FACTORS INFLUENCING EXEMPLARY SCIENCE TEACHERS' LEVELS OF COMPUTER USE

By

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This study examines exemplary science teachers' use of technology in science instruction, factors influencing their level of computer use, their level of knowledge/skills in using specific computer applications for science instruction, their use of computer-related applications/tools during their instruction, and their students' use of computer applications/tools in or for their science class. After a relevant review of the literature certain variables were selected for analysis. These variables included personal self-efficacy in teaching with computers, outcome expectancy, pupil-control ideology, level of computer use, age, gender, teaching experience, personal computer use, professional computer use and science teachers' level of knowledge/skills in using specific computer applications for science instruction.

The sample for this study includes middle and high school science teachers who received the Presidential Award for Excellence in Science Teaching Award (sponsored by the White House and the National Science Foundation) between the years 1997 and

2003 from all 50 states and U.S. territories. Award-winning science teachers were contacted about the survey via e-mail or letter with an enclosed return envelope. Of the 334 award-winning science teachers, usable responses were received from 92 science teachers, which made a response rate of 27.5%.

Analysis of the survey responses indicated that exemplary science teachers have a variety of knowledge/skills in using computer related applications/tools. The most commonly used computer applications/tools are information retrieval via the Internet, presentation tools, online communication, digital cameras, and data collection probes. Results of the study revealed that students' use of technology in their science classroom is highly correlated with the frequency of their science teachers' use of computer applications/tools.

The results of the multiple regression analysis revealed that personal self-efficacy related to the exemplary science teachers' level of computer use suggesting that computer use is dependent on perceived abilities at using computers. The teachers' use of computer-related applications/tools during class, and their personal self-efficacy, age, and gender are highly related with their level of knowledge/skills in using specific computer applications for science instruction. The teachers' level of knowledge/skills in using specific computer applications for science instruction and gender related to their use of computer-related applications/tools during class and the students' use of computer-related applications/tools in or for their science class. In conclusion, exemplary science teachers need assistance in learning and using computer-related applications/tool in their science class.

CHAPTER 1
DESCRIPTION OF THE STUDY

Introduction

In the United States, two important national projects have been designed to restructure science education and develop scientific literacy: The National Science Education Standards (National Research Council [NRC], 1996) and Project 2061: Science for All Americans (Czerniak, Lumpe, Haney & Beck, 1999; Rutherford & Ahlgren, 1989). These two projects have common goals and recommendations (Czerniak et al., 1999; Haney, Czerniak & Lumpe, 1996). Themes found in these recommendations include educational technology, constructivism, learning styles, classroom management, assessment and evaluation, equity, Science Technology and Society (STS), science subject matter, cooperative learning, hands-on/minds-on, and the nature of science (BSCS, 1994).

The use of educational technology in teaching and learning has been a focus for many national organizations, major state curriculum development projects, and educational policy reports. Cajas (2001) noted that the science educational reform efforts are *Benchmarks for Science Literacy* (American Association for the Advancement for Science [AAAS], 1993), the *National Science Education Standards* (National Research Council [NRC], 1996), and the *Standards for Technological Literacy* (International Technology Education Association [ITES], 2000). The International Society for Technology in Education (ISTE) also led a federally funded initiative to develop National Educational Technology Standards (NETS) for teachers, students, and administrators.

The NETS initiative aimed at teachers is referred to as NETS*T (ISTE, 2000). The NETS*T project states that to provide a technology-supported learning environment for students, teachers must be prepared to teach and create a technology-rich learning environments (NETS*T, 2002).

Various resources have been dedicated to infuse educational technology into science and other K through12 curricula. Recent research has shown that 99% of the nation's public schools provide students access to computers (Williams, 2000), and 77% provide Internet access to instructional classrooms (Cattagni & Ferris, 2001). However, according to the U. S. Department of Education (1999), only 20% of classroom teachers in the United States feel prepared to integrate computers into their teaching (U. S. Department of Education, National Center for Educational Statistics [USDOE/NCES], 1999). In addition, the Teaching, Learning, and Computing (TLC) survey data, drawn from a national representative survey of 4^{th} through 12^{th} grade teachers (n=2,252), showed that only 17% of science teachers (n=312) use computers weekly during their instruction (Becker, 2000). Study findings such as these suggest that a better understanding is needed of why some middle and high school science teachers use computers in their instruction and others do not use them.

Limited access to computers may no longer be a significant factor in teachers' computer use (Mitchell, 2000). Most schools and teachers have at least some access to computer-based technologies either in their classrooms or somewhere in their school (Becker, 2000; Williams, 2000). However, this technology is not being used in the classroom by teachers. Although teachers recognize the importance of integrating technology into their curricula, various kinds of barriers block their implementation efforts (Ertmer, 1999). Brickner (1995) categorized those barriers as first- and second-order barriers.

First-order barriers to technology integration are extrinsic to teachers and include a lack of access to computers and software, insufficient time to plan instruction, and inadequate technical and administrative support. In contrast, second-order barriers are intrinsic to teachers and include beliefs about teaching, computers, established classroom practices, and willingness to change. Ertmer (1999) noted that some first-order barriers may be eliminated by providing additional resources and computer-skill training. On the other hand, elimination of second-order barriers requires challenging teachers' belief systems, which is more difficult to address (Ertmer, 1999). Ertmer also pointed out that first- and second-order barriers are intertwined. A teacher's beliefs regarding pedagogy and the practice of teaching have been related to second-order barriers. Those practices differ for each teacher depending on the individual teacher's pedagogical style (Judson & Sawada, 2000; Pugalee, 2001). Because of these individual differences, teachers' belief systems which are related to technology use and factors affecting their belief systems, need to be studied.

Second-order barriers are related to teachers' internal variables. Teachers' internal variables have proven to be helpful in understanding their behavior or performance (Coovert & Goldstein, 1980). Examples of internal variables with respect to the use of technology are teachers' attitudes toward computer use, teachers' self-efficacy related to computer use, the locus of control, and innovativeness. Hence, it is necessary to study teachers' beliefs regarding computer use to understand why some science teachers use computers and others do not use them.

Many researchers have examined the characteristics of exemplary technology-using teachers to understand how they differ from other teachers (Becker, 1994; Berg, Benz, Lasley, & Raisch, 1997; Ertmer, Gopalakrishnan & Ross, 2001; Hadley & Sheingold, 1993; Zhao et al., 2001). According to Hadley and Sheingold , teachers who have a reputation of being expert computer users employ a wide variety of computer software, including simulations, programming languages, spreadsheet and database programs, electronic bulletin board communications software, and word processors to directly address curricular goals. They are enthusiastic and confident about using computers themselves, as well as seeing their students using computers for learning. Ertmer, Gopalakrishnan, and Ross (2001) found similar results in their study. According to Ertmer et al. (2001), exemplary technology-using teachers are motivated, energetic, and dedicated teachers. These teachers have gone beyond the usual responsibilities to design activities and create a learning environments that engages their students in meaningful technology use.

While some researchers (Becker, 2000; Brickner, 1995; Ertmer, 1999; Mitchell, 2000) examined the factors affecting teachers' use of computers in their instruction and the characteristics of exemplary technology-using teachers, other researchers have conducted studies to identify overall exemplary teaching practices and the constructs of effective teaching (Allington, Johnston & Day, 2002; Covino & Iwanicki, 1996). Further, other researchers have focused specifically on science teaching and have examined the teaching and learning strategies used by exemplary science teachers (Bonnstetter, Penick, & Yager, 1983; Fraser & Tobin, 1989; Penick & Yager, 1993; Tobin & Fraser, 1987; Treagust, 1991; Waldrip & Fisher; 1999; Weiss & Raphael, 1996).

The main purpose of those studies was to identify the characteristics of exemplary science teachers. Many different methodologies, such as surveys (Weiss & Raphael, 1996), interviews (Fraser & Tobin, 1989; Treagust, 1991), and direct classroom observations (Treagust, 1991), were used to study exemplary science teachers. According to Tyler, Waldrip and Griffith (2003), these studies showed "different dimensions of characteristics of effective teachers, ranging from identification of underlying beliefs, to broad principles focusing on management, to details of learning interaction, to lists of activity characteristics" (p. 5). Nevertheless, none of those studies examined exemplary science teachers' use of technology in teaching science.

Results of effective teaching studies revealed that the characteristics of effective science teachers are the same as those of effective teachers overall. Characteristics common to both effective teaching and exemplary science teaching are the use of appropriate management techniques, active engagement of students in learning, guidance through lessons rather than lecture, enthusiasm, high teacher and student expectations, extensive time spent in preparation, and learning and sharing with colleagues (Bonnstetter, et al., 1983; Fraser & Tobin, 1989; Penick & Yager, 1993; Tobin & Fraser, 1987; Treagust, 1991; Waldrip & Fisher; 1999; Weiss & Raphael, 1996). These characteristics create a positive classroom environment (Bonnstetter, et al., 1983). In addition to these general characteristics, it is essential for effective science teachers to understand science content in addition to using appropriate teaching strategies to create an environment for meaningful learning. Although the use of technologies in teaching and learning is recommended in the National Science Education Standards (National Research Council [NRC], 1996), Project 2061: Science for All Americans (Rutherford &

Ahlgren, 1989), and the National Educational Technology Standards (NETS) (ISTE, 2000), these studies have not examined exemplary science teachers' levels of computer use.

As previously mentioned, exemplary technology-using teachers share the same general characteristics of effective teaching. The report of the President's Committee of Advisors on Science and Technology (PCAST, 1997) asserted that the use of computer technologies by teachers facilitates their adoption of constructivist pedagogy. Researchers who studied technology integration by teachers reported that if there is no conflict between teachers' current pedagogy and new pedagogy related to the implementation of a new innovation, the process of implementation of new innovation proceeds much faster than for others (Becker, 1999; PCAST, 1997). We know that exemplary science teachers are already in favor of using constructivist pedagogy in their classroom. With this assumption, could we assume that exemplary science teachers use computer technology in their classrooms in an exemplary way? Yet another question remains: Is there a minimum level of computer use required to be an exemplary science teacher? If exemplary teachers do not use computer technology in exemplary ways, the reasons that hinder their technology use should be identified and described.

Theoretical Framework of the Study

This study has rooted itself in the theoretical and conceptual construct of (1) effective teaching, (2) exemplary science teaching, (3) level of technology use, and (4) factors influencing the teacher's level of computer use. The first two components of the theoretical framework have already been discussed in previous sections; therefore this section addresses the levels of computer use and factors that influence teachers' level of computer use.

Level of Technology Use: Hooper-Rieber

In a review of the literature, the Hooper-Reiber Model of Technology Adoption in the Classroom (Hooper & Reiber, 1995) emerged as a useful model for analyzing variables affecting exemplary science teachers' level of computer use. The Hooper-Reiber Model of Technology Adoption in the Classroom identifies five stages through which teachers progress as they learn to use new technologies in their teaching. These five stages are familiarization, utilization, integration, reorientation, and evolution.

During the familiarization stage, educators are first exposed to the innovation. Next, teachers enter the utilization stage during which they begin to use the innovation. During this stage, the innovation is expendable, and teachers frequently abandon the use of the innovation when they encounter difficulties (Hooper & Reiber, 1995). During the third stage, integration, teachers begin to use technology in ways that are indispensable to their teaching and their students' learning in the classroom. This stage represents the breakthrough in technology adoption. Teachers become dependent on the innovation for their work. Reorientation is the fourth stage of the model. At this stage teachers are not threatened by the presence of educational technology in the classroom. Teachers begin to reorient their relationship with technology, and they start to restructure their classroom methodology to use computer-related technology in a problem-based learning, in constructivist and collaborative learning projects, and in creating student-centered learning environments. The final stage, evolution, "serves as a reminder that the educational system must continue to evolve and adapt to remain effective" (Hooper & Reiber, 1995, p.157). A teacher at this level has created a flexible environment that is adaptive in order to meet the needs of individual learners.

