed questionnaires, representing 17% of the total mailed, were returned within the first two weeks of the initial mailing. The first follow-up contact letters (see Appendix D) were mailed approximately two weeks after the mailing of the survey packets. These were mailed to non-responding schools in an effort to remind them of the questionnaire. An offer to send a second survey packet was included in this letter. This follow-up letter resulted in the return of eight completed questionnaires, bringing the number completed to 32, or 23% of the total. Four additional questionnaires were returned uncompleted.

Approximately four weeks after the initial mailing, a second follow-up letter – complete with a second survey packet – was mailed to those schools which had not yet responded (see Appendix D). As a result, ten completed questionnaires were returned. The total number of completed questionnaires at this time was 42, representing 30% of the total.

In an effort to gain greater participation, letters explaining the purpose of the study and containing a request for encouragement to math department heads were mailed to the principals of the remaining ninety-three high schools that had not responded (see Appendix D). This was a calculated risk – letters to the principals asking for intervention on a voluntary questionnaire could have easily resulted in antagonizing the remaining mathematics department heads. However, after this mailing, an additional 38 completed questionnaires were returned, bringing the total number of completed questionnaire to 80, or 58% of the surveys mailed.

During this time two letters were received from mathematics department heads expressing displeasure with the method used to secure cooperation – both expressed the opinion that participation was being coerced by their principals. One of these letters was included with a completed questionnaire, while the second included a statement that the questionnaire would not be forthcoming.

In all, a grand total of 86 responses were received. Of these, 80 included completed questionnaires. These 80 completed questionnaires represent a response rate of 58% of the 139 schools to which questionnaires were originally mailed. From the original population of 178 public high schools, the 80 completed questionnaires represent 29% of the total population.

Data Analysis

All returned questionnaires were carefully examined for completeness and accuracy of response – verifying that respondents followed the guidelines in answering the questions. Since the majority of the questions were closed-response, it was relatively easy to determine if errors had been made by checking two or more responses when only one was appropriate. The data collected was in the form of nominal, or categorical, data that could easily be reported as tallies, frequencies, and percentages. Care was given to the selection of categories so that wherever appropriate, responses could only fall into one category. Results from these types of categories should sum to 100%, providing easy comparisons between categories.

Actual tabulation was done using an electronic spreadsheet. Data from completed questionnaires were coded and entered into templates designed to hold results from each school. From these school templates, question templates were developed which were used to calculate tallies, frequencies, and percentages. Further categorization was done for availability of calculators and computers so that breakdowns based on student population size and school setting would be possible. Availability of calculators and computers was also examined based on averages per school and averages per teacher in order to provide additional avenues for comparisons. Average per teacher is a meaningful indicator of what should be readily available for each teacher to use during class time – technology that is readily available may be used more frequently by mathematics teachers.

Limitations of the Study

The study dealt only with availability and uses of calculators and computers in high school mathematics classes, it did not attempt to examine any other types or tools of technology. While the desire was to survey all public high schools across the State of Virginia, only those granted permission by the division superintendent were included. Of these 139 schools, 80 completed and mailed questionnaires suitable for use. The results expressed in this study are only applicable to those 80 schools. These results paint a compelling picture of those schools that did respond, but do not reflect the availability and usage of technology for those high schools that did not respond or were not included in the study.

Mathematics department heads were selected as the recipients of the survey – however, some of the questions required that they obtain information from other mathematics teachers within the department, often a time consuming process. Finally, these questionnaires were self-administered in an uncontrolled setting – the accuracy of the results was totally dependent upon the care and accuracy of the respondent; and it may be the case that only those mathematics department heads who held strong views about technology use chose to respond.

Chapter 4

Results and Discussion

This chapter reports the demographic data describing the participant schools and settings; results for the research questions, broken down into subquestions where appropriate, and followed by discussion of the question results; and a final summary of all findings. In the sections that follow, tallies and averages have been used most often in describing the availability and usage of calculators and computers. Percentages have been used in describing the part to the whole. Often, descriptive data have been organized and displayed in formats using tables of values. Many of the values, especially averages and percents, have been rounded to the nearest whole number, unless otherwise specified. Due to rounding, summation of percentages describing unique, exclusive categories may not always equal 100 percent. With such rounding, it is possible to obtain values slightly smaller or slightly larger than 100 percent that still reference the sum total of all events. Also, the use of averages is helpful for the purpose of comparison, but does not express the range of values or individual responses.

Demographic Information

In all, a total of 80 public high schools were included in this study. These schools were located in all areas of Virginia. Distributions of the schools based on school population sizes were relatively balanced, while those based on settings show a larger number of rural schools than others (see Table 1). These schools were categorized based on student population sizes and settings – urban, suburban, and rural – as reported by the respondents.

For questions involving the availability of calculators and computers for student use during mathematics classes, breakdowns by size and setting are often included. From this breakdown, apparent discrepancies based on either size or setting may be noted.

Table 1.
Number of Participating Schools

Description	Number of Schools	%
School Size		
Small (750 or fewer)	29	36
Medium (751 - 1250)	25	31
Large (1251 or more)	26	33
School Setting		
Urban	18	23
Suburban	24	30
Rural	38	48

Through data gathered by the mathematics department heads during the completion of the survey, potentially 672 teachers – the sum total of all full-time mathematics teachers from the 80 participating high schools – are represented to some extent in this study. Without regard to school size or setting, this represents an average of eight teachers per school. This average is used in many questions dealing with the availability of calculators and computers in order to determine the average number of units available per teacher per school to provide a quick reference for comparison. More detailed comparisons based on school sizes and settings are possible using the data from Table 2.

Table 2.
Average Number of Mathematics Teachers per School

Description	Number of Teachers	Average per School
All Schools	672	8
School Size		
Small (750 or fewer)	124	4
Medium (751 - 1250)	209	8
Large (1251 or more)	339	13
School Setting		
Urban	192	11
Suburban	247	10
Rural	232	6

To examine usage of calculators and computers, specific mathematics courses should be designated for study. Of interest for this study are those core *SOL* courses for which calculators and computers are available and being used – Algebra I, Geometry, Algebra II, Math Analysis, Calculus, Discrete Mathematics, Probability and Statistics, and Computer Mathematics. These courses are not offered at every school represented in this study. Table 3 shows the number of schools for which the specified courses were available. Later calculations based on calculator and computer use in specific courses are typically based only on those schools in which the course is available.

Table 3.
Number of Schools Offering Core SOL Mathematics Courses

Name of Course	Number of Schools
Algebra I	80
Geometry	80
Algebra II	80
Math Analysis	67
Calculus	76
Discrete Mathematics	13
Probability & Statistics	28
Computer Mathematics	46

Results

For greater detail and clarity, the many of the original research questions have been broken down into additional subquestions. Separation of data between calculators and computers makes for easier access to pertinent information. When possible, similar table formats have been used for determining answers for similar questions.

Results for Question 1. How many calculators (scientific and graphing) and computers are available for use in high school mathematics classes in public high schools within the State of Virginia? How are these distributed in schools based on school size and school setting? What are the average numbers of calculators and computers available per school or per teacher in those schools providing calculators and computers?

Subquestion 1A. How many scientific calculators are available for use? How are these distributed in schools based on size and setting? What is the average number of scientific calculators available per teacher in those schools providing graphing calculators?

There are 3,300 scientific calculators of mixed brands available for student use. Scientific calculators are not available at all schools, in 41 of the schools (51%) scientific calculators were listed as being available for students to use.

Across the 41 schools, teachers have an average of ten calculators each. From Table 4, smaller schools are shown with a larger average per teacher than do other size schools. But only 34% of the smaller schools offer access to scientific calculators, as compared to 56% of the medium and 65% of the larger size schools.

Schools in rural settings are shown as having a slightly larger average per teacher than schools in suburban settings, and an average number twice that of teachers in urban settings. Calculations based on breakdowns by settings may be used to determine that roughly 55% of urban and suburban schools have scientific calculators available, while 47% of rural schools have these calculators available for student use.

Table 4.
Number of Scientific Calculators

Description	Number of Schools	Number of Calculators	Average per Teacher
Total	41	3,300	10
School Size			
Small	10	555	14
Medium	14	1060	9
Large	17	1685	8
School Setting			
Urban	10	649	6
Suburban	13	1361	10
Rural	18	1290	12

Subquestion 1B. How many graphing calculators are available for use? How are these distributed in schools based on size and setting? What is the average number of graphing calculators available per teacher in those schools providing graphing calculators?

A total of 41,992 graphing calculators are available for student use. Graphing calculators are available in all 80 of the schools represented in this study. The majority of these calculators are manufactured by Texas Instruments (Models 81, 82, & 83) and Casio (Models 9850 & 9857).

Across the 80 schools, teachers have an average of 66 calculators each. Table 5 shows that a relative balance for the average number of calculators available per teacher exists, regardless of school size or setting.

Table 5.
Number of Graphing Calculators

Description	Number of Schools	Number of Calculators	Average per Teacher
Total	80	41,992	66
School Size			
Small	29	7,465	64
Medium	25	13,544	68
Large	26	20,983	62
School Setting			
Urban	18	10,676	55
Suburban	24	15,670	63
Rural	38	15,646	67

Subquestion 1C. How many graphing calculators were provided by funding from the State of Virginia through the Technology Initiative for Graphing Calculators and Scientific Probes?

Of the 41,992 graphing calculators currently available at these schools, funding by the State of Virginia was used to provided 36,498 of the units (87%). All 80 of the schools received graphing calculators from the State through this funding. In sixty-eight of the schools (85%) the funding was used to purchase Texas-Instrument calculators – the vast majority of these being the model TI-83. The remaining 12 schools (15%) received Casio calculators as the units purchased with State funds – most of these were model 9850.

Subquestion 1D. Are overhead calculators available for use during mathematics classes?

In seventy-three of the schools (91%), teachers had at least one overhead calculator available for use during mathematics classes. At several of the schools, more than one unit was available for use. At five of those schools that did not have overhead calculators available (6%), units had been ordered but not received. The other two schools (3%) did not have overhead calculators due to lack of available funds.

Subquestion 1 E. Are teachers provided with scientific or graphing calculators for use during the school year?

At thirty-five of the schools (44%), teachers were reported as being provided with scientific calculators for use during the school year. The number of schools in which teachers were provided graphing calculators for use was 79 (99%). In the one school at which teachers were not provided with graphing calculators, teachers are allowed to use calculators during class time if extra calculators are available.

Subquestion 1F. How many computers are available in the classroom for student use during mathematics classes? How are these distributed in schools based on size and setting? What is the average number of computers available per teacher in those schools providing graphing calculators?

There are 504 computers available for student use in the classrooms during mathematics classes. In 57 schools (71%), computers are available in the classroom. This provides an average of slightly over one computer per teacher accessible by mathematics students in classroom settings. A more detailed analysis by school sizes and school settings is shown in Table 6. Smaller schools are shown with an average of almost two computers per teacher, while medium-sized schools average one computer per teacher, and large schools average slightly less than one computer per teacher. The averages per teacher based on school settings show slightly above one computer per teacher for urban and rural, with the average for suburban settings being almost half of a computer less.

In 72% of small and medium size schools, computers are available for classroom use during mathematics classes, as compared with 69% of the larger schools. For 71% of rural and suburban schools, computers are available for classroom use during mathematics, as is the case in 72% of the urban schools.