The Hooper-Rieber Model of Technology Adoption in the Classroom (see Figure 1-1) indicates that teachers who begin to use technology do so within a traditional instructivism paradigm of schooling. Hooper and Rieber (1995) assert that some of those teachers will eventually develop the knowledge and skills needed to use technology as a cognitive tool in a constructivist paradigm of teaching and learning.

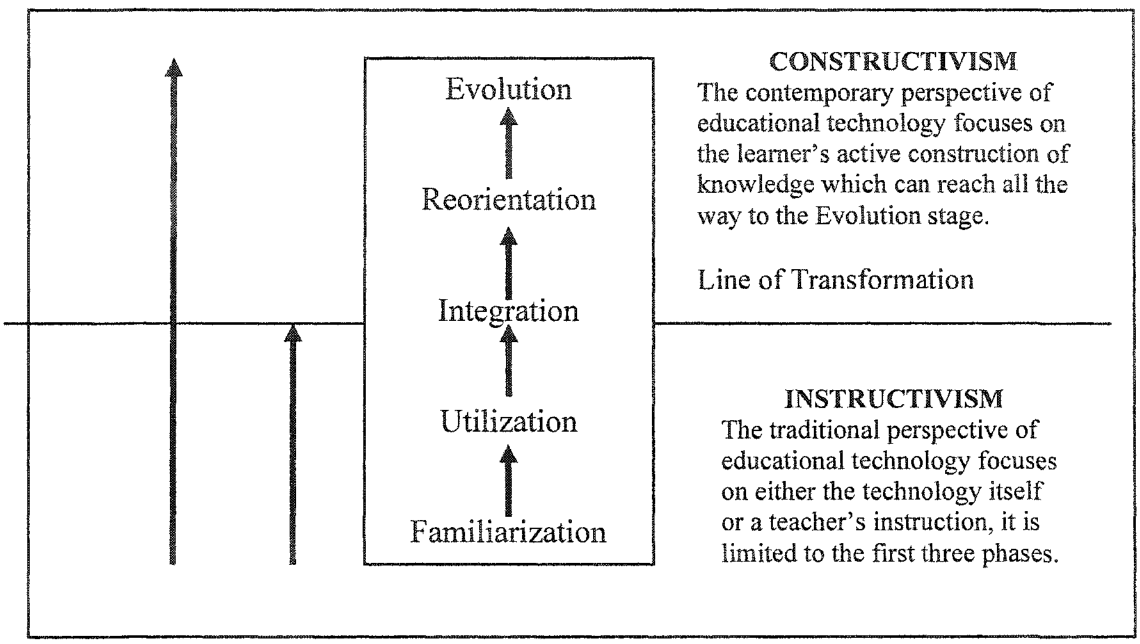

Figure 1-1. Hooper-Rieber Model of Technology Adoption in the Classroom.

According to Hooper and Rieber (1995), many teachers who make it to the integration (third) level of the model do not cross what Hooper and Rieber call the "line of transformation" between instructivist and constructivist pedagogical practice (Hooper & Rieber, 1995). The Hooper-Rieber Model of Technology Adoption in the Classroom provides a useful model for examining the factors affecting exemplary science teachers' level of computer use. Teachers cross the line of transformation in stage three, integration. Teachers cross the line of transformation when they change their use of technology to a student-centered constructivist pedagogy instead of a teacher-centered instructivist pedagogy. The relationships among intrinsic factors, such as self-efficacy in teaching with computers, pupil-control ideology, and extrinsic factors (i.e., computer experience, computer access, age, and gender, which are on opposite sides of the line of transformation) are of particular interest in this study.

Factors' Influencing Teachers' Level of Computer Use

Based on a review of the literature, significant factors influencing teachers' use of computers are self-efficacy in teaching with computers, pupil control ideology, computer experience, computer access, age and gender. Each of these factors will be described in this section.

Self-efficacy in teaching with computers

Self-efficacy can be described as one's beliefs in his ability to perform a particular behavior. The theory of self-efficacy was developed by Bandura (1977; 1986; 1997). Computer self-efficacy represents

> an individual's perceptions of his or her ability to use computers in the accomplishment of a task (i.e., using a software package for data analysis, writing a mail merge letter using a word processor), rather than reflecting simple component skills (i.e. formatting diskettes, booting up a computer, using a specific software features such as 'bolding text' or 'changing margins') (Compeau & Higgins, 1995, p. 191).

Thus, self-efficacy regarding computers refers to a person's perceptions and capabilities for applying computer technology (Compeau & Higgins, 1995). Bandura's theory of self-efficacy provides a basis for understanding the behavior of individuals with regard to their acceptance or rejection of technology (Olivier & Shapiro, 1993). An individual's feeling about a previous experience can affect beliefs about future performance. For this reason, individuals who perceive themselves as effective computer users predict positive computer experiences in the future. However, individuals who perceive themselves as ineffective computer users anticipate negative computer experiences in the future (Olivier & Shapiro, 1993).

The use of computer technology by teachers can be linked to teachers' self-efficacy beliefs. For instance, Compeau and Higgins (1995) examined the factors that affect an individual's use of technology. They found that participants with higher self-efficacy beliefs used computers more often and experienced less computer-related anxiety. According to Bandura (1977), an individual's sense of expectations based on personal mastery affects both the initiation and persistence in performing that behavior, which plays an important role in completing a task or behavior. For this reason, a person with high self-efficacy is more likely to persist in overcoming obstacles to reach his goal. Compeau and Higgins noted that individuals with higher self-efficacy beliefs with regard to computers see themselves as able to use computer technology, regardless of how difficult or challenging the task is. On the other hand, individuals who have lower self-efficacy beliefs about computers become more frustrated and more anxious working with computers and hesitate to use computers when they encounter obstacles.

Olivier and Shapiro (1993) remarked that it is crucial to study teachers' self-perceptions and behavior in studying the implementation and use of computer technology. Researchers found that self-efficacy is correlated with computer use (Compeau & Higgins, 1995; Compeau, Higgins, & Huff, 1999; Hasan, 2003; Marakas, Yi & Johnson, 1998; Potosky, 2002). However, literature on the effects of computer self-efficacy on science teachers' level of computer use is limited. Exemplary science teachers should have high self-efficacy in teaching science. However, there is no research in the literature regarding exemplary science teachers' self-efficacy in teaching with computers and how this influences their level of computer use.

Pupil control ideology

Dole (1986) suggested that one of the major tasks for teachers is to establish and maintain order in the classroom. Demmon-Berger (1986) found that effective teachers are good managers of their students and classroom, and they maintain good discipline in their classrooms. Pupil control is defined as the teacher's stated belief regarding the control of students in classrooms and schools (Willower, Eidell, & Hoy, 1973). Pupil control has been conceptualized along a continuum ranging from custodialism at one end to humanism at the other (Willower, et al., 1973). The Pupil Control Ideology Form (PCI) was constructed by Willower, et al. to measure a teacher's pupil-control ideology on a humanistic to custodial continuum. The model of the custodial orientation is the rigidly traditional classroom that institutes a highly controlled environment to maintain order. This orientation also stresses impersonality, distrust of students, and pessimism. In contrast to the custodial orientation, a humanistic pupil-control orientation classroom is viewed as an educational community in which students learn through experience and cooperative interaction with each other. The humanistic orientation puts emphasis on the psychological and sociological bases of students' learning and behavior. Humanistic teachers are optimistic, patient, easily approachable, and they encourage student self-discipline and independence.

Classroom control in science teaching is important, especially if teachers utilize a hands-on approach to science teaching (Enochs, Scharmann, & Riggs, 1995). According to Enochs, et al., activity-based science instruction can make some teachers uncomfortable who view pupil control in a custodial fashion. The inquiry approach of science teaching and learning may be ignored by teachers who favor custodial classroom control. On the other hand, teachers with a humanistic orientation believe their students are capable of learning through cooperation and experience (Hoy & Woolfolk, 1990). Science teachers with a humanistic orientation may be more likely to utilize inquiry, cooperative learning, discussion groups, and other forms of student-centered instruction (Enochs et al., 1995).

Teachers' classroom management orientation is also related to computer use in the classroom (Bean, 1988). While much attention has been given to pupil control in the school climate, teacher ideology and teacher effectiveness (Cicmanec, Johanson, & Howley, 2001; Enochs et al., 1995; Hoy &Woolfolk, 1990), relatively little attention has been given to the influence of pupil control on computer use in the classroom. There is no study examining exemplary science teachers' classroom management orientation and its influences on technology use in the classroom. This study investigates whether or not teacher-pupil control ideology is associated with exemplary science teachers' level of computer use.

Computer experience

When attempting to measure teachers' use of computers in teaching, it is necessary to consider their experience (Marcinkiewicz, 1991). Potosky and Bobko (1998) defined computer experience as

> the degree to which a person understands enough how to use a computer. That is, an experienced computer user understands enough about computers in order to use them, more or less independent of specific software packages, reasons for use, and computer hardware features. (p.338)

Computer experience is also defined as how one feels and thinks about existing computing events (Smith, Caputi, Crittenden, Jayasuriya, & Rawstorne, 1999).

Experience is also one of the important elements of Rieber and Welliver's (1989) description of the familiarization level in the model of Instructional Transformation (Marcinkiewicz, 1991). At the familiarization level, teachers get familiar with computers through their experiences with them.

Although there is not a consistent or universal definition of the term "computer experience" (Smith, et al., 1999), computer experience is often measured in terms of the amount of computer use by the individual. However, researchers have argued that measuring computer experience as a single component (i.e., amount of experience) has resulted in the oversimplification of computer experience (Szajna & Mackay, 1995). Jones and Clarke's (1995) defined computer experience in terms of four components: amount of use, opportunities of use, diversity of experience, and sources of information. Thus, by using the definition of Jones and Clarke (1995), computer experience can be organized as the sum of all computer-related events. These events include (1) current knowledge/skills for each computer application; (2) frequency of instructional use of each application in the classroom; (3) frequency of student use of each application; (4) amount of experience teachers have in using computers for personal use, classroom productivity, and instruction; (5) length of time spent in learning to use computers; (6) number of hours spent using a computer for personal use, classroom preparation, and for instruction; and (7) source of computer knowledge and the most significant computer learning experience for the participant.

Computer access

In the past, the low level of computer use by classroom teachers was commonly associated with limited access to computers (Rosen &Weil, 1995). However, recent studies indicate that limited access may no longer be the reason for low levels of use in many schools. Current research has shown that 99% of the nation's public schools provide student access to computers (Williams, 2000), and 77% provide Internet access to instructional classrooms (Cattagni & Ferris, 2001). Becker (1999) found that 32% of teachers do not use the Internet at all. Yet, 17% of science teachers reported that their students used computers often in their classroom. Becker (2000) noted that the location and number of computers in the science classroom influences science teachers' use of computers during instruction. When asking teachers whether or not they use computers, the location and number of computers should be considered to accurately evaluate the level of computer use for personal and classroom instruction.

Age and computers

Research on teachers' ages and ages influences on computer use are limited. The relationship between a teacher's age and computer use is not clear. Rosen and Weil (1995) found no relation between these variables. Other studies found a negative relationship between a teacher's age and his use of computers in teaching (Becker, 1999; Jennings & Onweuegbuzie, 2000). Lack of computer experience for older people might influence their feeling about using computers (Jennings & Onweuegbuzie, 2000). Although some studies found a relationship between a teacher's age and computer technophobia (Rosen & Weil, 1995), Czaja and Sharit (1998) found that sometimes younger study participants had a higher level of computer anxiety and a less positive attitude toward computer use than older study participants. In Jennings and Onweuegbuzie's study, older groups of participants reported a higher anxiety and a lower level of confidence. Hence, there is no consistent finding of the relationship between a user's age and computer use. A national study of teachers' use of the Internet revealed that younger teachers are more comfortable using the Internet (Becker, 1999). Becker mentioned that younger teachers displayed greater comfort with technology, which influences their use of technology in the classroom.

Weiss, Smith, and Malzahn (2001) conducted a study to provide information about the differences between recipients of the Presidential Award for Excellence in Science Teaching and a national sample of science teachers. By 2000, on a national scale, 81% of the recipient of this award (middle and high school science level) had taught for at least 20 years, while only 31% of middle and high school science teachers nationally had that much experience. Findings of the study revealed that these award recipients are older than their national counterpart. For this reason, the exemplary science teacher's age is an important factor in examining his use of technology. The majority of research reported a negative correlation between the teacher's age and computer-related tasks; however, there is no research that examines the relationship between the exemplary science teacher's age and level of computer use.

Gender differences

Research on gender differences indicates that women have more negative attitudes toward computers and less experience in using them than men have (Rosen & Maguire, 1990; Rosell & Gardner III, 2000; Smith & Necessary, 1996; Whitley, 1997). Men exhibited higher computer self-efficacy than women did (Cassidy & Eachus, 2002; Durndell, Haag, & Laithwaite, 2000). Maurer (1994) mentioned that gender differences in computer experience leads to these same differences in computer use and attitudes toward them. Yet other researchers indicated there are no gender effects on computer use (Jennings & Onweuegbuzie, 2001; Whitley, 1997). Murphy, Coover, and Owen (1989) reported gender differences are contributing factors in self-efficacy beliefs. Males have significantly higher computer self-efficacy than females have (Cassidy & Eachus, 2002).

This study examines teachers' self-efficacy as one of the factors influencing exemplary science teachers' use of technology. It is important to examine the teachers' gender as another factor. There is no study examining the exemplary science teachers' gender and his level of computer use.

Purpose of the Study

Research supports the idea that teachers play a critical role in the classroom (Bybee, 1993; Evertson, 1986; Rosenshine, 1979; Schrage, 1995; Shapiro, 1995), and their beliefs affect practice in the classroom (Bybee, 1993; Clark & Peterson, 1985; Ertmer, 1999; Pajares, 1992). Teacher beliefs specifically affect their use of technology in their teaching (Ertmer, 1999; Marcinkiewicz & Grabowski, 1992). To understand science teachers' practice in the classroom, it is important to examine their beliefs. This study examines exemplary science teachers' use of technology in science instruction, factors influencing their level of computer use, their level of knowledge/skills in using specific computer applications for science instruction, their use of computer-related applications/tools during their instruction, and their students' use of computer applications/tools in or for their science class. Research indicates that factors influencing teachers' use of computers are self-efficacy in teaching with computers, pupil control ideology, computer experience, computer access, age, and gender.

The purpose of this study is to investigate whether or not relationships exist, and also to investigate the strength of these relationships among a set of variables related to exemplary science teachers' characteristics (self-efficacy in teaching with computers, pupil control ideology, computer experience, computer access, age and gender) and levels of computer use, their level of knowledge/skills in using specific computer applications for science instruction, their use of computer-related applications/tools during their instruction, and their students' use of computer applications/tools in or for their science class.

Significance of the Study

This study has the potential to improve the quality of middle and high school science teachers' performance and learning opportunities for students. Because science teachers are fundamental to student success in science, we should know more about what contributes to their success. This is especially true for exemplary science teachers. How exemplary science teachers use technology and factors that influence them to use technology might have implications for, and connections to, teacher evaluations, training, and ultimately strategies toward improving pre-service teacher programs. Exemplary science teachers are highly motivated and successful in teaching their subject area. This study examines exemplary science teachers' use of technology in science instruction, factors influencing their level of computer use, their level of knowledge/skills in using specific computer applications for science instruction, their use of computer-related applications/tools during their instruction, and their students' use of computer applications/tools in or for their science class. The results of this study can provide teacher educators, classroom teachers, and administrators insight regarding how best to integrate computers into science teaching and create technology-rich learning environments.

Research Questions

The following research questions will guide this study.

1. Are exemplary science teachers' levels of computer use associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, computer access in the classroom, gender, and science teachers' level of knowledge/skills in using specific computer applications/tools for science instructions

2. Are exemplary science teachers' level of knowledge/skills in using specific computer applications for science instruction associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, personal computer use, professional computer use and teachers' use of computer related application/tool during class?

3. Are exemplary science teachers' use of computer related applications/tools during their instruction associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, personal computer use, professional computer use and science teachers' level of knowledge/skills in using specific computer applications for science instruction?

4. Are exemplary science teachers' students use of computer applications/tools in or for their class associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, personal computer use, professional computer use, computer access in the classroom and science teachers' level of knowledge/skills in using specific computer applications for science instruction?

Definition of Terms

The following terms can be useful in understanding the nature of this study.

Computer self-efficacy refers to a judgment of one's capabilities to use a computer. (Compeau & Higgins, 1995)

Computer experience is defined as "the degree to which a person understands enough how to use a computer" (Potosky & Bobko, 1998, p. 338).

Exemplary science teachers are defined as middle and high school teachers who have received the Presidential Award for Excellence in Science Teaching from the White House and National Science Foundation from 1997 to 2003.

Self-efficacy is defined as one's belief in his abilities to perform a particular behavior (Bandura, 1977).

Pupil-control ideology is defined as a teacher's stated belief regarding the control of students in classrooms and schools (Willower, et at., 1973).

Delimitations of the Study

This study focuses on the limited domain of teachers' use of computers in middle and high school science classes. Any generalization to other levels of school, such as elementary schools, or to other subject areas and types of technology may not be possible. This study is limited to a focus on middle and high school science teachers who received the Presidential Award for Excellence in Science Teaching from 1997 to 2003 from all 50 states and U.S. territories. Moreover, teachers who received the award prior to 1997 were not included in the study.

Limitations of the Study

Hooper and Rieber (1995) defined their Model for Technology Adoption in the Classroom within the broad domain of technology, not just computers. This specific study explores mainly computers, not other forms of technologies. This study focuses only on exemplary science teachers' use of computers. Any generalization of other types of technologies may not be possible.

The voluntary nature of the survey may limit the interpretation of the results. It is possible that the responses of those who chose to respond to the survey may differ significantly from those who did not participate in the survey.

Although many factors may affect exemplary middle and high school science teachers' levels of computer use, this study focuses only on science teachers who have been identified as exemplary by winning a Presidential Award. Consequently, their self-efficacy beliefs about teaching with computers, pupil-control ideology, computer experience, computer access, age, and gender are not generable to all science teachers.

Organization of Chapters

Chapter 1 provides information on effective teaching, exemplary science teaching, the level of technology use and factors influencing the teachers' level of computer use, identifing the purpose and significance of this study, and setting the limitations of the investigation. Chapter 2 reviews current research on effective teaching, exemplary science teachers, science teachers' use of computers, and factors affecting teachers' use of technology. Chapter 3 provides a detailed description of the study design, instrumentation, and methodology used in conducting the research. Chapter 4 interprets and discusses the data. Chapter 5 summarizes the implications of the findings and offers suggestions for future research in this area.

CHAPTER 2
REVIEW OF LITERATURE

Although Benchmarks for Scientific Literacy (AAAS, 1993) and the National Science Education Standards (NCR, 1996) recommended the use of technology as part of a science curriculum, the literature indicates that science teachers are not using technology for learning and teaching science (Becker, 1999; Cuban, 2001; Dickson & Irvin, 2002; German & Barrow, 1996; Lehman, 1994; OTA, 1995). Research suggests that inadequate access to computers is not a limiting factor for integration of computers in teaching. Yet some of the common limiting factors found are attitudes of teachers (Chiero, 1997; Farby & Higgs, 1997), computer anxiety (Anderson, 1996), external support (Becker, 1994), time (Hadley & Sheingold, 1993), and training (Dias, 1999; Sivin-Kachala & Bialo, 2000).

Teachers' beliefs affect their use of technology in the classroom (Ertmer, 1999; Marcinkiewicz & Grabowski, 1992). It is important to examine science teachers' beliefs to understand the reasons behind their practice of using computer technology for instructional practice. This study examines exemplary science teachers' use of technology in science instruction, factors influencing their level of computer use, their level of knowledge/skills in using specific computer applications for science instruction, their use of computer-related applications/tools during their instruction, and their students' use of computer applications/tools in or for their science class. This chapter is organized into four sections: 1) Effective teaching, 2) Exemplary science teacher research, 3) Technology use and access in secondary science, and 4) Factors influencing teachers' use of computers.

Effective Teaching

Examining teachers' beliefs system is important for understanding their lack of action on following the recommendations of national educational standards and frameworks (Bybee, 1993). Teachers' beliefs are critical in determining the factors that influence their practices in the classroom (Tobin, Tippins, & Gallard, 1994). Factors influencing teachers' belief system should be examined to understand their practice in the classroom. Clark and Astotu (1994) noted the importance of teachers' work as a critical element in effective teaching. Research findings support the assumption that teachers are the key to successful learning (Clark & Austo, 1994; Evertson, 1986; Goodland, 1984; Henson, 1988). Researchers have concluded that the quality of individual teachers influences student learning (Rosenshine, 1979; Schrage, 1995; Shapiro, 1995). Teachers become decision-makers who decide what is to be taught and how the material is to be presented (Evertson, 1986). Teachers' decisions regarding the implementation of the lesson influence the quality of the lesson and student attitudes toward school. They are the decision makers about whether or not technology is used in the science classroom. Anderson (1982) reported that students' self-esteem and attitudes toward schoolwork could be influenced by a teacher's decision regarding classroom activities and structure. It is important to study science teachers' belief system regarding the use of technology and their practices, especially teachers who are recognized as exemplary teachers. In this study, self-efficacy in teaching with computers and teachers pupil control orientations were chosen as factors influencing their decision to use computer related applications/tool.

Stronge and Tucker (2000) reported the importance of the work of Bill Sanders at the University of Tennessee's Value-Added Research and Assessment Center in understanding the relationship between teacher quality and student learning. According to Stronge and Tucker, Sanders found that "when children, beginning in third grade, were placed with three high performing teachers in a row, they scored, on average, at the 96th percentile on Tennessee's statewide mathematics assessment at the end of fifth grade" (p. 9). In comparison, when students with similar achievement background were placed in three low performing teachers, their average score on the same mathematics assessment test was at the 44th percentile. These research findings supported the idea that teachers make a difference on student success. Sanders summarized the findings as follows (Stronge and Tucker):

> the results of this study well document that the most important factor affecting student learning is the teacher. In addition, the results show a wide variation in effectiveness among teachers. The immediate and clear implication of this finding is that seemingly more can be done to improve education by improving the effectiveness of teachers than by any other single factor. Effective teachers appear to be effective with students of all achievement levels, regardless of the level of heterogeneity in their classroom. (p. 9)

Research findings support the premise that teachers are the most important factor affecting the learning environment and student learning. Hence, it is necessary to study the belief systems of teachers who are recognized as exemplary in teaching their subject areas. Before examining factors that could influence science teachers' use or nonuse of computers, the notion of effective teaching and who are effective teachers will be explored.