Between IBM-clone PCs and Macintosh computers, the IBM-clone PC was most common, used at 40 schools (50%). Macintosh computers were reported as being used in the classrooms of 12 schools (15%). One school (1%) was listed with Apple computers in the classroom, and no listing for type was given from 4 of the schools (5%).

Table 6.
Number of Computers in Classrooms

Description	Number of Schools	Number of Computers	Average per Teacher[a]
Schools Reporting Use	57	504	1.1
School Size			
Small	21	130	1.6
Medium	18	180	1.3
Large	18	194	0.8
School Setting			
Urban	13	163	1.2
Suburban	17	143	0.8
Rural	27	198	1.2

Note. [a]Average per Teacher is an approximate substitution for Average per Room – the numbers of rooms were unavailable. Also, Averages per Teacher have been rounded to the nearest tenths.

Subquestion 1G. How many computer labs are available for use by students during mathematics classes? How are these distributed in schools based on size and setting? What is the average number of labs available per school in those schools providing graphing calculators?

There are 123 computer labs available for use by students during mathematics classes. In 73 schools (91%), at least on lab is available for use during mathematics classes. Overall, there is an average of slightly fewer than two labs per school.

In 96% of the larger schools, at least one computer lab is available for student use during mathematics classes, as compared with 92% of the middle size schools and 86% of smaller schools. In 96% of suburban schools, at least one computer lab is available, as compared to 89% of urban and rural schools.

While all of these schools had at least one computer lab available for use during mathematics classes, several had more than one lab. Twenty-three of the schools (29%) had two labs available for use. Eight of the schools (10%) had three labs, and in three schools (4%) more than three labs were available for use during mathematics classes. The average number of computers per lab was roughly 20 machines. PC machines are used in the labs of 49 of these schools (61%). Macintosh computers are used in the labs of 10 schools (13%). Four (5%) were reported as having a mix of PC and Macintosh machines, while the computer type in ten of the schools (13%) was not specified.

Table 7.
Number of Computer Labs

Description	Number of Schools	Number of Labs	Average per School[a]
Schools Reporting Use	73	123	1.7
School Size			
Small	25	38	1.5
Medium	23	43	1.9
Large	25	42	1.7
School Setting			
Urban	16	33	2.1
Suburban	23	40	1.7
Rural	34	50	1.5

Note. [a]Averages per Lab have been rounded to the nearest tenths.

Subquestion 1H. Are computers with large screen displays (TV monitors, LCD panels, projection monitors, etc.) available for use during mathematics classes?

In thirty-six of the schools (45%), teachers have access to computers with large screen displays during mathematics classes. Of the remaining schools, four (5%) were listed as having had display units ordered. For many of the schools which did not have large screen displays, lack of funding was offered as the reason for the unavailability.

Subquestion 1I. Are teachers provided with computers for use during the school year?

Sixty-two of the schools (78%) were reported as providing teachers with computers for use during the school year. While most of these computers were located in mathematics classrooms, several of the computers used by teachers are located in libraries or teacher workrooms. In addition, many respondents noted that these computers were only available during the school day – none indicated that computers were provided for use at home.

Discussion for Question 1. It appears evident that a large supply of graphing calculators available for use in the mathematics courses at all the high schools represented in this study. Scientific calculators are not as readily available, being provided in only 51% of the schools participating in this study. Computers, located either in classrooms or labs, are available to a great degree, with over 90% of the schools having computer access for students during mathematics classes.

There does not seem to be any serious disparity of distribution for calculators and computers, with the exception of scientific calculators. In only about 30% of the smaller schools are scientific calculators available, as compared to approximately 60% of the other size schools. Teachers have access to approximately 66 graphing calculators on average – large enough for at least one classroom set with others available for special use or assignment to students. Teachers also have access to graphing calculators for their own use during the school year.

The widespread availability of graphing calculators, and lack of disparity in distributions according to size and setting, may be directly attributed to funds provided by the State of Virginia for the purchase of graphing calculators. In all 80 schools, State funding was used to purchase graphing calculators, increasing the overall number of graphing calculators from 5494 before the purchases to 41,992 after. This is an increase of 36,498 calculators and represents over a 600% jump in the number of calculators available to students. Without State aid, it seems unlikely that graphing calculators would be as readily available.

Computer availability is also widespread across all schools regardless of sizes or settings. While computers in the mathematics classrooms are provided in only 71% of the schools, over 90% of schools contain at least one computer lab which may be accessed by students during mathematics classes. Larger schools located in suburban areas are slightly more likely to have computer labs for use by students during mathematics classes than are smaller schools located in rural and urban areas.

<u>Results for Question 2</u>. In what types of professional development activities have mathematics teachers participated over the past eight years in order to prepare for the use of calculators and computers in teaching activities?

Subquestion 2A. Over the past eight years, how many hours of involvement have occurred in calculator learning activities such as: self-training, school sponsored in-service, division sponsored in-service, conference presentations, formal college coursework, summer institutes, and other settings?

During the past eight years, it was reported that in 63 of the schools (79%) at least one teacher from each school participated in a calculator learning activity. A total of 32,790 hours were spent in these activities. Self-training activities accounted for 12,930 of these hours, or 39% of all hours of learning activities. School and division in-service activities were used by teachers to acquire 9,716 hours (30%) of learning activities. Summer institutes and college coursework were reported for a total of 7,521 hours (23%). The remaining 2,623 hours, or 8%, were overwhelmingly due to attendance at conference presentations. Applied across all 672 teachers potentially represented in this study, these figures may to used to calculate an average time of approximately six hours per teacher per year for calculator learning activities.

Subquestion 2b. Over the past eight years, how many hours of involvement have occurred in computer learning activities such as: self-training, school sponsored in-service, division sponsored in-service, conference presentations, formal college coursework, summer institutes, and other settings?

During the past eight years, it was reported that in 61 of the schools (76%), at least one teacher from each school participated in a computer learning activity. A total of 23,068 hours were spent in these activities. Self-training activities accounted for 11,979 of these hours, or 52% of all hours of learning activities. School and division in-service activities were used by teachers to acquire 6,892 hours (30%) of learning activities. Summer institutes and college coursework were reported for a total of 3,492 hours (15%). The remaining 705 hours, or 3%, were overwhelmingly due to attendance at conference presentations. Applied across all 672 teachers potentially represented in this study, these figures may to used to calculate an average time of approximately four hours per teacher per year for computer learning activities.

Discussion for Question 2. The results from this question must be viewed with limitations. The survey participants – mathematics department heads – were asked to determine the total number of hours of professional development activities for calculator and computer use in which members of the department had accumulated. They were further asked to categorize these into different types of activities, and list the numbers of teachers involved. The time frame for these activities was based on the previous eight years – chosen based on the publication date of the NCTM Curriculum and Evaluation Standards for School Mathematics (1989) and the belief that it would take about a year of so for this document to reach widespread availability. Sixty-three of the 80 mathematics department heads attempted to provide information for this section. Several that did not respond indicated that obtaining this information would be too time consuming, or simply impossible.

With these limitations in mind, the results would seem to be an indicator that the bulk of development and instruction for calculator and computer use is being obtained through teacher self-training activities. Almost 40% of all hours spent on calculator learning activities, and over 50% of the hours spent on computer learning activities, were reported as taking place with self-training actions. While self-training is often necessary, it may not provide teachers with support from other colleagues, nor the opportunities to explore what others have already attempted.

School and division in-service activities provide roughly 30% of the hours for both calculator and computer learning activities. Such in-service events are typically of short duration, and follow-up activities may occur irregularly, or not at all. Summer institutes and college coursework provided another 23% of the hours with activities for learning to use calculators and 15% of those hours for computer activities. The remaining hours represented attendance at conferences. Teachers were asked to provide examples of other types of development or instructional activities which were used to guide the use of calculators and computers, but none were included.

Finally, while the average numbers of hours spent in learning activities by teachers per year for calculator and computer use may not be an accurate indicator, it is still cause for concern. According to the data from this study, teachers average about 6 hours per year working with calculator learning activities, and 4 hours per year with computer activities. For calculators and computers to be integrated into mathematics courses, it would seem that more time than this is necessary for preparing to use these tools.

Results for Question 3. What additional elements, in the form of individuals or groups, exist for providing directions, influence, support, or encouragement for the use of technology in mathematics classrooms?

Subquestion 3A. How often do members of the mathematics department meet to discuss technology use for mathematics courses?

Of the 80 schools participating in the study, teachers in eight of the schools (10%) were reported as meeting at least once a week to discuss technology use in mathematics courses. For 27 of the schools (34%), teachers were listed as meeting once a month for the purpose of discussing technology use. In another 25 schools (31%), teachers met at least once during the marking period – marking periods may vary from six to nine weeks. In thirteen of the schools (16%), teachers met once a year to specifically discuss technology. In four other schools (5%), teachers met as needed to talk about technology, while in three schools (4%), teachers were reported as never meeting to discuss technology.

Subquestion 3B. How active in influencing technology uses for calculators and computers are specific individuals or groups such as: superintendents or school boards; directors of instruction or mathematics supervisors, building principals or administrators; mathematics department heads; mathematics department teachers; and parent or community members?

To measure influence, three categories were used, based on the degree to which an individual or group either directly interacted with technology or made decisions that affected the technology use of others. The following scale was used for recording purposes: (a) A person or group was rated as high in influence for interactions or decisions affecting technology use at least once a week or more frequently; (b) moderate in influence for interactions or decisions affecting technology use at least once per marking period, but less frequently than once a week; and (c) low in influence for interactions that affected interactions or technology use no more than once per year.

A complete breakdown is shown in Table 8. Listed as having the highest degree of influence on the interactions or decisions affecting calculator use in 93% of the schools were the mathematics department teachers, followed by the mathematics department head in 65% of the schools, and the director of instruction or mathematics supervisor in 40% of the schools. The highest degree of influence on the interactions or decisions affecting computer use for 61% of the schools were the mathematics teachers, followed by the mathematics department heads at 40% of the schools, the director of instruction or mathematics supervisor for 30% of the schools, and including the principal as 24% of the schools.

Table 8.
Degree of Influence on Calculator and Computer Use

Group	High		Moderate		Low	
	Calculator	Computer	Calculator	Computer	Calculator	Computer
Division Superintendent or School Board	13	19	20	26	68	55
Director of Instruction or Math Supervisor	40	30	30	39	30	32
Building Principal or Administrators	12	24	44	38	44	39
Mathematics Department Head	65	40	27	41	7	19
Mathematics Department Teachers	93	61	7	28	0	12
Parents or Community Members	8	7	23	27	70	68

Note. Totals only sum to 100% across rows for like events. For example, the building principal's degree of influence was as rated high for 12% of the schools, moderate for 44% of the schools, and low for 44% of the schools. These totals reflect 100% of the reporting schools.

Subquestion 3C. Do teachers at the school have access to a full-time technology specialist (or similar professional) who provides training and support for teachers using calculators and computers in the classroom? If yes, how often have members of the mathematics department met with this person to discuss issues dealing with technology use?

For 43 of the 80 schools (54%), a technology specialist (or similar professional) is available to provide training and support for teachers using calculators and computers in the classroom. For five of these schools (6%), respondents noted that this was a new position within the system. Of the 43 schools listed as having a technology specialist, no response for frequency of meetings with members of the mathematics department was given for 14 of the schools (33%). Of those schools having a response for frequency of meetings, 12, or 28% of the 43 schools having a technology specialist, were listed as meeting once per semester. Table 9 contains more complete data for the frequency of meetings between mathematics teachers and the technology specialist.

Table 9.
Meetings between Mathematics Teachers and Technology Specialist

Frequency (Once per)	Number of Schools	% [a]
Day	1	2
Week	3	7
Month	2	5
Semester	12	28
Year	8	19
As Needed	3	7
No Response Given	14	33

Note. [a]Percentages are based on a total of 43 schools.

Subquestion 3D. Are Internet/World-Wide-Web access and electronic mail accounts available through the school for teacher use?

While neither of these are individuals or groups, they both may provide two-way access to the ideas and experiences of others for using calculators and computers in the mathematics classroom. Internet/World-Wide-Web access was reported as being available for teacher access in 60 of the schools (75%). This access was provided using a variety of methods. For 27 of the schools, or 34% of all schools, dial-up modems through a local internet provider service were used to provide access. Thirty-three of the schools (41%) had school networks with some form of high speed data lines. In 57 of these 60 schools (95%) teachers were encouraged to browse the internet to find lesson plans, examples of innovative ideas for technology use in mathematics classes, and other opportunities for professional growth.

Forty schools (50% of all schools) were reported as having electronic mail accounts available for teacher use. However, comments included indicated that many of these accounts were actually VaPEN accounts. The questionnaire did not provide data that determine if these are accounts furnished through the school, or VaPEN accounts that are accessible by teachers during the day while at school.

<u>Discussion for Question 3.</u> Teachers sharing experiences in using calculators and computers in the classroom may be one of the most influential methods of providing support. However, based on the results from the study, the members of an entire mathematics department do not meet very often to discuss issues involving technology. In just over 30% of the schools, the mathematics department members meet on a monthly basis to discuss the use of technology in the classroom. Another 30% meet at least once during the marking period for similar discussions.

Mathematics teachers and department heads were reported as being the most influential of groups who might have an impact on the use of calculators and computers in the classroom. Teachers are seen as having greater control over issues dealing with calculator use (93% of the schools) than those of computer use (61% of the schools.) Directors of instruction or mathematics supervisors were also credited as being influential in many of the schools within the study. The high incidence of influence on the use of calculators by mathematics teachers and department heads, coupled with regular meetings for discussions about calculator and computer use in the classroom occurring once a month or less, may raise concerns about how information is being gained and distributed among teachers using calculators and computers.

In over half of the schools included in this study, the teachers have access to a technology specialist, whose job responsibilities include providing training and support for teachers using calculators or computers in the classroom. In almost half of these schools, the teachers were listed as meeting with this individual once a semester or less. One third of the schools in which access to a technology specialist was available had no listing supplied for any type of meeting with the technology specialist.

Access to other ideas and influences that encourage calculator and computer use may be provided through the use of the Internet or electronic mail. In 60 of the schools surveyed, teachers are provided some type of access to the internet, and in 57 of these teachers are encouraged to browse the internet to find lesson plans, examples of innovative ideas for technology use, and other opportunities for professional growth using calculators and computers. Email is available to teachers in some fashion at half of the schools. Unfortunately, the questionnaire did not provide data for determining how much time teachers were actually involved in using the internet or email to enhance calculator and computer use in the classroom.

Results for Question 4. What level of familiarity do teachers have with documents in which increased use of technology in mathematics classes is advocated? What levels of influence on the actual use of technology in mathematics classes are assigned to these documents by teachers?

The documents rated for familiarity and influence included: (a) NCTM Curriculum and Evaluation Standards (1989), (b) NCTM Professional Standards for Teaching Mathematics (1991), (c) NCTM Assessment Standards for School Mathematics (1995), (d) Standards of Learning for Virginia Public Schools (1995), (e) Virginia Technology Standards for Instructional Personnel (1997), (f) Six-Year Educational Technology Plan for Virginia (1995), and (g) local school/ division technology plan. Three categories – high, moderate, and low – were used to measure the familiarity teachers had with these documents. The following scale was used for recording purposes: (a) Thoroughly reading the document one time or more was rated as high in familiarity; (b) having read most parts of the document, but not all, was rated as moderate in familiarity; and (c) hearing others speak of the document, or having know knowledge at all was rated as low in familiarity.

These same three categories – high, moderate, and low – were used to measure the degree of influence on technology use teachers assigned to these documents. The following scale was used for recording purposes: (a) Documents that influenced the use of technology on a weekly to daily basis were rated as high in influence; (b) those influencing the use of technology on a monthly basis, or at least once during the marking period, but not on a weekly basis were rated as moderate in influence; and (c) documents that rarely influence, or have no influence, on the use of technology were rated as low in influence.

From Table 10, close to 70% of the teachers hold a moderate level of familiarity with the three NCTM standards documents, while most of the others have a high level of familiarity. Slightly better than 80% of the teachers have a high level of familiarity with the Virginia Standards of Learning document. On average, 50% of the teachers have a moderate level of familiarity with the other three documents, while approximately 35% express the level of familiarity as low for these documents.

The levels of influence these documents hold for technology use follow similar patterns for the most part. Approximately 60% of the teachers rated the influence of the three NCTM standards documents as moderate. However, another 20% rated this influence as low. The influence of the Virginia Standards of Learning document was rated as high by over 90% of the teachers, with most of the remaining using a rating of moderate. Influence of the remaining documents was distributed, with an average of 20% of the teachers listing the influence as high, 43% as moderate, and 36% as low.

Table 10.
Familiarity and Influence of Documents in which Increased Technology Use is Advocated

Document	Rating (%)					
	High		Moderate		Low	
	Familiarity	Influence	Familiarity	Influence	Familiarity	Influence
NCTM Curriculum Standards	30	22	66	59	4	20
NCTM Professional Standards	23	13	70	62	8	16
NCTM Assessment Standards	26	14	69	61	7	25
Virginia's Standards of Learning	81	91	9	9	0	1
Technology Standards for Instr. Personnel	19	22	50	44	32	34
Six-Year Educational Technology Plan	6	16	49	39	46	46
Local Technology Plan	20	26	55	47	26	29

Note. Totals only sum to 100% across rows for like events. For example, the totals for familiarity for the NCTM Curriculum Standards are 30% for high, 66% for moderate, and 4% for low. These totals reflect 100% of the reporting schools.

Discussion for Question 4. Results from Question 3 indicate that for most of the schools, the teachers were ranked as having the greatest degree of influence on the use of calculators and computers. Results from that same question also indicate that teachers do not meet often as a department to discuss technology, nor do they frequently meet with the technology specialist when that person is available. Results from Question 2 indicate that teachers gain most of their learning experiences for using calculators and computers through self-training activities. This would seem to suggest that teachers are working in isolated conditions, and relying on their own judgement, as calculators and computers are being introduced into the classroom.

The documents from Question 4 may be categorized as those presenting a vision (the NCTM standards documents), those laying out standards of expectations and competencies (Virginia SOL and standards for instructional personnel documents), and those laying out specific paths for reaching technology goals for hardware and use (State and local technology plans.) Teachers working to bring technology use into the classroom might be expected to have some degree of familiarity with many of these documents. The only document recognized as being very familiar and having a great deal of influence on technology use by teachers in over 80% of the schools is the Standards of Learning for Virginia Public Schools. This should not be unexpected given the current emphasis being placed on satisfying SOL requirements so that students have a better chance of performing well on SOL end-of-course testing – these SOL tests make up a key component of the criteria used for school accreditation within the State of Virginia (Board of Education, 1997). NCTM documents and technology plans are reported by half to three/fourths of the schools as having moderate influence with moderate familiarity on the part of the teachers.

Results for Question 5. In which courses are calculators and computers used? How frequently are they being used? In what ways are they being used?

Subquestion 5A. In which courses are calculator and computer use permitted? In which courses are calculator and computer use required?

Displayed in Table 11 is a breakdown of permitted and required use of calculators and computers for those schools in which the specified courses are available. From the data in this table, almost all of the schools in which these courses are taught permit calculator use in the courses. The lone exception is in Computer Mathematics, for which only 20 schools (43%) were listed as permitting calculator use.

Of these schools in which calculator use is permitted, an increasing number were reported to require calculator use as students moved from lower-level mathematics courses to higher-level courses. Twenty-four schools (30%) were reported as requiring calculators for class use in Algebra I. The number of schools in which calculator use was required jumped to 43 for Algebra II (54%), 50 for Math Analysis (77%), and 63 for Calculus (83%). Geometry courses were listed with required use being reported at 16 schools (20%).

Computer use is permitted in over half of the schools. In over 70% of the schools, computer use is permitted for Algebra I (57 schools for 71%), Geometry (60 schools for 75%), Algebra II (58 schools for 73%), and Math Analysis (49 schools for 73%). Use is permitted in 51 schools for Calculus (67%). All 46 schools permit computer use in Computer Mathematics courses.

Table 11.
Schools Permitting/Requiring Calculator or Computer Use in Mathematics Courses

Course	Schools Permitting Use[a]				Schools Requiring Use[b]			
	Calculator		Computer		Calculator		Computer	
	#	%	#	%	#	%	#	%
Algebra I	80	100	57	71	24	30	0	0
Geometry	79	99	60	75	16	20	3	5
Algebra II	80	100	58	73	43	54	2	3
Math Analysis	65	97	49	73	50	77	3	6
Calculus	76	100	51	67	63	83	4	8
Discrete Mathematics	13	100	12	92	8	62	0	0
Probability & Statistics	27	96	16	57	19	70	3	19
Computer Mathematics	20	43	46	100	9	45	35	76

Note. [a]Percentages for schools permitting use are based on the total numbers of schools in which the courses are offered (see Table 3.) [b]Percentages for schools requiring use are based on the total numbers of schools in which use is permitted.

Of those schools in which computer use is permitted, Computer Mathematics is shown with required use in 35 schools (76% of those permitting use.) In a small number of schools, less than four for each course, computer use is required for Geometry, Algebra II, Math Analysis, Calculus, and Probability and Statistics.

Subquestion 5B. How frequently are calculators and computers being used in the classroom?

Three classifications – high, moderate, and low – were used to measure the frequency of use for calculators and computers in the classroom. The following scale was used for recording purposes: (a) Daily use of calculators and computers was rated as <u>high</u> use; (b) use which occurred consistently at least once a week, but not daily was rated as <u>moderate</u> use; and (c) use of calculators and computers less than three times per month (or never) was rated as <u>low</u> use.

Calculator use is a daily occurrence in well over 40% of the schools for the core *SOL* courses (see Table 12). Daily use of calculators is reported as increasing at many schools as students progress from the lower-level mathematics courses to the upper-level courses. Thirty-five of the schools (44%) having Algebra I are shown with calculator use on a daily basis. In 55 of the schools (69%) at which Algebra II is available, calculators are used on a daily basis, as is the case in 55 schools (82%) of the schools with Math Analysis. For 64 of the schools (84%) in which calculus is offered, calculators in this course are used on a daily basis. In three schools (7%), calculators are used on a daily basis in Computer Mathematics.