Effective Teaching and Teachers

When exploring the concept of effective teaching and teachers, important questions to ask are: "What is effective teaching?" and "What behaviors or skills are required to be an effective teacher?" Brophy and Evertson (1976) described effective teaching as:

> not simply a matter of implementing a small number of basic skills. Instead effective teaching requires the ability to implement a large number of diagnostic, instructional, managerial, and therapeutic skills, tailoring behavior in specific context and situations to specific needs of the moment. Effective teachers not only must be able to do a large number of things; they also must be able to recognize which of the many things they know how to do applies at the given moment and able to follow through by performing the behavior effectively. (p. 139)

On the basis of research by Porter and Brophy (1988), effective teachers are described as:

> semi-autonomous professionals who are clear about their instructional goals; knowledgeable about their content and strategies for teaching it; communicate to their students what is expected of them; use existing instructional materials to enrich and clarify content; are knowledgeable about their students; adapting to students' needs and anticipating misconceptions in their existing knowledge; teach students metacognitive strategies and give them opportunities to master them; address both higher and lower level cognitive objectives; monitor students' understanding by fostering regular, appropriate feedback; integrate their instruction with that in other subject areas; accept responsibility for student outcomes; and are thoughtful and reflective about their practice. (p. 75)

While researchers were defining what is effective teaching and determining the characteristics of effective teachers in every subject area, science educators conducted several studies to specifically examine effective science teachers. Those studies are *Project Synthesis* (Harms & Yager, 1981), the *1982 Search for Excellence in Science Education* (Bonnstetter et al., 1983), *Exemplary Practice in Science and Mathematics Education Study* (Tobin & Fraser, 1987), the *National Science Teaching Standards* (NRC,1996), and the *Presidential Award for Excellence in Science Teaching Studies* (Weiss & Raphael, 1996). Those studies made important contributions to understanding effective science teaching. In the next section, each study is briefly described and the findings of each study summarized.

Exemplary Science Teacher Research

Project Synthesis

The purpose of *Project Synthesis* was to "examine the countenance of science education as it exists at the pre-college level and to make basic recommendations regarding future activities in science education" (Harms & Yager, 1981, p. 5). Twenty-three American science educators examined the status of pre-college science education and determined the "actual" and "desired" state of science education in America (Bonnstetter, et al., 1983; Harms & Yager, 1981). The project committee examined three National Science Foundation studies: *The Status of Pre-College Science, Mathematics and Social Science Education: 1955-1975* (Helgeson, Blosser, & Howe, 1977), the *Case Studies in Science Education*, (Stake & Easley, 1978), and the *1977 National Survey of Science, Mathematics and Social Education* (Weiss, 1978).

The focus of *Project Synthesis* was to reformulate goals of science education and to develop a rationale for the discipline of science education (Yager, 1982). Yager (1981) summarized the "desired" state of science education as:

1. A new definition, focus and rationale for science education are needed with the focus on students' needs in a changing technological society.
2. A new science curriculum should include current problems and issues.
3. Science teachers need educational support to succeed in new directions in science education.
4. New teaching materials should that cover new teaching philosophies, and new teaching strategies are needed.
5. Research and practice must work together in science education.

6. Student evaluation strategies should be reevaluated.

Search for Excellence in Science Education

After *Project Synthesis*, educators continued to work toward an appropriate model for science education by creating the *1982 Search for Excellence in Science Education* study. The National Science Teachers Association and the University of Iowa Science Education Center sponsored the study, which was funded by the National Science Foundation. The Search for Excellence in Science Education (SESE) direction-finding committee began by identifying exemplary pre-college science programs based on the criteria of the desired state of science education (Bonnstetter et al., 1983).

The research team identified programs that best met the established criteria for exemplary programs. Key teachers (n=216) from each exemplary program were identified and requested to complete an extensive questionnaire regarding their teaching experience, educational preparation, extent of their professional involvement, and their view of science. In the study, researchers noted that the teachers from exemplary programs did not mean that those teachers were necessarily exemplary science teachers. In this study, key teachers completed three questionnaires. One of the questionnaires was sent to a national random sample of all educators as part of the Project Synthesis. The key teachers' survey, compared with a national sample of educators' data, was collected as part of the Project Synthesis.

The result of the study showed that the key teachers had more teaching experience than the national sample had. The degree level of key teachers was also higher than the national sample. They attended professional organizations and made presentations at local science teachers' meetings, and at least half of the key teachers made presentations at state, regional, or national science teachers' meetings. The *Search for Excellence* teachers were also more interested in getting help in implementing discovery and inquiry instructional approaches. Teachers of exemplary programs did not feel that limitations influenced their teaching, but teachers from the national sample found those factors to be a serious problem.

Bonnstetter at al. (1983) summarized the findings from the Search for Excellence in Science Education teachers as "A View of Excellence":

Search for Excellence in Science Education teachers (Bonnstetter at al., 1983, p.33):

1. Provide a stimulating environment.
2. Create an accepting atmosphere.
3. Expect different students to achieve differently.
4. Put in far more than minimal time.
5. Have high expectations of themselves.
6. Challenge students beyond ordinary school tasks.
7. Are themselves models of active inquiry.
8. Do not view classroom walls as a boundary.
9. Frequently use societal issues as a focus.
10. Work easily with community leaders, administrators, and parents.
11. Are extremely flexible in their time, schedule, curriculum, expectations, and view of themselves.
12. Are concerned with developing effective communication skills.
13. Provide systematically for feelings, reflections, and assessments.
14. Require considerable student self-assessment.
15. Ask questions, expecting to hear new, and often unpredictable, answers.
16. Expect students to question facts, teachers, authority, and knowledge.
17. Encourage pragmatism.
18. Stress science literacy.
19. Want students to apply knowledge.
20. Do make a difference.

Exemplary Practice in Science and Mathematics Education Study

Tobin and Fraser (1987) conducted the *Exemplary Practice in Science and Mathematics Education* (EPSME) which is another important study in the field of science education, following the *Search for Excellence* S*tudy*. This study was conducted in Western Australia and focused on exemplary teachers' practices in the classroom rather than exemplary programs (Tobin & Fraser, 1990). The main assumption behind the

Exemplary Practice in Science and Mathematics Education study was that case studies of the best teachers could provide significant information on how to improve science teaching.

Results of those case studies showed that exemplary teachers were more friendly, supportive, and purposeful. They were comfortable in using hands-on activities during instruction and felt confident in their abilities to teach science. Student participation was an important part of their classroom instruction. Teachers used effective teaching strategies to create a pleasant classroom environment.

Tobin and Fraser (1990) mentioned that to become an effective teacher requires more than effectively managing the classroom and presenting content from books. Effective teaching practice derives from science teachers' beliefs about teaching and learning. Their beliefs influence them in creating and maintaining a classroom environment, encouraging students to participate, and monitoring student progress in understanding of science content.

National Science Teaching Standards

In the previous section, findings from the effective science teaching and exemplary science teachers' studies were reviewed. While researchers try to examine the characteristics of exemplary teachers in an effort to improve science teaching, the National Research Council (NRC) coordinates the development of national standards for K through 12 science education. Before setting the national standards in science, the American Association for the Advancement of Science (AAAS) established *Project 2061* to achieve a consensus on what students should know and be able to do in science. The National Science Education Standards describes what all students must understand and be able to do in science during their learning experience. The inquiry approach was one of the important features of the standards (NRC, 2000). The principles on which the standards were based are (NRC, 1996, p. 1):

1. Science is for all students.
2. Learning science is an active process.
3. School science reflects the intellectual and cultural traditions that characterize the practice of contemporary science.
4. Improving science is part of systematic education reform.

Extensive research and recommendations help science teachers to set new goals for effective science instruction. These principles provide a foundation for planning and implementation of the science courses. The next section of this review of literature examines teachers who were recognized as exemplary science teachers to better understand their behavior and learn how they become exemplary teachers.

Presidential Award for Excellence in Science Teaching

In 1983, the White House and the National Science Foundation established the Presidential Award for Excellence in Mathematics and Science teaching. The award's goal was to recognize outstanding science and mathematics teachers across the United States. As part of the nomination process, administrators, peers, parents, students, and community members could nominate teachers. Teachers would then complete an application information package and send it to their local state board of education. At the state level, a selection committee reviews the applications, and three nominees are chosen for each category: elementary science, elementary mathematics, secondary science, and secondary science. Candidates are judged by the National Science Foundation criteria of:

> Subject matter competence; sustained professional growth in science and mathematics and in the art of teaching; an understanding of how students learn science and mathematics; ability to engage students through a variety of teaching strategies; ability to foster curiosity and to generate excitement about the uses of science and mathematics; a conviction that all students' can learn science and

> mathematics and a sensitivity to the needs of all students linguistics, learning, and social uniqueness; an experimental and innovative attitude in their approach to teaching; and professional involvement and leadership. (Weiss & Raphael, 1996, p. 1)

A nominee from each state is chosen by the National Science Foundation and receives the award for that specific category. Before 1990, only secondary teachers were considered for awards, but in 1990 elementary teachers were also included (Weiss & Raphael, 1996). Technology use of the science teachers is not found in the criteria of the National Science Foundation.

Characteristics of Presidential Awardees

Weiss and Raphael (1996) conducted a study to examine the background and preparation, classroom practices, and professional activities of the teachers who received the Presidential Award for Excellence in Mathematics and Science Teaching. A questionnaire was also sent to a national probability sample of approximately 6,000 elementary and secondary teachers.

Results of this study indicated that these award winners have more education and have completed more courses in science during their undergraduate studies as compared to their national counterparts. Participation in professional development activities was also high for these award winners. While most of the Presidential Award winners felt they were well qualified to teach science subjects, only 30% of the national sample felt the same. Similar to previous studies, the findings of the study showed that exemplary science teachers had characteristics similar to effective teachers. Their teaching strategies enable them to create an inquiry-based learning environment, and their students are more likely to use technology in the classroom. In conclusion, Presidential Science

Awardees seems to have characteristics that are consistent with the recommendations of professional associations, state, and national standards.

Technology Use and Access in Secondary Science

This section of literature reviews recent research of how computers are used by secondary science teachers. Researchers involved in national studies examined computer use and access in secondary education. *The Teaching, Learning and Computing Survey* (1998), the *1999 National Survey of Teachers' Use of Digital Content*, and the *2000 National Survey of Science and Mathematics Education* examined technology use and access in secondary science education. While examining the technology use in classroom, access to that technology should be considered to better understand the factors influencing teachers' use of technology.

The Teaching, Learning, Computing (TLC) Survey

The *Teaching, Learning and Computing* survey was conducted in 1998 and questioned more than 4,000 teachers in 1,100 schools across the United States. The findings of the study revealed that one-third (34%) of high school science teachers never used computers with the students in the classroom. A majority of the teachers (71%) reported assigning their students work involving computers on an occasional basis, yet only one-third of the teachers did so on a regular basis (Becker, Ravitz, Wong, 1999). Researchers found that while 60% of science teachers reported they use computers in their classrooms in at least one of the courses they taught that year, only 12% of science teachers reported that their students frequently use computers. The survey defined "frequent student computer use" as use of computers more than 20 times during the school year (Becker, et al., 1999). Frequency of computer use was highly dependent on the number of computers in the classroom. Science teachers were more likely to use computers while teaching if they had at least one computer in their classroom for every four students. Survey findings documented that only 7% of the teachers had at least a 1:4 ratio computers to students in their classroom. Fifty percent of the teachers were using computers for word processing, 36% for CD-ROM reference software, and 30% for the World Wide Web. Science teachers also were using computers for simulation or exploratory environment (5%), CD-ROM (15 %), and World Wide Web (22%) (Becker et al., 1999).