At the other end of the frequency of use are those schools in which calculators are rarely or never used. For thirty-five of the schools (76%) in which Computer Mathematics is offered, calculator use is rated as low. For all other courses, ten percent or fewer of the schools are listed as using the calculators less than three times per month or never.

Very few schools were reported as using computers on a daily basis for mathematics classes. The highest rating was that of Computer Mathematics, in which eight schools (17%) were reported as using computers daily. For all remaining courses, almost 70% of all schools in which these courses were available were reported as low in computer use – computers were used three times or less per month, or never, for classes in these schools. Moderate use of computers was reported across all classes in approximately 25% of the schools, with the exception of Computer Mathematics, in which 38 schools (83%) were reported as using computers at least once a week.

Table 12.
Frequency of Calculator and Computer Use

Course	High				Moderate				Low			
	Calculator		Computer		Calculator		Computer		Calculator		Computer	
	#	%	#	%	#	%	#	%	#	%	#	%
Algebra I	35	44	0	0	38	48	23	29	7	9	57	71
Geometry	30	38	0	0	42	53	25	31	8	10	55	69
Algebra II	55	69	0	0	22	28	26	33	3	4	54	68
Math Analysis	55	82	0	0	8	12	17	25	4	6	50	75
Calculus	64	84	0	0	10	13	18	24	2	3	58	76
Discrete Mathematics	9	69	0	0	4	31	3	23	0	0	10	77
Probability & Statistics	24	86	1	4	2	7	7	25	2	7	20	71
Computer Mathematics	3	7	8	17	8	17	38	83	35	76	0	0

Note. All percentages are based on the numbers of schools in which the courses are offered.

Subquestion 5C. On what assignments – homework, classwork, quizzes, and tests – are calculators and computers being used?

Table 13 may be used for determining the breakdown of calculator and computer use for assignments. For almost 80% of the schools and higher, calculators are being used for homework assignments, quizzes, and tests in Algebra I, Geometry, Algebra II, Math Analysis, Calculus, Discrete Mathematics, and Probability and Statistics. The percentage of schools in which calculators are being used for these courses increases to over 93% for use on classwork assignments. In approximately 25% of the schools, calculators are being used for all forms of assignments (i.e., homework, classwork, quizzes, and tests) in Computer Mathematics.

Computers are not reported as being used on these assignments by as many schools. In fewer than 20% of these schools, computers are used in Algebra I, Geometry, Algebra II, Math Analysis, Calculus, Discrete Mathematics, and Probability and Statistics for homework. The percentage of schools increases to about 35% for the reported use of computers on classwork assignments, but drops to less than 10% for quizzes and tests.

For assignments in all courses except Computer Mathematics, calculators were used to check work (78% and higher), perform calculations (90% and higher), explore relationships (60%) and higher, graph data or relationships (61% or higher), and solve application problems (67% or higher). In some schools, students also used calculators on assignments to develop math models (33% and higher) and develop programs (14% and higher.) In approximately 30% of the schools, students used calculators in Computer Mathematics to perform similar activities.

Similar usage of computers for assignments was reported less frequently. For all courses except Computer Mathematics, computers were used to check work (6% and higher), perform calculations (8% and higher), explore relationships (31%) and higher, graph data or relationships (28% or higher), and solve application problems (25% or higher). In some schools, students also used computers on assignments to develop math models (14% and higher) and develop programs (3% and higher.)

Table 13.
Assignments on Which Calculators and Computers are being Used

Course	Assignment															
	Homework				Classwork				Quizzes				Tests			
	Calculator		Computer		Calculator		Computer		Calculator		Computer		Calculator		Computer	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Algebra I	63	79	7	9	75	94	30	38	68	85	3	4	68	85	4	5
Geometry	64	80	11	14	75	94	32	40	69	86	3	4	69	86	3	4
Algebra II	71	89	8	10	78	98	29	36	75	94	4	5	76	95	4	5
Math Analysis	58	87	12	18	63	94	27	40	62	93	6	9	62	93	5	7
Calculus	69	91	9	12	74	97	23	30	73	96	4	5	73	96	4	5
Discrete Mathematics	10	77	0	0	13	100	6	46	11	85	0	0	11	85	0	0
Probability & Statistics	24	86	2	7	26	93	8	29	23	82	0	0	23	82	0	0
Computer Mathematics[a]	12	26	16	35	12	26	29	63	11	24	25	54	11	24	25	54

Note. All percentages are based on the numbers of schools in which the courses are offered. Categories are not unique – totals may sum to more than 100%. [a]Eleven of the schools in which computer use was reported had no response for assignment categories.

Discussion for Question 5. In almost all of the 80 schools included in this study, calculator use is permitted in the core SOL courses – Algebra I, Geometry, Algebra II, Math Analysis, Calculus, Discrete Mathematics, Probability and Statistics, and Computer Mathematics. Over half of these schools also are reported as permitting computer use in these same classes. As students progress through the Algebra I - Geometry - Algebra II - Math Analysis - Calculus sequence of courses, required calculator use occurs in more schools. Required for use in Algebra I for 30% of the schools, this steadily increases to required use for 83% of the schools offering Calculus.

Daily use of calculators in these classes is also reported in an increasing number of schools as students progress through the Algebra 1 - Calculus sequence. In Algebra I, daily use of calculators occurs in 44% of the schools. Daily use steadily increases through Calculus, in which calculators are used on a daily basis in 84% of the schools.

Calculators are being used in all types of assignments – homework, classwork, quizzes, and tests – in well over 80% of the schools. As the level of the course increases, the percentage of schools using calculators in these assignments also increases, reaching well into the upper 90s of percentage use.

Based on result from this study, the State of Virginia has supplied these schools with the bulk of the calculators, and that graphing calculators outnumber scientific calculators by about 13 to 1. The calculators provided by State funding were not available for use prior to December 1997. With such high levels of daily use being reported during the survey process – occurring during the months of January and February of 1998 – it must be assumed that either students supplied their own calculators, particularly graphing calculators, or that the few available classroom sets of calculators were frequently passed from teacher to teacher.

Computer use in mathematics courses does not approach the widespread use of calculators. Almost 70% of all schools were reported as having computer use of three times per month or less across all courses except Computer Mathematics. Given that computer labs are available for use by students during mathematics class in over 90% of the schools, and that over 70% of the schools averaged one computer per teacher for a room, it does not seem there is a lack of computer equipment. Lower levels of comfort for use, inability to schedule time in the computer labs, and lack of available software were a few of the reasons listed by the respondents for this seeming lack of computer use in mathematics classes.

<u>Results for Question 6</u>. In what ways do the instructional and assessment practices of teachers incorporate the uses of calculators and computer? What problems have been overcome (must be overcome) in order to achieve appropriate usage of calculators and computers? What successes have resulted from calculator and computer usage?

Unlike results for the previous questions, the data used for Question 6 come totally from free responses provided by the teachers on the survey. Consequently, the responses are less controlled and more diverse. Moreover, in some cases, the participants responded based on their positions as department heads. At other times, the results are representative of the respondents acting as teachers, or answering from the perspectives of teachers.

Not all participants responded to the questions on this portion of the survey. Of the 80 surveys, seven had no responses to this portion. Five of the respondents who chose to leave this section undone stated that they did not know enough to provide accurate answers, or that the time was not available to provide answers.

Subquestion 6A. In what ways do the instructional practices of teachers incorporate the use of calculators and computers?

For eleven of these department heads (14%), the teachers at their schools have modified their instructional practices to incorporate use of calculators simply by permitting the students to use calculators in class and on assignments. No indication was given that the teachers have made any other modifications to the nature of the curriculum or classroom activities.

Forty-four of the department heads (55%) indicated that calculators have been incorporated in ways designed to meet SOL standards. Frequently mentioned as uses designed to meet these standards were: performing computations, checking solutions, factoring, graphing, solving systems of equations, solving matrices, performing statistical analyses, solving application and concept problems, investigating and modeling, and exploration of concepts. Many of these also included responses that indicated that the use of calculators brought about more efficient use of class time, and helped shorten long, tedious processes.

A variety of responses came from the remaining questionnaires. Three (4%) indicated that overhead calculators were used for demonstrations and in leading lessons. Ten of the department heads (13%) indicated that calculator use was infrequent in Geometry courses, carefully controlled in Algebra I, but wide open in the Algebra II courses and beyond.

Computer use was incorporated at a much lower frequency, according to these survey respondents. Only 17 of the teachers (21%) included statements about computer use. Of these, six stated that computers were not used for any instructional practices. For those few having responses concerning computer use, computers were most frequently used to provide remediation or individualized instruction (used in six schools), drill and practice (three schools), or to explore relationships and develop conjectures or conclusions (three schools).

The use of spreadsheets was limited to teachers in preparing activities and keeping records. Similarly, word processing activities were limited to teachers preparing instructional activities or assessments. The only software mentioned by name was <u>The Geometer's Sketchpad</u> – used by students in three schools to explore relationships in Geometry.

Subquestion 6B. In what ways do the assessment practices of teachers incorporate the use of calculators and computers?

While three of the respondents (4%) indicated that calculators are not used in assessment activities, 25 of the survey respondents (31%) indicated that teachers do allow calculator use on a full range of assessment activities involving homework, classwork, quizzes, and tests. In four school, teachers develop tests containing two parts – one part is completed without the use of calculator and emphasizes basic skills, while the second part requires the use of a calculator and involves exploration and modeling. Several department heads indicated that the degree of use was left to the individual teachers, but typically, calculators were used in assessment activities more in upper level courses, such as Math Analysis and Calculus, rather than lower level courses, like Algebra I.

Very little mention was made of computer use for assessment activities. In only one school was widespread use of computers in assessment indicated, occurring in computer mathematics courses. Several respondents indicated that teachers used computers to calculate and record electronically the grades of their students.

Subquestion 6C. What problems have been overcome (must be overcome) in order to achieve appropriate usage of calculators and computers?

The number one response given as a problem dealt with lack of skills and knowledge on the part of the teachers. In 26 of the schools (33%), the department heads indicated that teachers were in need of professional development for areas of calculator and computer use such as: learning how to use calculators and computers, overcoming prejudice and bias against using calculators and computers, learning how to accept changes in the curriculum, learning how to change teaching strategies to allow technology use, and learning how to develop assessments that go beyond computation.

Ten respondents listed problems with the logistics of keeping track of the calculators – assigning calculators to students, providing students with calculators for use at school and home, charging or replacing dead batteries, and overcoming difficulties arising from student use of different types of calculators. Six department heads also mentioned past difficulties in the acquisition of calculators – schools were not able to provide the necessary numbers of calculators, forcing students to purchase calculators on their own. Also mentioned by one respondent was the need to have textbooks that included technology use.

Nine of the department heads responded that too much emphasis on calculator use resulted in students being unable to deal with basic skills. In particular, calculator use of students in elementary and early middle school years was cited as detrimental to development of basic skills.

Problems dealing with computers included: not having enough computers in the classrooms (14 schools), lack of access to the computer labs (12 schools), lack of available software (6 schools), and the unavailability of trained personnel in the lab or school to help with student and teacher use of computers. Three respondents indicated that the teachers at the schools could do a better job meeting SOL requirements using calculators rather than computers. Two department heads also noted lacking the time necessary to engage in computer activities.

Subquestion 6D. What successes have resulted from the usage of calculators and computers in mathematics classes?