Findings from the *Teaching, Learning, and Computing* survey showed that by 1998, a typical school had one computer for every six students. As expected, the frequency of computer use is related to the availability of computers in the classroom. Availability of computers in the classroom is highly important in science teaching. Students should be able to use computers when they need to retrieve information, collect and analyze data, share findings with students from other schools, and participate in research projects.

1999 National Survey of Teachers' Use of Digital Content

The survey was sent to 15,000 public school educators in grades K through 12 with 3,000 surveys going to 6th to 12th grade science teachers. Twenty-three percent of the respondents described themselves as science teachers. Results of the survey revealed that 97% of the teachers have regular access to computers at home and/or at their school for professional activities. While 36% of the teachers did not have computer access in their classroom, 56% of the teachers have Internet access. While 38% of the teachers never had students use computers, 28% reported some computer use by students in their classroom. Nearly half of the science teachers who responded to the survey mentioned that they used software for instructional purposes in science teaching. Concerning the use of Internet access, 44% of the teachers reported they did not have Internet access in their classroom. Sixty-one percent of the teachers who had access to the Internet use websites to enhance instruction in their classroom. While 53% of the teachers used software for instruction, science teachers reported difficulty in finding appropriate science software.

Findings from the study revealed that by 1999 limited access to computer and Internet access influenced teachers' use of technology for instructional purposes. The situation of computer access and science teachers' use of computers might be different in today's classrooms. It is necessary to examine the current state of technology use for science teaching.

The 2000 National Survey of Science and Mathematic Education

The survey was distributed to a national sample of approximately 9,000 K-12 teachers to obtain current information about their background and experience, curriculum and instruction, and availability and use of instructional resources (Weiss, Smith, & Malzahn, 2001). The return rate for the national sample was 74%.

Results of the study revealed that while 53% of middle school science teachers indicated feeling at least fairly well prepared to use the Internet in science for general reference, only 29% of them indicated the same level of comfort in using the Internet for collaborative science projects with other schools. Yet, 50% of the middle and high school teachers felt comfortable using the Internet for general references in teaching science. While 45% of high school science teachers indicated feeling at least fairly well prepared to use computers for laboratory simulations, only 24% of middle school teachers felt the same way. Sixty-seven percent of high school science teachers indicated feeling somewhat confident in using calculators or computers to collect and/or analyze data. The study also showed that high school science teachers felt more prepared to use computers and the Internet to teach science when compared to middle school science teachers.

Section Summary

In summary, these three studies have addressed the availability of technology for science teachers' personal and professional use, and how science teachers have reported using those educational technologies in their instructions. Although some teachers indicated use of technology in their instruction, others do not use technology in their instruction. Teachers who do not use technology in their instruction are more likely to cite lack of computer access in the classroom as a limiting factor. In comparison to recommendations from national science standards and organizations, these studies indicate that technology integration in science classroom is limited. Therefore, factors influencing science teachers' use of technology should be studied.

Factors Influencing Teachers' Use of Computers

This section of the review of literature will provide evidence that self-efficacy in teaching with computers, pupil control ideology, computer experience, computer access, age, and gender are important components to consider when investigating factors that influence science teachers' use of computers.

Self-efficacy

Self-efficacy refers to "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). As a psychological construct, self-efficacy is rooted in a social learning theory developed by Bandura (1977, 1982, and 1986). One's judgment of his capability to perform a specific task is a strong predictor of his capabilities to accomplish that task

(Marakas, Yi, & Johnson, 1998). What a person perceives as his capabilities to perform a particular behavior influences his choice of activities, degree of effort, and persistence of effort (Bandura, 1986).

Bandura (1977) describes two dimensions of self-efficacy beliefs (self-efficacy and outcome efficacy) upon which behavior is based. He defines self-efficacy beliefs as judgments of how well one can execute courses of action required to deal with prospective situations. Outcome expectancy refers to the judgments about likely consequences of a behavior in a particular situation (Bandura, 1982).

Self-efficacy beliefs for teaching

Many researchers have applied Bandura's social learning theory concepts to teachers (Ashton & Webb, 1986; Gibson & Dembo, 1984). A teacher's efficacy refers to the "belief or conviction that he/she has the ability to influence how well students learn, even those who may be difficult or unmotivated" (Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998, p. 202). Bandura (1986) noted that the construct of personal efficacy is situation-specific, as well as subject-specific. For example, a teacher's self-efficacy may be low in a specific subject area, such as science, and high in another, such as language arts (Koul & Rubba, 1999). This may result in more time being devoted to that preferred subject area and increased participation in professional development activities in the subject area. If Bandura's theory of self-efficacy is applied to science teaching, we could predict that teachers, who believe that science learning can be influenced by effective science teaching (outcome expectancy) and who also believe in their own ability to teach science effectively (self-efficacy), will more regularly and effectively teach science (Riggs, 1991).

Self-efficacy beliefs and computer use

Computer self-efficacy is derived from the general concept of self-efficacy (Bandura, 1986) and refers to a belief concerning one's capabilities to use a computer to perform a computing task successfully (Compeau & Higgins, 1995). Ertmer, Evenbeck, Cennamo, and Lehman (1994) mentioned that individuals need to feel confident and comfortable with computer technology in order to use it. Computer self-efficacy influences on individual's decision to use computers (Hill, Smith, & Mann, 1987)

Computer self-efficacy has been identified as a key factor among the various individual factors by researchers who have examined computer-related ability and the use of computers (Marakas, Yi, & Johnson, 1998; Potosky, 2002). Furthermore, Marakas et al. suggested that computer self-efficacy influences a person's perceptions of his ability to perform a computing task *and* future intentions to use computers. Olivier and Shapiro (1993) reviewed the research on self-efficacy and self-efficacy in the microcomputer environment. The authors indicated that persons with high self-efficacy tend to be more successful than those with lower self-efficacy. Positive experiences with computers positively influence development of self-efficacy.

Several studies have examined factors influencing computer self-efficacy beliefs (Hasan, 2003; Marakas, et al., 1998; Potosky, 2002). Among the variables examined as factors of computer self-efficacy, computer experience has been mentioned as having a positive relationship with computer self-efficacy beliefs. Hasan (2003) examined the influence of eight types of computer experiences on computer self-efficacy. His research suggests that experiences with computer programming and graphics applications have strong and significant effects on computer self-efficacy beliefs, whereas experiences with spreadsheet and database applications demonstrated weak effects. Zhang and Espinoza

(1998) examined the relationship between students' attitudes toward computers and their self-efficacy beliefs. Students' attitudes toward computers (comfort/anxiety and usefulness) were found to predict self-efficacy, which, in turn, was negatively correlated with a desire to learn about computer technology.

Kellenberger (1996) investigated the self-efficacy of student teachers (n=222) working with computers in class. His research examined the relationships among computer experience, perception of the value of computers, and computer self-efficacy. The results of the study revealed that perceived past success with computers and beliefs about the value of computers for personal needs have the strongest effects on self-efficacy. Those findings are consistent with the literature suggesting that computer self-efficacy is influenced by computer experience (Ertmer, et al., 1994; Kinzie, Delcourt, & Powers, 1994; Zhang & Espinoza, 1998). According to social cognitive theory, prior experience represents the most accurate and reliable source of self-efficacy information toward similar tasks. This relationship between computer self-efficacy and computer experience is consistent with Bandura's (1986) proposition that prior experience in social cognitive theory.

Brosnan (1998) investigated the effects of computer anxiety and self-efficacy on the performance of computer-related tasks with 50 undergraduate students. Brosnan (1998) found that computer anxiety was directly related to performance outcomes but the effect of self-efficacy related to how the outcomes were achieved. Researchers suggested that resistant computer users could be encouraged through enhancing their self-efficacy. They recommended the use of carefully designed software to assist in enhancing computer-related self-efficacy.

Pupil Control Ideology

Pupil control has been conceptualized along a continuum ranging from "custodialism" at one end to "humanism" at the other (Willower, Eidell, & Hoy, 1973). Willower, et al. (1973) defined pupil control ideology as a teacher's stated belief regarding the control of students in classrooms and schools. The Pupil Control Ideology Form (PCI) was constructed by Willower, et al. (1973) to measure the pupil control ideology of teachers on a humanistic-custodial continuum. Teachers with a custodial orientation tend to a) emphasize the maintenance of order, b) prefer impersonal relationships in the classroom, c) express mistrust of students, d) perceive students as irresponsible and undisciplined persons, and e) expect students to accept the decisions of teachers without question. At the other end of the scale, a humanistic pupil control orientation emphasizes a) an accepting, trustful view of students, b) confidence in students' ability to be self-disciplining, and c) that students are responsible.

Enochs, Scharmann, and Riggs (1989) conducted a study with 73 pre-service elementary education majors to examine the relationship of pupil control to self-efficacy and outcome expectancy. They found that pre-service teachers with higher science teaching self-efficacy scores had more humanistic orientations toward classroom management. However, the relationship between science teaching outcome expectancy and orientation toward classroom management was not significant.

Melby (1996) compared high efficacy and low efficacy elementary school teachers. A series of analysis of variance procedures indicated that teacher efficacy was significantly related to perceived stability of student behavior. High efficacy teachers were less likely to: judge their difficult students as having chronic behavior problems; more likely to expect student behavior improvement; less likely to feel angry, embarrassed, or guilty about student misbehavior, more likely to like problem students, and more likely to feel confident about being able to manage misbehavior. In addition, high efficacy teachers tended to possess stronger humanistic pupil control ideologies and tended to utilize fewer negative consequences and severe punishments.

Research has shown that teachers with a high teacher efficacy tend to favor more humanistic orientation and less controlling classroom management techniques when establishing and implementing frameworks for students' behaviors (Enoch, et al., 1995; Henson, 2001; Woolfolk & Hoy, 1990; Woolfolk, Rosoff, & Hoy, 1990). The ability to control students in a classroom is a critical factor in any educational setting (Brouwers, & Tomic, 2000). Two studies (Honey & Moelly, 1990; Sandholtz, Ringstaff, & Dwyer, 1997) have suggested a relationship between teachers' use of computers and their approach to classroom management. However, there is no research study investigating science teachers' pupil control orientation and use of technology in the classroom. Thus, there seems to be reason to investigate the possibility of relationships between pupil control ideology and science teachers' level of computer use.

Computer Experience

Researchers (Chen, 1986; Koohang, 1984, 1987; Papwich, Hyde, & Zakryjsek, 1987; Simonson, Maurer, Montag-Toaradi, & Whitaker, 1987) have found a positive correlation between computer knowledge, attitudes toward computers, and length of computer experience. Weil, Rose and Wugalter (1990) found that an individual's feelings about computers are influenced by the quality of his or her first experience with computers. According to the researchers, if a teacher's first experience in introducing computers to his students causes computer anxiety and discomfort with their teaching assignment, the teacher's first experience might cause later discomfort with technology (Weil, et al., 1990).

Computer experience has also been associated with determining computer use. Hill, Smith and Mann (1987) found a significant positive correlation between previous computer experience and computer self-efficacy beliefs in a sample of 133 female undergraduates. They found that experience only influenced behavioral intentions to use computers indirectly through self-efficacy. Thus, positive past experience with computers will increase self-efficacy beliefs. Ertmer, et al.(1994) found that although positive computer experience increased computer self-efficacy, the actual amount of experience (i.e., time on task) was not correlated with the self-efficacy beliefs of undergraduate students.

Miller and Olson (1995) examined how competent, non-technological teachers used computers for 10 years in a longitudinal study. They found that teachers' prior practice was more prominent in determining how technology was used than technology itself. Researchers mentioned that when the teachers preferred to use the computer software in different ways, they learned to look seriously at their prior practice for clues as to how they adapted programs to their curricula. Even though no data were available to calculate the effect size, the longitudinal nature of the research and the discussion indicate strong support for a relationship of prior practice to teachers' future computer use.

Parr (1999) studied efforts in teacher development and support for technology over five years. Forty-eight teachers had access to portable computers and ongoing, onsite professional development. The results of the study revealed that while teachers' personal use was extensive and their confidence levels and skills improved, use of computers in the classroom stayed low. Parr (1999) noted that teachers' personal pedagogical beliefs were identified as inhibiting implementation technology use in the classroom.

Kim (2002) examined the relationships between gender, computer experience, and overall academic performance on computer attitudes and user satisfaction. The results of the study revealed that computer experience and gender make a significant difference in the computer attitudes of the respondents. Compeau and Higgins (1995) found that self-efficacy had a significant effect on learning particular computer applications (i.e., WordPerfect, Lotus 1-2-3). Delcourt and Kinzie (1993) investigated teachers' attitude and self-efficacy in relation to computer technology. The results of their study ". . . suggest that experience with computers technologies, either through a course or through frequent use, is a critical area for examination in the study of attitudes and self-efficacy" (Delcourt & Kinzie, 1993, p. 40).

Prior experience influences a person's performance on computer-related tasks (Rozell & Gardner III, 2000). Chiero's (1997) quantitative study of 36 classroom teachers, who were enrolled in one of three different university courses, explored their perspectives on factors that promote or inhibit computer use. The results of the study revealed that the highest percentage of subjects used computers for preparing instructional materials (94.4%); the second most popular use was looking for information on particular subjects (58.3%). Multiple linear regressions analyzed the collective predictiveness of environmental factors (time training, technology-related support, access to computers, and collaboration) and individual characteristics (gender, age, experience, self-perception of computer expertise, and source of computer learning) on frequency of use for each activity. An individual teacher's self-description of computer expertise was found to be the strongest predictor of whether or not a teacher would use computers to prepare instructional materials. A higher self-rating for this task predicted more frequent use of computers.

Research findings revealed that teachers' feelings about computers were influenced by teachers' computer experiences. The quality of the first experience might cause computer anxiety and discomfort. Thus, there is a relationship between computer experience and teachers' attitudes toward computer and self-efficacy. When attempting to measure teachers' use of technology, it is necessary to consider their experience with technology. There is no research study examining exemplary science teachers' computer experience and how this influences their use of computers.

Age

There has been limited consistency in findings in the examination of age and computer use. Czaja and Sharit (1998) conducted a study of 384 participants who were divided into three age levels (29 to 39 years, 40 to 59 years, and 60 to 75 years). They found the older group had the lowest level of computer anxiety. In addition, the older participants actually had more overall positive attitudes toward computers than did the younger participants. However, Jennings and Onweuegbuzie (2001) found in their study that the youngest group of students reported less computer anxiety and higher levels of confidence than the other groups reported.

Becker (1999) examined teacher and student use of Internet as part of the *Teaching, Learning and Computing: 1998 Survey*. Study findings revealed that younger teachers were more likely to use the Internet for themselves or with students. Although younger teachers had less experience in teaching, their comfort with technology gives them great advantages in using technology (Becker, 1999).

Gender

Jennings and Onweuegbuzie (2001) examined whether or not the variables of age, gender, attitudes toward mathematics and student type were significantly related to the four dimensions of computer attitude: anxiety, confidence, liking, and usefulness. This study was conducted with a sample of 351 male and female undergraduate college students. Their study revealed that gender was not related to computer attitudes. But, in a study of 316 undergraduate college students, Smith and Necessary (1996) found that statistically males had more positive attitudes toward computers than females did. Chiero (1997) found that males were associated with more frequent computer use than females were. This finding is also consistent with other studies that found more male representation among exemplary computer-using teachers (Becker, 1994; Hadley & Sheingold, 1993).

Meta-analysis of gender differences regarding computer use, attitudes, and achievement revealed that there is a considerable difference between the factor of gender and computer use (Kay, 1992). Kay found that 78% of the 32 studies on computer use reported that males used computers more often than females were computers. Kay examined 98 studies on computer attitudes and gender. Half of these studies mentioned that males had more positive attitudes toward computers than females had. Almost half of the 48 studies examining gender differences and performance on computer-related activities revealed that males perform better than females perform.

Some studies have reported gender differences as a contributing factor in self-efficacy beliefs. Murphy, Coover, and Owen (1989) found gender differences in relation to self-efficacy for advanced skills and mainframe computer skills, with men showing higher self efficacy on both. However, there was no gender difference for beginning level computer skills. Cassidy and Eachus (2002) also found that males have significantly higher computer self-efficacy than females have. In addition, their study showed that training does not change the differences in self-efficacy. Males consistently showed higher computer self-efficacy than females showed in both trained and untrained groups (Cassidy & Eachus, 2002). On the other hand, Torkzadeh and Koufteros (1994) reported that the gender difference in computer self-efficacy is neutralized following training.

There is a difference between males and females on the basis of their perceptions of computers. Cooper and Stone (1996) mentioned that while females describe computers as tools to complete a task, males use more personal and intimate terms in describing them. The literature supports the idea that a teacher's gender might influence their use of technology. It is important to consider how gender could influence an exemplary science teacher uses of technology.

Summary

The use of technologies in teaching and learning is recommended in the National Science Education Standards (National Research Council [NRC], 1996), Project 2061: Science for All Americans (Rutherford & Ahlgren, 1989), and the National Educational Technology Standards (NETS) (ISTE, 2000). National studies examined the computer use and access in the secondary science classrooms. Although a majority of science teachers have an access to technology in their classroom, they are not using technology as recommended by state and national standards. This review of the literature has presented research findings about exemplary science teachers. These research studies noted that exemplary science teachers have all the characteristics that are recommended by professional associations, and state and national standards. But there is no research examining exemplary science teachers' use of technology. This review of literature has also presented evidence suggesting that self-efficacy in teaching with computers, pupil control ideology, computer experience, computer access, age, and gender are significant factors that influence a teacher's use of computers. Currently, there is no known study examining exemplary science teachers' use of technology and factors influencing their use of technology. The literature review indicates a need for future research into the factors affecting science teachers' level of computer use.

CHAPTER 3
METHODOLOGY

In this chapter the research questions that will guide the study are given, the selection and description of the study sample are identified and discussed, the data collection, instrumentation, and procedures are described, and the data analysis techniques to be used are presented.

Introduction

This study examines the following outcome variables regarding exemplary science teachers: their use of technology in science instruction; factors affecting their level of computer use; level of knowledge/skills in using specific computer applications/tools for science instructions; their use of computer-related applications/tools during their instruction, their students' use of computer applications/tools in or for their science class. Research indicates that factors influencing teachers' use of computers include: personal self-efficacy in teaching with computers; outcome expectancy; pupil control ideology; age; gender; teaching experience; personal computer use; professional computer use; and science teachers' level of knowledge/skills in using specific computer applications/tools for science instruction.

Research Questions

This study will investigate the relationship among factors affecting exemplary science teachers' levels of computer use. The following research questions will guide this study:

1. Are exemplary science teachers' levels of computer use associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, computer access in the classroom, gender, and science teachers' level of knowledge/skills in using specific computer applications/tools for science instructions?

2. Are exemplary science teachers' level of knowledge/skills in using specific computer applications for science instruction associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, teaching experience, personal computer use, professional computer use and teachers' use of computer related application/tool during class?

3. Are exemplary science teachers' uses of computer related applications/tools during their instruction associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, teaching experience, personal computer use, professional computer use and science teachers' level of knowledge/skills in using specific computer applications for science instruction?

4. Are exemplary science teachers' students use of computer applications/tools in or for their class associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, teaching experience, personal computer use, professional computer use, computer access in the classroom and science teachers' level of knowledge/skills in using specific computer applications for science instruction?

Selection and Description of the Study Sample

The sample for this study included middle and high school science teachers who received the Presidential Award for Excellence in Science Teaching (PAEST) from the White House and the National Science Foundation between the years 1997 and 2003 from all 50 states and U.S territories. Between 1997 and 2003, 355 secondary science school teachers (grades 7 through 12) have been awarded the PAEST.

Data Collection, Instrumentation, and Procedures

Data Collection

Award winning science teachers were contacted via e-mail or a letter about the survey (with a return envelope). The survey was posted online and an e-mail message was send to all exemplary science teachers requesting that they follow the included URL address to access the web-based survey. After one week, a reminder e-mail was sent to all exemplary science teachers who had yet to respond.

Participants received a copy of the Research Study Informed Consent form as an attachment to the e-mail. The informed consent document was in a Microsoft Word and pdf format (see Appendix A). Participants were asked to read the informed consent. On the first page of the survey, participants willing to participate in the study clicked on the box with the following wording: "I have read the above document and agree to participate." Those who clicked on the informed consent box continued forward to the online survey. Participants were not allowed to reach the survey unless they selected the informed consent box. All participants were informed that participation in this study was voluntary, that they may skip any survey questions they did not wish to answer, and that they may withdraw from the study without consequence. There were no anticipated risks, compensation, or other direct benefits to them as participants in this study. All participants were given information on how to contact the principal investigator, the supervisor, and the University of Florida Institutional Review Board (UFIRB) if they had any questions or concerns. Award-winning science teachers who did not provide their e-mail contact information were sent a packet via U.S. mail that included a hard copy of the questionnaire, a cover letter explaining the purpose of the study, Information Consent Form, and a postage-paid return envelope.

The main instrument of the study was a web-based questionnaire. The questionnaire is provided in Appendix B. The questionnaire has six general sections: 1) demographics (17 items); 2) the level of computer use (4 items); 3) specific computer applications for science instructions (19 items); 4) use of the Internet for science instruction (15 items); 5) self-efficacy in teaching with computers (21 items); and 6) pupil control ideology (10 items). The demographic data were collected with 16 items: 1) the year and state that they received the award; 2) highest degree of education; 3) current primary occupations; 4) last year that they taught; 5)main subject(s) taught by teachers; 6) current grade level taught; 7) gender; 8) age; 9) amount of teaching experience; 10) amount of experience that teachers have in using computers for personal use; 11) amount of experience that teachers have in using computers for classroom productivity and instruction; 12) source of computer knowledge; 13) the most significant professional development computer learning experience for the participant; 14) participation to the professional development activities; 15) number of hours spent using a computer for personal use, professional development, and science teaching; and 16) access to computers and the Internet at home, in the science classroom/science lab, computer lab at the school and in the library/media center.

Instrumentation

Along with the demographic information collected, this study used the *Level of Computer Use* assessment (Marcinkiewicz & Welliver, 1993), *Microcomputer Utilization in Teaching Efficacy Beliefs Instrument (MUTEBI)* (Enochs, Riggs, & Ellis, 1993), *The Pupil Control Ideology (PCI)* (Willower, Eidell and Hoy, 1973) and the *Technology Use in Science Education Scale* (TUSES) (developed for this study). The number of items, reliability coefficients, and types of instrument (i.e., adapted or researcher-created) are summarized for each component of the survey in Table 3-1.