Overwhelmingly, the successes recounted by the respondents centered on changes in student behaviors. Thirty-five of the department heads (44%) listed student successes through the use of calculators or computers. These successes included: greater levels of student interest, motivation, and excitement in working mathematics, higher levels of student confidence and greater self-esteem when using calculators, greater involvement in selecting and solving problems – especially real-life problems dealing with “weird” numbers, enhanced abilities and understanding of mathematics processes, and improved performance in test taking situations – including AP testing.

It was also noted by 16 department heads that teachers were able to spend more time on applications and concepts rather than computational skills, and that higher-level skills and concepts were more fully developed by using calculators and computers. With technology use, teachers reported being able to move through material more rapidly, increasing the amount of material that could be covered during the course. SOL requirements were listed as being easier to meet through the use of calculators and computers.

Discussion for Question 6.

For many of the schools, changes in instructional practices due to requirements from the Standards of Learning for Virginia Public Schools have brought about increased use of calculators – particularly graphing calculators. For teachers in these schools, calculators are still used for computation and checking solutions, but use has expanded well beyond these basics. These teachers are asking their students to use the calculators to explore mathematics in a multitude of ways, including: factoring, graphing, solving matrices and systems of equations, performing statistical analyses, solving application and concept problems, and modeling. While these activities are not new to high school mathematics, these teachers indicated that with the use of the calculator, students could cover more of this type of material in a shorter span of time.

Assessment practices are changing in that more teachers are allowing calculators to be used. In a limited number of schools, teachers are modifying assessments so that a portion of the assessment is done without the use of a calculator and is designed to test basic skills; the second portion is done using a calculator and involves exploration and modeling – aspects of higher order thinking skills. At this point, individual teachers, rather than entire mathematics departments, are seen as making the decisions affecting the degree to which calculators are allowed for assessment, as well as any changes necessary in the assessment activities.

Computer use, in either instructional or assessment practices, remains limited. When used, computers were typically involved with remediation, drill and practice, and individualized student activities. A few schools were listed as using computers to allow students to explore relationships and develop conjectures or conclusions.

Problems to be overcome before appropriate use of calculators and computers can be achieved included lack of calculators and computers. Based on results from this study, lack of graphing calculators should no longer present as much of a problem. Computers are likewise available, but not in sufficient quantities within the classroom. Computer labs are available, but competition for use with teachers from other disciplines may make it difficult to schedule computer lab time for mathematics courses. In addition, the school computer lab may not have much specialized mathematics software available.

Problems to be overcome also included those of professional development for teachers in using calculators and computers. Department heads reported that some teachers simply do not see the need for change and are resistant to incorporating different strategies for using technology. Some do not know how to use calculators and computers, and need help learning basic functions. Yet another problem deals with changes to the curriculum – department heads report that teachers need to learn how to alter the curriculum to implement calculator and computer use, as well as the strategies they would use for instruction and assessment.

Regardless of the problems, the successes as listed by the department heads would seem to make the transition to calculator and computer use worthwhile. Department heads indicating success in incorporating technology in math classes report encouraging changes taking place in student behavior and achievement: (a) Students are more excited working with mathematics when using calculators and computers; (b) student achievement increases, allowing students with weaker skills in computation and manipulation to explore concepts that were previously difficult due to the level of computation, and allowing other students to move through challenging material at a faster pace while developing greater understanding; (c) increased levels of motivation, confidence, and self-esteem occur for students working with calculators and computers in mathematics. Students are also able to explore a wider range of problems, including more real-life problems, when calculators and computers are used.

Summary Discussion

In addition to the answers for the original research questions, three primary findings result from this study: (1) Through funding provided by the State of Virginia, adequate quantities of graphing calculators and computers exist for use by students in mathematics classes; (2) the widespread use of graphing calculators in the classroom is being driven by the Standards of Learning for Virginia Public Schools; computer use is more limited, despite the availability of computers in classroom and lab settings; and (3) teachers are reported as wanting more professional development activities designed for incorporating calculator and computer use into the classroom, but have taken only limited advantage of existing opportunities, preferring to use self-training and school or division in-service activities to satisfy their needs.

Previous studies have reported that lack of funding keeps schools from providing technology resources for students to use (Honey & Henriquez, 1993; OTA, 1995; Sheingold & Hadley, 1990). However, recent funding provided by the State of Virginia has allowed all 80 of these schools to purchase large quantities of graphing calculators – enough that an average of 66 graphing calculators per teacher exists; at the least a number sufficient for a classroom set for each teacher with additional calculators available to be used by limited numbers of students outside of class. Widespread use of graphing calculators for homework, classwork, quizzes, and tests was reported by all schools in all SOL courses except Computer Mathematics.

Funding for the purchases of computers has also been provided by the State during recent years. With this funding, computers are available in mathematics classrooms for over 70% of the schools – typically one computer per room. At least one computer lab, available for use during mathematics classes, was reported in over 90% of the schools. However, actual use of computers for mathematics classes was reported as very limited in over 70% of the schools. This is in keeping with findings reported by Honey and Henriquez (1993) and the Office of Technology Assessment (1995), in which computer use was reported as limited, even when access was available.

Scientific calculators, purchased using local funds, were not widely available. Fewer than 3,500 scientific calculators are available in only 41 of the schools. Without funding from the State, individual schools did not rush to purchase large quantities of scientific calculators, even though these calculators are inexpensive and have been readily available for the past decade.

The widespread use of the graphing calculator comes about as a result of teachers working to meet requirements established by the Standards of Learning for Virginia Public Schools (1995). Owens and Waxman (1995) suggest that technology may be the catalyst for change in mathematics education. But in this case, the catalyst for change is the Standards of Learning document. In over 90% of the schools, teachers are reported as being very familiar with this document, and credit it with a high degree of influence on the use of technology – especially graphing calculators – in the mathematics classroom.

Other documents, such as the NCTM Standards documents (1989, 1991, 1995) are credited with moderate degrees of familiarity and influence on technology use by teachers in approximately 60% of the schools. The impact of these is not as widespread as that of the Virginia SOLs. Not as many teachers are reported as making changes in instructional and assessment practices as suggested in either the NCTM Curriculum and Evaluation Standards for School Mathematics (1989) or the Assessment Standards for School Mathematics (1995).

However, teachers do report that students who use calculators and computers in mathematics classes exhibit positive changes in attitudes towards mathematics and performance on assignments. This has previously been reported by Honey and Henriquez (1993) and Sheingold and Hadley (1990) for use of computers in the classroom. Results from this current study indicate that in over 40% of the schools, higher levels of interest and excitement were noted for students using graphing calculators or computers on assignments. Students were described by mathematics department heads as being more confident of their abilities to perform assignments when using calculators or computers, and exhibiting improved performances on assessments.

Teachers are reported as having the highest degree of influence over the use of calculators (in 93% of the schools) and computers (in 61% of the schools) in the classroom. However, department heads at over 30% of the schools indicated that teachers were in need of professional development for incorporating technology into the classroom. This is in keeping with findings by Becker (1992) and the Office of Technology Assessment (1995) in which a majority of teachers reported insufficient training to adequately use computer equipment and software.

According to Hache (1997), teachers who are interested in technology will find ways to obtain the development activities they require. During the past eight years, almost 80% of the schools reported having at least one teacher participate in professional development activities for incorporating technology in the classroom. But the total number of hours reported sums to 32,790, or six hours per teacher per year, for calculator training activities and 23,068 hours, or four hours per teacher per year, for computer training activities. In both cases the bulk of these activities are listed as resulting from self-training activities.

Professional development activities have more lasting effects when collegial support is available (Adajian, 1996). One way of increasing the value of self-training activities is through departmental meetings in which issues of technology are discussed. However, such meetings are not occurring frequently. At 31% of the schools teachers were reported as meeting no more than once a month to discuss technology use in the classroom. For 34% of the schools, the teachers meet no more than once per marking period to discuss technology use.

The State of Virginia is attempting to provide greater opportunities and incentives for professional development. The newly approved Technology Standards for Instructional Personnel (1997) require teachers to acquire and demonstrate competencies in the use of computer technology. The State has also begun training sessions for local technology specialists who will in turn act to develop the skills of teachers at a local level (White, 1998). But in those schools that currently have a technology specialist, no response for the frequency of meetings between this person and members of the mathematics department was given for 14 of the schools, while 12 of the schools were listed as meeting with the technology specialist once per semester in order to discuss professional development activities using calculators or computers.

Graphing calculators and computers are in place. A mandate for technology use in mathematics classes exists through the Standards of Learning for Virginia Public Schools (1995). But teachers need to participate more frequently in professional development activities, and work together to build better lines of communication for sharing ideas about using technology in the classroom.

Chapter 5

Conclusions

This chapter contains a review of the goals of the study and conclusions based on the results of this study. Recommendations for future studies are proposed. Also included is a section detailing lessons learned during the process of conducting the study.

The goals for this study were to investigate the availability and distribution of calculators and computers, and the ways in which these are being used in mathematics classes of public high schools across the State of Virginia. The study also examined elements that provide direction, influence, support, or encouragement for teachers in the use of calculators and computers in the mathematics classroom.

Based on the results of this study, the following conclusions are offered:

Conclusion 1. Through funding provided by the State of Virginia, adequate quantities of graphing calculators and computers exist for use by students in mathematics classes. Results show that prior to State funding for purchasing graphing calculators, only 3300 scientific calculators (averaging about five per teacher) and 5494 graphing calculators (averaging about eight per teacher) had been purchased by these schools. State funding increased the number of available graphing calculators by over 600 %.

Conclusion 2. The widespread use of graphing calculators in the classroom is being driven by the Standards of Learning for Virginia Public Schools; computer use is more limited, despite the availability of computers in classroom and lab settings. Teachers use of calculators in the mathematics classroom is cited most often as providing ways to satisfy SOL requirements. Without this incentive, many teachers would not be using calculators in the classroom, citing refusal to change teaching methods, beliefs that calculators do not enhance the learning processes, and uncertainties over the place of calculators in the classroom as primary reasons for lack of use. Teachers are not using computers in instructional or assessment strategies to any great degree, often citing lack of accessibility, lack of appropriate software, or the belief that SOL requirements are more easily satisfied using graphing calculators.

Conclusion 3. Teachers are reported as wanting more professional development activities designed for incorporating calculator and computer use into the classroom, but have taken only limited advantage of existing opportunities, preferring to use self-training and school or division in-service activities to satisfy their needs. Overall, teachers are averaging around six hours per year for professional development activities involving calculators and four hours per year for professional development activities involving computers. While teachers indicated that they recognize the need for greater professional development in using technology in the classroom, they rarely take advantage of existing opportunities, often citing time as the limiting factor preventing them from participating.

Recommendations

Based on the conclusions from this study, the following recommendations are suggested as potential areas for further research in the use of calculators and computers in high school mathematics classes:

1. A study be conducted into the long term purchasing activities and plans of schools concerning calculators and computers. The majority of the schools in this study have obtained the bulk of their calculators and computers through State funding using technology initiatives. As these calculators and computers age and become less capable of meeting requirements, the burden of replacement falls on the schools. However, it has been shown that schools are not able or are unwilling to engage in large scale purchases – thus the interest in determining now how these schools expect to provide replacement equipment.