The outcome variables in this study is included The *Level of Computer Use,* teachers' level of knowledge/skills in using specific computer applications for science instruction; science teachers' use of computer related application/tool during their instruction; and their students' use of computer applications/tools in or for their science class. The explanatory variables in this study are comprised of: personal self-efficacy in teaching with computers; outcome expectancy; pupil control ideology; level of computer use; age; gender; teaching experience; personal computer use; professional computer use and science teachers' level of knowledge/skills in using specific computer applications for science instruction. The complete survey can be found in Appendix B.

Table 3-1. List of Number of Items, Reliability and Source of Each Scale

Description	#of Items	Reliability Coefficient
Outcome (dependent) variable		
Levels of Computer Use (LCU)	4	.96
Technology Use in Science Education Scale (TUSES)	34	Researcher-created
Teachers' level of knowledge/skills in using specific computer applications for science instruction	34	
Science teachers' use of computer related application/tool during their instruction		
Their students' use of computer applications/tools in or for their science class	34	
	34	
Explanatory (independent) variables		
Self-efficacy in Teaching with Computers (MUTEBI)	21	
Outcome expectancy	7	.78
Personal self-efficacy	14	.91
Pupil Control Ideology Scale (PCI)	10	.71
Demographic information	17	Researcher-created

Outcome Variables

The level of computer use is the outcome variable to be used in this study. *The Level of Computer Use* (LCU) scale (Marcinkiewicz & Welliver, 1993) used to classify each teacher's use of computers into one of three levels includes: Nonuse, Utilization or Integration. The LCU is based on the Model of Instructional Transformation

(Marcinkiewicz & Welliver, 1993; Reiber & Welliver, 1989). The Model of Instructional Transformation uses Vroom's Expectancy Theory (1964) to explain how teachers progress through five stages of involvement with computers (Reiber & Welliver). These five stages are *familiarization*, *utilization*, *integration*, *reorientation*, and *evolution*. The Level of Computer Use assessment is a paired comparison design adapted from the *Level of Computer Use* assessment developed by Marcinkiewicz and Welliver, which identifies only two levels of use: *utilization* and *integration*. Marcinkiewicz and Welliver defined "use" as "the integrated employment of computers in teaching" (p. 2). At the utilization level, the absence of computers in the classroom does not prevent the implementation of instruction by a teacher. However, at the integration level, teachers integrate computers as another instructional tool and prepare the instruction around computer-related activities. Hence, the absence of computers in the classroom prevents implementation of instruction. Marcinkiewicz and Welliver (1993) described the distinction between the utilization and integration levels in terms of:

> the expendability of the computer technology. Expendability describes the relationship of computer technology to a teacher's planned instruction--whether or not instruction would be able to continue in the hypothetical event of, say the sudden absence of computer technology. It is this dimension of expendability that was identified as the cut-off for membership in either category." (p. 2)

The Level of Computer Use assessment in this study uses four sets of paired statements. For each pair of statements, respondents are asked to select the one statement with which they most agree (see Table 3-2).

The responses are scored using the following scheme. Items that identify the utilization level are assigned a value of 1, and items that identify the integration level are assigned a value of 2 (Marcinkiewicz & Welliver; 1993). After adding teacher responses for the four items, a score of 4 indicates a teacher is at the utilization stage, and a score of 8 indicates a teacher is at the integration stage (Marcinkiewicz & Welliver, 1993). Teachers with scores of 5, 6, or 7 are considered to be at the utilization level. The *Level of Computer Use* assessment has a coefficient of reproducibility of .96 (Marcinkiewicz & Welliver).

Table 3-2. The Levels of Computer Use Assessment Items

Item		Statement	Level	
1.	a.	In my instruction, the use of the microcomputer is supplemental.	*	(1)
	b.	The microcomputer is critical to the functioning of my instruction.	**	(2)
2.	a.	The use of the microcomputer is not essential in my instruction.	*	(1)
	b.	For my teaching, the use of the microcomputer is indispensable.	**	(2)
3.	a.	The microcomputer is critical to the functioning of my instruction.	**	(2)
	b.	The use of the microcomputer is not essential in my instruction.	*	(1)
4.	a.	For my teaching, the use of the microcomputer is indispensable.	**	(2)
	b.	In my instruction, the use of the microcomputer is supplemental.	*	(1)

** Indicates an item at the integration level.
* Indicates an item at the utilization level.

During the development of the LCU assessment, four items were selected from 15 items on the basis of a field test with a sample of 50 elementary schoolteachers. In a subsequent field test of the survey, 23 elementary schoolteachers responded to the survey. The estimated reliability of the LCU from this second field trial using the Coefficient of Reproducibility (CR) was .74. Following the second trial, researchers reworded one of the items. The new version of the LCU was administered to 170 elementary schoolteachers. In this trial, the CR was calculated at .96. The teachers were also asked to respond to a control item about their self-reported computer use. The responses of the teachers to the control item were matched with those on the LCU. Researchers used that information to provide additional data for estimating criterion-related validity.

Responses indicated a high level of criterion-related validity (Marcinkiewicz & Welliver, 1993). Consistency of classification was estimated by calculating Cohen's kappa (Kappa= .72) (Marcinkiewicz & Welliver). Cronbach's alpha reliability coefficient for this study sample was 0.95.

Explanatory Variables

The Microcomputer Utilization in Teaching Efficacy Beliefs Instrument (MUTEBI) is a 21-item Likert-type self-reported measure of "the self-efficacy beliefs of teachers as they relate to utilizing microcomputers in science instruction" (Enochs, Riggs, & Ellis, 1993, p. 258). The MUTEBI contains two subscales: Personal Self-Efficacy (SE) and Outcome Expectancy (OE), which are consistent with the theoretical construct of self-efficacy (Bandura, 1986, 1997). The Personal Self-Efficacy scale evaluates "teachers' beliefs in their own ability to utilize the microcomputer for effective instruction" (p. 258). The Outcome Expectancy items measure "teachers' beliefs with regard to teacher responsibility for students' ability or inability to utilize the microcomputer in the classroom" (p.258). The MUTEBI was derived from the Science Teaching Efficacy Beliefs Instrument, Form A (STEBI A) (Riggs & Enochs, 1990). The items at the Table 3-3 show the similarities between the two instruments:

Table 3-3. Comparison between STEBI-A and MUTEBI

ITEM	STEBI-A	MUTEBI
Self efficacy		
1. Even if I try very hard, I do not teach science as well as I do most subjects.	*	
2. Even when I try very hard, I do not use the computers as well as I do other instructional resources.		*
Outcome Expectancy		
1. If students are underachieving in science, it is most likely due to ineffective teaching.	*	
2. If students are unable to use the computer, it is most likely due to their teacher's ineffective modeling.		*

In the creation of the MUTEBI, three science and two computer educators reviewed the items after the modification to the STEBI A was made. The MUTEBI utilized a Likert scale format with response categories of: strongly agree, agree, uncertain, disagree, and strongly disagree. The initial form of MUTEBI consisted of 8 items for the Outcome Expectancy scale and 14 items for the Personal Self Efficacy scale. The original version was administered to 119 science teachers. After the initial items analysis, one item was dropped from the Outcome Expectancy scale. The initial reliabilities for this sample were .78 for the OE scale and .91 for the SE scale. After the revision to the scale, new teachers were added to the original sample (n=197). Factor analysis procedures were applied to the revised scale. The two factors emerged with eigenvalues greater than 1. To test the validity of the two constructs proposed by Bandura (1981), a confirmatory factor analysis was run.

To cross-validate the two scales, respondents were asked two additional questions: "(1) How long have you been using microcomputers in science teaching? and (2) In your use of microcomputers in science teaching, do you consider yourself a nonuser, novice, user, expert, or past user?" (p. 259). According to the researchers, this version of the MUTEBI instrument provides a valid and reliable measure of computer self-efficacy that can be used in a variety of research settings (Enochs et al., 1993). Cronbach's alpha reliability coefficient for this study sample was 0.84 for the OE scale and 0.92 for the SE scale.

The Pupil Control Ideology Form (PCI). In this study, pupil control ideology was measured by the PCI form (Willower, et al., 1973). The PCI was constructed by Willower, Eidell and Hoy to measure the pupil control ideology of teachers on a humanistic-custodial continuum. Reliability for the Pupil Control Ideology form was established by Willower et al. on 170 teachers using correlated split-half and odd-even item sub-scores in a test-retest situation using a Pearson product-moment coefficient (0.91) and a Spearman-Brown formula (0.95). The validity of the survey was established by using principals' judgments concerning the ideology of selected teachers. The original scale included 20 items. The reliability of the instrument is high. Internal consistency estimates exceeded .90, and stability coefficients generally ranged from .65 to .85 (Woolfolk, Rosoff, & Hoy, 1990). The dimensionality of the PCI has been investigated with a sample of 199 primary and intermediate teachers (Graham & Benson, 1985). Researchers performed exploratory and confirmatory factor analysis on the results and found that a 10-item single factor version of the scale provided the best description of the data. Items such as "Pupils can be trusted to work together without supervision" (humanistic) and "Pupils often misbehave in order to make the teacher look bad" (custodial) are rated on a scale ranging from "1" (strongly agree) to "5" (strongly disagree), with a score range of 10 (intense humanistic orientation) to 50 (intense custodial orientation). All items are scored and summed so that the higher the score, the more custodial the orientation. The alpha reliability coefficient of the 10-item version is .71. Cronbach's alpha reliability coefficient for this study sample (exemplary science teachers) was 0.75. This 10-item version, using a 5-point Likert-type response scale, ranging from strongly agree to strongly disagree, was used in this study.

Instrument development procedures for the *Technology Use in Science Education Scale*

The *Technology Use in Science Education Scale* (TUSES) was developed for this study to gather information about a science teacher's computer use. This scale was developed based on an extensive literature review of the different ways science teachers use computers in the teaching of science.

The *Technology Use in Science Education Scale* (TUSES) consists of 72 items in two sections. The first section measures a respondent's personal use of computers in science education (21 items). For each item, a teacher's current level of knowledge and skills is measured using a 5-point Likert scale: "0" indicating none of knowledge; "1" indicating a little, "2" moderate level; "3" a high level; and "4" indicating expert. A teacher's personal use of technology is measured using a 4-point Likert scale: "0" indicating no personal use of computer application; "1" indicating use of application less than six times a year; "2" one to three times a month; and "3" more than once a week.

The second section covers 51 items associated with a respondent's use of specific computer applications for science instruction. Each item in the second section is measured in three ways: a teacher's current level knowledge/skills; a teacher's instructional use of each application; and students' use of specific computer applications. A teacher's current level of knowledge and skills of a specific computer application for science instruction is measured using a 5-point Likert scale: "0" indicating none of knowledge; "1" indicating a little; "2" moderate level; "3" a high level, and "4" expert. A teacher's instructional use of each application and students' use of specific computer applications is measured using a 4-point Likert scale: "0" indicating no personal use of computer application; "1" indicating use of application less than six times a year; "2" one to three times a month; and "3" more than once a week.

Pilot Study

A panel of eight experts (three science education professors, one instructional technology professor, one science education doctoral student with an instructional technology emphasis, and three instructional technology doctoral students with an science background) validated the content and face validity of the instrument. A Content Expert Review Questionnaire and A Survey of Technology Use in Science Education Evaluation Form (see Appendix C) were provided to all the experts so they could provide their best professional judgment on the relevance, clarity, and appropriateness of each item and identify potential survey problems, such as ambiguous or difficult questions, irrelevant items, missing items, terms that need clarification, or survey format. On the basis of their response, modifications to the instrument were made before the pilot test was distributed. One of the items was divided into two parts because of the ambiguity of the item. Nine of the items from the second part of the survey were eliminated on the basis of the experts' suggestions because of the potential confusion of the items. Survey items were reorganized on the basis of the similarities of the items.