2. A study be conducted to determine the types of professional development activities in which high school mathematics teachers would participate willingly in order to gain information about calculator and computer use, learn strategies for incorporating calculator and computer use into instructional and assessment activities, and develop a network of communication with other mathematics teachers through traditional communication methods, as well as the use of Internet services such as the World-Wide-Web and electronic mail.

Lessons Learned

I believe that the greatest lesson from this process is that research can be difficult, time consuming, and frustrating. However, the results that emerge as the pieces begin to fall into place make it worthwhile, and even exciting.

Since hindsight is so much better than foresight, especially for the novice researcher, there are several things that I would have approached differently. First, in my zeal to find out everything about calculator and computer use, I ended up gathering more data than I could possibly use. But not all of the data was meaningful. Questions concerning specific use of software by category ended up having little or no value in the actual data analysis. On the whole, the closed-response format provided sufficient data for analysis, and was easy to categorize and tally. But some of the questions required the participant to either respond based on his or her observations of others, or seek out other teachers in order to determine appropriate answers. For questions of this type, a few mathematics department heads (no more than seven) did not respond – citing an inability to answer for other teachers or a lack of time to gather proper responses. By being a bit more focused, I could have reduced the length of the questionnaire, phrased questions so that the mathematics department heads did not have to rely on others for responses, and perhaps achieved a greater rate of response.

Second, I would have notified the principals of the high schools about the study and probably would have sent the questionnaire directly to them to be distributed to the mathematics department head. Even though the teacher part of me denies this, I got a much better response rate after sending a letter to the principals asking for their aid in encouraging participation from their mathematics department heads.

Third, the use of closed-response questions provided easy choices from which the respondents could select the most appropriate answer. But the open-response questions provided much richer data with which to work – subject, of course, to greater misinterpretation on my part.

Finally, I had hoped to include and interview portion in this study. That did not come about due to lack of interest on the part of the participants (I cannot blame them for that – I am not certain I would want to commit to an interview after having completed a lengthy questionnaire), and a general lack of time while working with this study. But I think that the interview process would have added to the depth of the study, and provided greater insight into areas of professional development and other influences affecting technology use in mathematics classes.

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Appendix A

Teacher Survey Packet

Cover Letter to Teachers
Detail Letter to Teachers
Completion/Consent Form
Survey Booklet

January 3, 1998

Mathematics Department Head
Virginia Public High School
Mailing Address
City, VA 00000-0000

To the Mathematics Department Head:

Please offer your expertise in completing the accompanying survey on the availability and uses of technology in public high school mathematics classes in the State of Virginia. While the study will be valuable in providing data which will describe the current state of technology use, it is even more important to me personally. I am working with this study as part of my doctoral program at Virginia Tech in the College of Human Resources and Education. The results of this study will constitute the bulk of my field research, and I would like for this to be as complete as possible. I am unable to offer to you any form of compensation, but I will gladly share the results of this survey with you if you wish. Thanks in advance for your help!

In this packet, you should find two letters, the survey booklet, a completion/consent form, a white regular envelope, and a small, clasp mailing envelope. Please take a moment to read the other letter, as it provides greater detail for background information. Don't be put off by the size of the survey booklet. It looks "longer" than it really is. When you have completed the survey, place it into the clasp mailing envelope and send it to me. Please take a moment to fill out the included completion/consent form, place it into the white, regular envelope and send it off -- this will let me know that you have completed and mailed the survey. Since the survey has no identifying marks on it, returning this completion/consent form is the only method I have of keeping track of which high schools have responded.

As with most surveys, confusion may arise from the ways in which questions are worded or instructions are written. In particular, number 17 in the booklet has instructions to use a number rating, but the table shows to mark cells using a check mark. Please use the number rating. Numbers 10-11, 16-17, and 24-27 are meant to be used to represent the views of all members of your mathematics department. I know these may be difficult to obtain, but would ask that you do your best to provide an accurate representation of the views of your department members.

Let me stress that participation in this study is completely voluntary. The results will not include your name, the name of your school, or the name of your school division. There is no code on the survey to link the survey to your school.

Time permitting, I am planning on conducting a series of interview sessions after the surveys have been collected and analyzed. These sessions will be brief, and will emphasize the uses of technology in your classroom, benefits and concerns arising from the uses of technology, and changes which have occurred in your instructional and assessment practices as a result of using technology. Again, participation is totally voluntary. No recording of any type will be made during the interview session, and only handwritten notes will be taken during any sessions.

As a former mathematics department head, I know that you do not have much free time. Thank you for taking the time to complete this survey. If you have any questions, please contact me.

Thank you!

Jack Donald

January 3, 1998

Mathematics Department Head
Virginia Public High School
Mailing Address
City, VA 00000-0000

To the Mathematics Department Head:

Rockbridge County Schools, in conjunction with Virginia Tech, will be conducting a survey concerning the use of technology in public high school mathematics classes in the State of Virginia. The purpose of this study is to gather descriptive data on the availability and uses of calculators and computers in high school mathematics classes which would represent a "snapshot" in time. This data will be available to the State of Virginia and all school divisions to aid future planning. The survey consists ofa self-administered mail survey, and (time permitting) a voluntary interview session, targeting the mathematics department heads from all the public high schools within participating divisions.

Permission for your school to participate in this survey has been granted by your division superintendent. We are asking that you take the time to complete the mail portion of this survey and return it as soon as possible. Under pilot testing conditions, all participants finished the survey in under 20 minutes. As former teachers ourselves, we know that your time is limited and valuable. However, it is our belief that you are the most knowledgeable person to contact for providing the information we are seeking. Please remember that the data being gathered concerns your entire mathematics department.

We stress that the results from this survey will not be used for any type of comparisons of technology use among specific school divisions or individual high schools. In fact, the survey questionnaire is not coded in any fashion and asks for no information which would allow it to be associated with any specific high school. However, we do expect the results to be useful in establishing a base-line reference point -- important at this time due to the increased emphasis on technology use as expressed in Virginia's *Standards of Learning*, *Technology Standards for Instructional Personnel*, and *Six Year Education Technology Plan for Virginia*. The survey is being conducted under guidelines established by Virginia Tech. Your participation is strictly voluntary. Confidentiality is guaranteed. Results of the survey will be shared with all interested parties, and we will be happy to make the results available for you.

For most questions on this survey, you should circle the single response that is most accurate. Some questions have more than one possible response, and include instructions to "Circle all that apply." A few questions require completion of tables, either by assigning a number value or by marking the appropriate cells. Some open-ended free response questions have been included concerning changes to your instructional and assessment practices due to technology use, as well as problems which have been encountered, and successes which have resulted due to availability and use of technology.

Please place the completed survey into the clasp mailing envelope provided. At this time, also complete the included return-letter which signifies that you have completed and mailed the survey. This return-letter should not be included in the clasp mailing envelope, but should be placed in the white regular envelope and mailed separately. Completion records will be based on postcards received since no codes are included in the survey. Please note that the return-letter also includes a consent form for indicating your interest in participating in interview sessions -- if you have more to share concerning technology use in mathematics education, please check the appropriate boxes.

Thank you for your time and consideration of this activity. If you have any questions, or need any additional information, please contact one of us.

Sincerely,

Dr. Glen H. Stark	Dr. Sue G. Magliaro	Jack Donald
Superintendent,	Dept. of Teaching & Learning	Technology Specialist,
Rockbridge Co. Schools	Virginia Tech	Rockbridge Co. Schools

Completion of Survey

0 The completed survey was mailed on ____.

0 Please send me a copy of the completed survey results.

Name: ____
Virginia Public High School
Mailing Address
City, VA 00000-0000

Consent Form for Interview Session

0 I am not interested in participating in an interview session.

0 I am interested in participating in an interview session. My preferences for the interview format to be used are:

__________ Face - to - face Interview Session

__________ Telephone Session -- Phone Number: ____________________

Time to Call: ______________________

__________ Email Session -- Address: ______________________________

Please use 1 for your first choice, 2 for your second, and 3 for your third choice of formats.

By agreeing to participate in this interview session, I am aware of and accept the following:

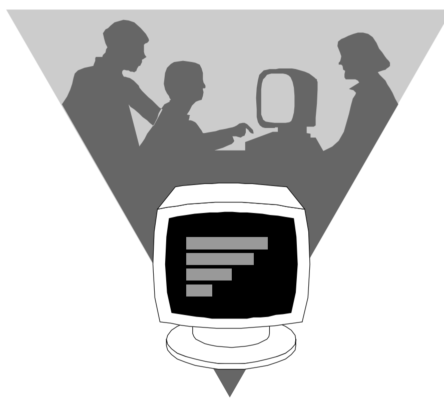
1. The interview sessions will emphasize the uses of technology in my classroom, benefits and concerns arising from the uses of technology, and changes which have occurred in my instructional and assessment practices as a result of using technology.
2. Due to time constraints, not every interview volunteer may be selected to participate.
3. A set of interview questions will be sent to me prior to the interview. However, I acknowledge that other topics may be explored as a result of my answers.
4. No permanent record such as video- or audio-taping will be done of my interview session. Only handwritten notes will be taken during all audio (face-to-face and telephone) sessions. Interview notes will be coded by number. The participant's name and associated code number will kept separated from the coded interview notes. The primary researcher will do the coding of names and interview notes. All other researchers will see only the coded interview notes.
5. No risks are expected to be associated with this interview. My name will not be used in any statement of results, and my high school and school division will not be identified by name. At no time will the results of my interview be released to anyone other than individuals from Rockbridge County Schools and Virginia Tech working on this project without my written consent.
6. No compensation will be provided for participation in this interview.
7. I am aware that I may receive a copy of the survey results.
8. I am free to withdraw from this interview session at any time. I may choose not to answer any of the interview questions.
9. This study is being conducted under guidelines established by the Institutional Review Board for Research Involving Human Subjects of Virginia Tech.

I voluntarily agree to be a potential participant in this study.

________________________________ ________________________________

Signature of Individual Printed Name of Individual

Technology in Mathematics Education



A Survey of the Availability and Uses of Calculators and Computers in Public High School Mathematics Classes in Virginia

Mathematics Department Head:

Rockbridge County Schools, in conjunction with Virginia Tech, is conducting a survey concerning the use of technology in public high school mathematics classes across the State of Virginia. The purpose of this study is to gather descriptive data on the availability and uses of calculators and computers in high school mathematics classes which would represent a “snapshot in time”. This data will be available to the State of Virginia and all school divisions to aid in future planning. The survey consists of a self-administered mail survey, and (time permitting) a voluntary interview session, targeting high school mathematics department heads from public high schools across Virginia.

Permission for you to participate in this survey has been granted by your division superintendent. We ask that you take the time to complete the mail portion of this survey and return it as soon as possible. Under pilot testing conditions, all teachers finished the survey in less than 20 minutes. As a former mathematics teacher and department head, I know that your time is limited and valuable. However, it is our belief that you are the most knowledgeable person to contact for providing the information we are seeking. Please remember that the data being gathered concerns your entire mathematics department.

We stress that the results from this survey will not be used for any type of comparisons of technology use among individual high schools. In fact, the survey questionnaire is not coded in any fashion and asks for no information which would allow it to be traced to a given high school. The survey is being conducted under guidelines established by Virginia Tech. Your participation is strictly voluntary. Confidentiality is guaranteed. Results of this survey will be shared with all interested parties, and we will be happy to make the results available for you.

For most questions on this survey, you should circle the single response that is most accurate. Some questions have more than one possible response and include instructions to “Circle all that apply.” A few questions require completion of tables, either by assigning a number value or by marking the appropriate cells. The category “Other” may be used when the responses provided don’t match your situation — please provide a brief description of what “Other” means by completing the “Specify” blank. Some open-ended, free-response questions have been included concerning changes to your instructional and assessment practices due to technology use, as well as problems which have been encountered and successes which have resulted due to availability and use of technology.

Please place the completed survey into the mailing envelope provided. An address sticker should already be attached to the envelope. However, if this is missing, please mail the completed survey to:

Jack Donald
Technology Specialist
Rockbridge County Schools
417 Morningside Drive
Lexington, VA 24450

I would also ask that you mail the included postcard which signifies that you have completed the survey.

PART ONE -- ABOUT YOU AND YOUR SCHOOL

1. Including yourself, how many full-time high school mathematics teachers are at your school?

   ___________ Full-Time High School Mathematics Teachers

2. How often do members of the mathematics department meet to discuss technology use in math classes?

   At least once per week 1
   At least once per month 2
   At least once per marking period 3
   At least once per year................................ 4
   Never.. 5
   Other 6
   SPECIFY:__________________________

3. How many students attend your high school?

   500 or fewer... 1
   501 - 750 2
   751 - 1000 3
   1001 - 1250 4
   1251 - 2000 5
   Over 2000... 6

4. What is the setting for your high school?

   Urban 1
   Suburban 2
   Rural 3
   Other 4
   SPECIFY:__________________________

5. How many sections of each of the following high school mathematics courses are available during this current school year?

	Math Courses Available									
	Algebra I	Geometry	Algebra II	Math Analysis	Calculus	Discrete Mathematics	Probability & Statistics	Computer Mathematics	Other 1:	Other 2:
Number of Sections Available										

PART TWO -- USING TECHNOLOGY
Calculators

6. Approximately how many scientific and graphing calculators does your school currently have available for student use in high school mathematics classes?

Type	**Number Available**	**Most Common Brands**	**Most Common Models**
Scientific Calculators			
Graphing Calculators			

7. Approximately how many graphing calculators are being provided to your school this year as a result of the State of Virginia's *Technology Initiative for Graphing Calculators and Scientific Probes*? (If no calculators are being provided, please leave both tables blank.)

Already Received 1

Number of Calculators	**Date Received**	**Brand(s)**	**Model(s)**

Not Yet Received, but Expected 2

Number of Calculators	**Date Expected**	**Brand(s)**	**Model(s)**

8. Are overhead calculators (graphing or scientific) available for the math teachers in your department to use during the high school mathematics classes?

No 1
WHY?_____________________________
____
Yes 2
Other 3
SPECIFY:__________________________

9. Please complete the following table by marking all cells which apply for ***calculator use*** in the specified high school mathematics courses at your school. Use a check mark (4) to mark the appropriate cells. If two or more teachers are teaching the same courses, and have different requirements for ***calculator use***, please use different color inks to differentiate between teachers.

	Math Courses Available									
Calculator Use	Algebra I	Geometry	Algebra II	Math Analysis	Calculus	Discrete Mathematics	Probability & Statistics	Computer Mathematics	Other 1:	Other 2:
Please Mark the Appropriate Cells with a Check Mark (4)										
Calculator Use in Class 1. Not Allowed 2. Permitted 3. Encouraged 4. Required										
Type of Calculator Used 1. Scientific Only 2. Graphing Only 3. Either										
Calculators Used on: 1. Homework 2. Classwork 3. Quizzes 4. Tests										
Frequency of Calculator Use in Class: 1. Never 2. Rarely (1 to 3 times/month) 3. Infrequently (once/week) 4. Frequently (2 to 3 times/week) 5. Used Daily										
Calculators Used to: 1. Check Work 2. Perform Calculations 3. Explore Relationships 4. Graph Data & Relationships 5. Develop Math Models 6. Solve Application Problems 7. Develop Programs										
Calculators Supplied by: 1. School 2. Students										

10. Please describe the degree of influence held by each individual or group on determining appropriate uses for ***calculators*** in all high school mathematics courses at your school. Use different color inks to differentiate between teachers.

    5 Extremely Influential -- Involved daily
    4 Very Influential -- Involved once or twice per week
    3 Influential -- Involved once or twice per month
    2 Somewhat Influential -- Involved once or twice per marking period
    1 Barely Influential -- Involved once or twice per year
    0 Not Influential at All -- Has no influence on the use of calculators

Name of Individual/Group	**Degree of Influence (0 - 5)**
Division Superintendent/School Board	
Director of Instruction/Math Supervisor	
Building Principal/Administrators	
Math Department Head	
Math Department Teachers	
Parents/Community Committee	
Other:	

Computers

11. Please describe the degree of influence held by each individual or group on determining appropriate uses for ***computers*** in all high school mathematics classes at your school. Use different color inks to differentiate between teachers.

    5 Extremely Influential -- Involved daily
    4 Very Influential -- Involved once or twice per week
    3 Influential -- Involved once or twice per month
    2 Somewhat Influential -- Involved once or twice per marking period
    1 Barely Influential -- Involved once or twice per year
    0 Not Influential at All -- Has no influence on the use of computers

Name of Individual/Group	**Degree of Influence (0 - 5)**
Division Superintendent/School Board	
Director of Instruction/Math Supervisor	
Building Principal/Administrators	
Math Department Head	
Math Department Teachers	
Parents/Community Committee	
Other:	

12. Approximately how many computers does your school have available for use by students in high school mathematics classes?

Location	Number Available	Most Common Brands	Most Common Models
Math Classrooms	Total: ____ Average per room:		
Computer Labs	Number of labs: ____ Average per lab:		

13. Are computers with large screen displays (TV monitors, LCD panels, projection monitors, etc.) available for the mathematics teachers in your department to use during mathematics classes?

No 1
WHY?____________________________
____
Yes 2
Other 3
....SPECIFY: ___________________________

14. Do your mathematics students have Internet/World-Wide-Web access within the school?

No.. 1
Yes 2
CIRCLE CONNECTIONS: MODEM / SCHOOL NETWORK / LOCAL INTERNET PROVIDER
Other 3
....SPECIFY: ___________________________

15. Do your mathematics students have electronic mail (e-mail) accounts provided by the school?

No 1
Yes 2
Other 3
SPECIFY:__________________________

16. Please complete the following table by marking all cells which apply for ***computer use*** in the specified high school mathematics courses at your school. Use a check mark (4) to mark the appropriate cells. If two or more teachers are teaching the same courses, and have different requirements for ***computer use***, please use different color inks to differentiate between teachers.

	Math Courses Available									
Computer Use	Algebra I	Geometry	Algebra II	Math Analysis	Calculus	Discrete Mathematics	Probability & Statistics	Computer Mathematics	Other 1:	Other 2:
Please Mark the Appropriate Cells with a Check Mark (4)										
Computer Use in Class 1. Not Allowed 2. Permitted 3. Encouraged 4. Required										
Computers Used on: 1. Homework 2. Classwork 3. Quizzes 4. Tests										
Frequency of Computer Use in Class: 1. Never 2. Rarely (1 to 3 times/month) 3. Infrequently (once/week) 4. Frequently (2 to 3 times/week) 5. Used Daily										
Computers Used to: 1. Check Work 2. Perform Calculations 3. Explore Relationships 4. Graph Data & Relationships 5. Develop Math Models 6. Solve Application Problems 7. Develop Programs										

17. Please indicate the average frequency of use for all high school mathematics classes or projects of the following software categories. If two or more teachers are teaching the same courses, and have different frequencies of use, please use different color inks to differentiate between teachers.
    Use the ratings:

    4 Used Daily
    3 Frequently (2 to 3 times per week)
    2 Infrequently (once per week)
    1 Rarely (1 to 3 times per month)
    0 Never Used (or leave BLANK)

	Math Courses Available									
Software Use	Algebra I	Geometry	Algebra II	Math Analysis	Calculus	Discrete Mathematics	Probability & Statistics	Computer Mathematics	Other 1:	Other 2:
Please Mark the Appropriate Cells with a Check Mark (4)										
General Productivity										
1. Word Processing										
2. Spreadsheet										
3. Data Base Management										
4. Authoring										
5. Presentation										
Internet/World-Wide-Web										
1. Browsing										
2. Newsgroups/Use-Lists										
3. Email										
4. File Transfer										
Math Specific Software Used to:										
1. Perform Drill & Practice										
2. Provide Tutorial/Remediation										
3. Perform Calculations										
4. Explore Relationships										
5. Graph Data										
6. Develop Math Models										
7. Solve Application Problems										
8. Develop Programs										

Technology and the Teachers

18. Does your school provide mathematics teachers with scientific calculators to use during the school year?

    No 1
    Yes 2
    TYPE: ______________________________
    Other 3
    SPECIFY: ___________________________

19. Does your school provide mathematics teachers with graphing calculators to use during the school year?

    No 1
    Yes 2
    TYPE: ______________________________
    Other 3
    SPECIFY: ___________________________

20. Does your school provide mathematics teachers with computers to use during the school year?

    No 1
    Yes 2
    TYPE: ______________________________
    Other 3
    SPECIFY: ___________________________

21. Does your school encourage mathematics teachers to browse the Internet / World-Wide-Web or Virginia's Public Education Network (VAPEN)?

    No 1
    Yes 2
    PURPOSE: ___________________________
    ____
    ____
    ____
    ____
    Other 3
    SPECIFY: ___________________________

22. Does your school provide mathematics teachers with electronic mail (email) accounts?

    No 1
    Yes 2
    Other 3
    SPECIFY: ___________________________

PART THREE -- PROFESSIONAL DEVELOPMENT FOR USING TECHNOLOGY

23. Does your school division have a full-time technology specialist whose responsibilities include training teachers in using calculators and computers in the classroom?

No 1
Yes 2
HOW OFTEN THIS YEAR HAVE MATH TEACHERS MET WITH THIS PERSON (ALONE OR IN GROUPS)?
____
Other 3
SPECIFY:___________________________

24. Within the mathematics department, which types of ***calculator training*** have the mathematics teachers taken advantage of during the past eight years? Please use a check mark (**4**) to represent <u>involvement</u> for each teacher. The <u>total hours</u> should represent an approximate cumulative total for all the mathematics teachers in your mathematics department.

Type of Calculator Training	Teacher Involvement	Total Hours
Self-Training		
School Sponsored In-Service		
Division Sponsored In-Service		
Conference Presentations		
Formal College Coursework		
Summer Institute (T^3, AP, etc.)		
Other (Please Specify):		

25. Within the mathematics department, which types of ***computer training*** have the mathematics teachers taken advantage of during the past eight years? Please use a check mark (**4**) to represent <u>involvement</u> for each teacher. The <u>total hours</u> should represent an approximate cumulative total for all the mathematics teachers in your mathematics department.

Type of Computer Training	Teacher Involvement	Total Hours
Self-Training		
School Sponsored In-Service		
Division Sponsored In-Service		
Conference Presentations		
Formal College Coursework		
Summer Institute (T^3, AP, etc.)		
Other (Please Specify):		

PART FOUR --USING THE STANDARDS

26. Use the following values to express the overall degree of familiarity of the members of your mathematics department with the documents listed. Use different color inks to differentiate between teachers.

5 Extremely Familiar -- Have read the document many times
4 Very Familiar -- Have thoroughly read the document once
3 Familiar -- Have read most parts of the document
2 Somewhat Familiar -- Have read some parts of the document
1 Barely Familiar -- Have heard others speak of the document
0 Not Familiar at All -- Have no knowledge of the document

Name of Document	Degree of Familiarity (0 - 5)
NCTM Curriculum and Evaluation Standards for School Mathematics	
NCTM Professional Standards for Teaching Mathematics	
NCTM Assessment Standards for School Mathematics	
Standards of Learning for Virginia Public Schools	
Technology Standards for Instructional Personnel	
Six-Year Educational Technology Plan for Virginia	
Your Local School Division Technology Plan	

27. Use the following values to express the overall degree of influence which the documents listed below exert on technology use on all high school mathematics courses at your school. Use different color inks to differentiate between teachers.

5 Extremely Influential-- Influences the use of technology on a daily basis
4 Very Influential -- Influences the use of technology on at least a weekly basis
3 Influential -- Influences use of technology on at least a monthly basis
2 Somewhat Influential -- Influences use of technology on an infrequent basis
1 Barely Influential -- Rarely influences the use of technology
0 Not Influential at All -- Has no influence on the use of technology

Name of Document	Degree of Influence (0 - 5)
NCTM Curriculum and Evaluation Standards for School Mathematics	
NCTM Professional Standards for Teaching Mathematics	
NCTM Assessment Standards for School Mathematics	
Standards of Learning for Virginia Public Schools	
Technology Standards for Instructional Personnel	
Six-Year Educational Technology Plan for Virginia	
Your Local School Division Technology Plan	

PART FIVE -- TECHNOLOGY USE AND INSTRUCTIONAL PRACTICES

28. Briefly describe the ways in which the <u>instructional practices</u> of the mathematics teachers in your school incorporate the use of calculators and computers.

29. Briefly describe the ways in which the <u>assessment activities</u> of the mathematics teachers in your school incorporate the use of calculators and computers.

30. (A) What problems must be (have been) overcome in your school in order to achieve appropriate use of calculators and computers in mathematics classes?

    (B) What successes have been enjoyed in your school as a result of calculator and computer use in mathematics classes?

Once again, I want to thank you for taking the time to complete this survey. For additional comments or questions you may have, I may be reached by phone at (540) 463-4247 (work) or (540) 464-1211 (home), or by email at jdonald@rcs.rang.k12.va.us. Please do not hesitate to contact me.

Thanks!

Jack Donald
Technology Specialist
Rockbridge County Schools

Appendix B

Superintendent's Packet

Letter of Transmittal to Superintendents
Permission Form

November 5, 1997

Superintendent
Virginia School Division
Mailing Address
City, VA 00000-0000

Dear Superintendent

Rockbridge County Schools, in conjunction with Virginia Tech, will be conducting a survey concerning the use of technology in high school mathematics classes in the State of Virginia. The purpose of this study is to gather descriptive data on the availability and uses of calculators and computers in high school mathematics classes which would represent a "snapshot" in time. This data will be available to the State of Virginia and all school divisions to aid future planning. The survey consists of a self-administered mail survey, and (time permitting) a voluntary interview session, targeting the mathematics department heads from all the high schools within participating divisions. We have included a sample of the mail survey questionnaire for your review.

We are asking that you grant permission for us to include your division in this survey. Included in this packet, in addition to a sample survey, is a permission form and a stamped, addressed envelope for returning this form. We stress that the results from this survey will not be used for any type of comparisons of technology use among specific school divisions. In fact, the survey questionnaire is not coded in any fashion and asks for no information which would allow it to be associated with any specific high school. However, we do expect the results to be useful in establishing a base-line reference point -- important at this time due to the increased emphasis on technology use as expressed in the Virginia *Standards of Learning* and the *Six Year Education Technology Plan for Virginia*. Results of the survey will be shared with all interested parties, and we will be happy to send a copy to you, regardless of your decision for participation.

If you approve, we will mail copies of the survey directly to the mathematics department heads at the high schools within your division. This mailing is scheduled to take place during the early portion of December.

Thank you for your time and consideration of this activity. If you have any questions, or need any additional information, please contact any one of us.

Sincerely,

Dr. Glen H. Stark
Superintendent,
Rockbridge Co. Schools
ph: (540) 463-7386

Dr. Sue G. Magliaro
Dept. of Teaching & Learning
Virginia Tech
ph: (540) 231-8338

Jack Donald
Technology Specialist,
Rockbridge Co. Schools
ph: (540) 463-4247

Superintendent
Virginia School Division
Mailing Address
City, VA 00000-0000

November ____, 1997

Jack Donald
Rockbridge County Schools
417 Morningside Drive
Lexington, VA 24450

Mr. Donald:

The boxes checked below indicate this school division's willingness to participate in the survey of availability and uses of calculators and computers in public high school mathematics classes in Virginia.

0 This division grants permission for all of the high schools within the division to participate in the survey.

-- OR --

0 This division grants permission for only the high schools listed below to participate in the survey.

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

-- OR --

0 This division does not grant permission for this survey to be sent to any high schools within the division.

---

0 Please send this school division a copy of the final results of this survey.

____

Signature of Superintendent or Designee

Appendix C

Research Questions and Corresponding Survey Questions

Research Questions	Survey Questions
1. How many calculators (scientific and graphing) and computers are available for use in high school mathematics classes in public high schools within the State of Virginia? How are these distributed in schools based on school size and school setting? What are the average numbers of calculators and computers available per school or per teacher in this schools providing calculators and computers?	Part Two – Questions 6, 7, 8, 12, 13, 18, 19, 20
2. In what types of professional development activities have mathematics teachers participated over the past eight years in order to prepare for the use of calculators and computers in teaching activities?	Part Three – Questions 24, 25
3. What additional elements, in the form of individuals or groups, exist for providing directions, influence, support, or encouragement for the use of technology in mathematics classrooms?	Part Two – Questions 10, 11, 21, 22, 23
4. What level of familiarity do teachers have with documents in which increased use of technology in the mathematics classes is advocated? What levels of influence on the actual use of technology in mathematics classes are assigned to these documents by teachers?	Part Four – Questions 26, 27
5. In which courses are calculators and computers used? How frequently are they being used? In what ways are they being used?	Part Two – Questions 9, 16, 17
6. In what ways do the instructional and assessment practices of teachers incorporate the uses of calculators and computers? What problems have been overcome (must be overcome) in order to achieve appropriate usage of calculators and computers? What successes have resulted from calculator and computer usage?	Part Four – Questions 28, 29, 30

Appendix D

<u>Follow-up Letters</u>

First Follow-up Letter to Teachers
Second Follow-up Letter to Teachers
Follow-up Letter to Principals

Mathematics Department Head
Virginia Public School
Mailing Address
City, VA 00000-0000

To the Mathematics Department Head:

During the second week of January, Rockbridge County Schools mailed a survey to you concerning the use of technology in high school mathematics classes in the State of Virginia. Our records indicate that you have not mailed in the completion form indicating that the survey was completed and mailed. I am writing to ask that you please consider completing the survey and sending it to us as soon as possible. I know that the survey seems lengthy, and that the original posting of the survey coincided with semester exams in many school divisions. However, your participation in this study will provide a broader response base and enable me to present a more complete report. I would greatly appreciate your support.

If you have misplaced the original survey, a second copy may be requested through email to jdonald@rcs.rang.k12.va.us, or by phone to Rockbridge County Schools Division Technology Services (540 463-4247) between 8:00 a.m. and 12:00 noon or through my home number at 540 464-1211 at any time (an answering machine will record your message between the hours of 8:00 a.m. and 5:00 p.m.) Please don't hesitate to ask for a replacement copy.

Again, I know how difficult it is to find time to complete surveys such as this one. Thanks for taking your time to complete the survey.

Sincerely,

Jack Donald

Mathematics Department Head
Virginia Public High School
Mailing Address
City, VA 00000-0000

To the Mathematics Department Head:

In our quest for accuracy and widespread sampling, I am sending you a second copy of the survey concerning the use of technology in public high school mathematics classes in Virginia. I would remind you that this survey is being sponsored by Rockbridge County Schools under guidelines established by Virginia Tech. Your division superintendent has seen a sample copy of the survey and given permission for you to participate in this study. I know that many of you are far too busy to spend time completing this survey, but I am asking for your cooperation and participation. On a personal note, much of my doctoral research is based on the results of this study – your participation would mean a great deal to me.

I apologize for continuing to seek your cooperation in this study, but I do believe that the participation of your math department would provide a broader response base and a more complete report. If you have any questions I can be reached through email to jdonald@rcs.rang.k12.va.us, by phone to Rockbridge County Schools Division Technology Services (540 463-4247), or by home phone (540 464-1211). Again, I know how difficult it is to find the time to complete surveys such as these. Thanks for bearing with me.

Sincerely,

Jack Donald

Principal
Virginia Public High School
Mailing Address
City, VA 00000-0000

Dear Principal:

Rockbridge County Schools, in conjunction with Virginia Tech, has been gathering data concerning the use of technology in public high school mathematics classes in the State of Virginia. Your division superintendent granted permission for your high school to be included in a survey designed to collect data. During the second week of January, your mathematics department head was mailed the survey and requested to complete and return this when possible. With semester end approaching for many school divisions, and bad weather forcing the closing of schools for much of late January and early February, I know that time was limited. Our records indicate that your mathematics department head has not mailed back a completed survey.

In an attempt to provide a second chance under less trying conditions, we have recently mailed a second survey to your mathematics department head. This survey is being used to collect descriptive data about the use of technology in your mathematics programs. There is no coding or identifying mark of any type that could be used to associate the data with your school – nothing which could be used to trace results back to a given school. Participation in the study is voluntary. However, the participation of your school in this survey would provide a broader response base and a more complete report. With this in mind, we would very much appreciate any encouragement you could provide your mathematics department head regarding the completion of the survey.

Thank you very much for any help you choose to provide. If you have any questions, or need any addition information, please contact me.

Sincerely,

Jack Donald

Vita

Jack B. Donald
905 Valley Pike
Lexington, VA 24450
Phone: 540 464-1211
Email: jdonald@rockbridge.net

Academic Experiences

August 1993 - December 1998	Virginia Polytechnic Institute and State University Blacksburg, VA Doctor of Education – Curriculum and Instruction
June 1991 - August 1992	Virginia Polytechnic Institute and State University Blacksburg,VA Master of Arts in Education – Curriculum and Instruction
September 1974 - June 1978	Washington & Lee University Lexington, VA Bachelor of Science – Mathematics
August 1969 - June 1974	Lexington High School Lexington, VA

Professional Experiences

March 1998 - Present	Technology Director Rockbridge County Schools Lexington, VA
July 1997 - February 1998	Technology Specialist Rockbridge County Schools Lexington, VA
August 1992 - June 1997	Mathematics/Physics Teacher Rockbridge County High School Lexington, VA
August 1981 - June 1992	Mathematics/Physics Teacher Lexington High School Lexington, VA
January 1979 - June 1981	Mathematics Teacher William Fleming High School Roanoke, VA