The *Technology Use in Science Education Survey,* an online survey and paper version of the survey (a total of 63 items), was pilot-tested by administering it to the members of the Florida Science Teachers Associations. The researcher sent an e-mail to a selected list of science teacher listserv moderators to seek permission to send an e-mail seeking study participants to the organization's listserv. Once permission was given, the researcher sent an email to the listserv members, which included an introduction to the study, informed consent documents, inclusion criteria, and a link to the online survey. In both data gathering procedures, a reminder e-mail was sent one week after the original e-mail. The Survey Instrument was pilot-tested by administering it to the science teachers attending the University of Florida Mini Med School Workshop (n=15) (paper version) on the 6th of October, 2004 and the Florida Association of Science Teachers Conference (n=59) (14 paper version and 45 web-version) on the 15th of October, 2004. A total of 74 middle and high school science teachers completed the survey. Before the final distribution of the survey, the survey instrument was revised based on the results of the pilot study. By using the pilot study data, an item analysis was conducted on all items. Item analysis enables the evaluation of the quality of the items. If all the respondents answered the same way on one item, there is no variability in the response (spread), and the item is not providing enough information to discriminate against the respondents. Therefore, these items either should be revised or removed from the survey instrument on the basis of the importance of the item for the survey.

Based on the results of the pilot study, the survey was revised before its final distribution. Using the result of the pilot study, the quality of the survey items was evaluated by performing an item analysis using SPSS. The following items were eliminated from the study: items 28 (calculator based laboratory), item 29 (word processing), item 36 (Hyperstudio, Hypercard), item 38 (digital microscopy), item 47 (microcomputer-based laboratories), item 51 (discussion groups (listserv and newsgroups), and item 61 (participating in joint projects). Item 48 was divided into two items as "online communication between teachers and students (e-mail)" and "online communication between teachers and students (online discussions)'. A total of 56 items remained for the survey. Reliability analysis of each component of the survey is provided in Table 3-4. It should be noted that it is possible that there was no spread of responses on certain items because those specific technology applications/tools were uniformly used or not used by science teachers in this study. Nonetheless, items not providing sufficient information to discriminate were eliminated. Because of the length of the survey, only the second part of the survey was used in this study.

Table 3-4. Reliability – Cronbach's Alpha Values

	Cronbach's alpha
Section 1-Professional use of computers in science education	
Teachers' knowledge/skills	.95
Teachers' professional use	.86
Section 2- Use of specific computer application for science instruction	
Teachers' knowledge/skills	0.96
Teachers' instructional use	0.90
Students' use of technology	0.92

Data Analysis Techniques

The variables for this study were chosen based on guidance from the literature. The variables selected for analysis included: exemplary science teachers' self-efficacy beliefs about teaching with computers; pupil control ideology; computer experience; computer access; age; and gender. Descriptive and inferential statistics were conducted on survey data. Descriptive statistics of frequency, percentages, and standard deviation were reported. For the first research question, survey responses were analyzed with regression analysis procedures using exemplary science teachers' level of computer use with the outcome variable defined by the Hooper-Rieber Model on stages of development. Scores for this outcome (dependent) variable correlated with scores for each explanatory (independent) variable of exemplary science teachers' self-efficacy beliefs about teaching with computers, outcome expectancy, pupil control ideology, computer access in the classroom, gender, and science teachers' level of knowledge/skills in using specific computer applications/tools for science instruction. Regression analysis was used to model the relationship between the response variable and the set of explanatory variables.

The first regression formula used in the study is:

$$Y = \alpha + \beta_1 X_1 + + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$$

When the six explanatory variables are placed in the regression model, the following formula results:

Exemplary science teachers' levels of computer use = α (constant)+ β_1*(self-efficacy in teaching with computers) + β_2 *(outcome expectancy)+ β_3*(pupil control ideology)+ β_4*(computer access in the classroom)+ β_5*(gender) + β_6*(science teachers' level of knowledge/skills in using specific computer applications/tools for science instruction) + ε (error).

The regression formula for the second research question is as follows:

$$Y = \alpha + \beta_1 X_1 + + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \varepsilon$$

When the nine explanatory variables are placed in the regression model, the following formula results:

Exemplary science teachers' level of knowledge/skills in using specific computer applications for science instruction = α (constant)+ β_1*(personal self-efficacy in teaching with computers) + β_2 *(outcome expectancy)+ β_3*(pupil control ideology)+ β_4* (level of computer use)+ β_5*(age) +β_6*(gender)+β_7*(personal computer use)+β_8*(professional computer use)+β_9*(teachers' use of computer-related applications/tools during class)+ ε (error).

The regression formula for the third research question is as follows:

$$Y = \alpha + \beta_1 X_1 + + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \varepsilon$$

When the nine explanatory variables are placed in the regression model, the following formula results:

Exemplary science teachers' uses of computer-related applications/tools during their instruction = α (constant)+ β_1*(personal self-efficacy in teaching with computers) + β_2 *(outcome expectancy)+ β_3*(pupil control ideology)+ β_4* (level of computer use)+ β_5*(age) +β_6*(gender)+β_7*(personal computer use)+β_8* (professional computer use)+β_9 (science teachers' level of knowledge/skills in using specific computer applications for science instruction)+ ε (error).

The regression formula for the fourth research question is as follows:

$$Y = \alpha + \beta_1 X_1 + + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \varepsilon$$

When the 11 explanatory variables are placed in the regression model, the following formula results:

Exemplary science teachers' students use of computer applications/tools in or for their class = α (constant)+ β_1*(personal self-efficacy in teaching with computers) + β_2 *(outcome expectancy)+ β_3*(pupil control ideology)+ β_4* (level of computer use)+ β_5*(age) +β_6*(gender)+β_7*(teaching experience)+β_8*(personal computer use)+β_9*(professional computer use)+β_{10} (computer access in the classroom)+ β_{11} (science teachers' level of knowledge/skills in using specific computer applications for science instruction)+ ε (error).

Summary

Chapter 3 described the method used to investigate the study. The major instruments will be the *Level of Computers Use* assessment (Marcinkiewicz & Welliver, 1993), the *Microcomputer Utilization in Teaching Efficacy Beliefs Instrument (MUTEBI)* (Enochs, et al., 1993), *The Pupil Control Ideology (PCI)* (Willower, et al., 1973), and *Technology Use in Science Education Scale* (TUSES) (developed for this study). Logistic regression will be used to model the relationship between the response variable and the set of explanatory variables.

CHAPTER 4
PRESENTATION AND ANALYSIS OF DATA

This study examines exemplary science teachers' use of technology in science instruction, factors influencing their level of computer use, level of knowledge/skills in using specific computer applications for science instruction, their use of computer-related applications/tools during their instruction, and their students' use of computer applications/tools in or for their science class. After a relevant review of the literature, certain variables were selected for analysis. These variables included personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, teaching experience, personal computer use, professional computer use and science teachers' level of knowledge/skills in using specific computer applications for science instruction.

Survey Responses

A total of 355 middle and high school science teachers received the Presidential Award for Excellence in Science Teaching (PAEST) in the period between 1997 and 2004. Award-winning science teachers' names were obtained from the PAEMST webpage. Most of these 355 teachers were e-mailed a request to participate in the study. Sixty-two of awardees did not provide their e-mail address on the web-page and could not be contacted via e-mail. After the first e-mail request (n = 293), 58 of these messages were returned to the sender due to inactive e-mail accounts. A second e-mail message was sent to those science teachers after verifying each address. As a result of the second e-mail, 41 message addresses were returned as invalid. A total of 67 teachers responded to the first request and, of those, 57 award winning science teachers' surveys were valid. Those science teachers with valid e-mail addresses who had not responded to the first e-mail request to participate were sent a second message requesting their participation. Fifteen awardees responded to the reminder e-mail making a total of 72 (28.6%) who responded completely to the questionnaire.

Because 62 of the award-winning science teachers did not provide their e-mail address and 41 of the e-mail addresses were returned as invalid, a total of 103 packets were mailed to them via U.S. postal service. The packets included questionnaire, a cover letter explaining the purpose of the study, and a postage-paid return envelope. Eleven envelopes were returned as undeliverable. A total of 20 responses (24.4%) were received from these teachers. Of the 334 award-winning science teachers, usable responses were received from a total 92 science teachers, making a response rate of 27.5%.

Sample Profile

Demographic Characteristics

Table 4-1 provides the distribution of exemplary science teachers by gender. Of the 92 respondents, 35 (38%) were male and 55 (59.8 %) were female. Two respondents did not report their gender. Table 4-1 also provides the distribution of exemplary science teachers by age.

Eighty-nine of the respondents reported information about their ages. The age of respondents ranged from 33 to 65 years. Ages were reported in 10 year increments with 10 (10.9%) subjects falling into the 30 to 39-year-old bracket; 37 (40.2%) in the 40 to 49-year-old bracket; 37 (40.2%) in the 50 to 59-year-old bracket; and 5 (5.4%) in the 60 to 69-year-old bracket.

Table 4-1. Participant Characteristics – Gender and Age (n=92)

Characteristics		n	%
Gender (n=90)			
	Male	35	38.0
	Female	55	59.8
Age (n=89)			
	33- 39	10	10.9
	40-49	37	40.2
	50-59	37	40.2
	60-69	5	5.4

Educational Experience

Table 4-2 provides the distribution of exemplary science teachers by the highest academic degree earned. Of those who responded, 14 (15.2%) teachers reported having earned doctorates in science education-related areas. Three (3.3%) respondents reported holding educational specialist degrees. Sixty-seven (72%) respondents reported holding a master's degree, and eight (8.7%) respondents reported having a bachelor's degree.

Table 4-2. Participant Characteristics – Highest Degree (n=92)

Characteristics		n	%
Highest degree earned (n=92)			
	4-year college degree	8	8.7
	Master's degree	67	72.8
	Educational specialist	3	3.3
	Doctoral degree	14	15.2

Teaching Experience

The number of years served as a science teacher ranged from 8 to 41 years with a mean of 22.13 years (see Table 4-3). Teaching experience was reported in 10-year increments with 2 (2.2%) subjects in the 8 to 9-year range of teaching experience; 32 (35.6 %) falling in the 10 to 19-year range; 37 (41.1 %) falling in the 20 to 29-year range; 18 (20.0 %) falling in the 30 to 39-year range; and 1 (1.1%) falling in the 40 to 41-year range. Teachers reported that they taught grades 6 to 8 (20%) or grades 9 to 12 (69.6%) with only a small percentage of teachers instructing grades 7 through 12 (5.7%). Twenty-nine taught courses in biology (31.6%), 23 in physics (25%), 22 in chemistry (23.8%), 9 in physical science (9.8%), and 32 in the other sciences (34.92%).

Table 4-3. Participant Characteristics –Teaching Experience (n=92)

Characteristics	n	%
Teaching experience (n=90)		
1-9	2	2.2
10-19	32	35.6
20-29	37	41.1
30-39	18	20.0
40-41	1	1.1
Current grade level (s) taught (n=87)		
6-8 grades	18	19.6
9-12 grades	64	69.6
6-12 grades	5	5.4
Main subjects(s) taught (n=92)		
Biology	29	31.6
Physics	23	25.0
Chemistry	22	23.8
Physical science	9	9.8
Other sciences	32	34.9

Computer Experience

Table 4-4 provides a summary of demographic characteristics that describe exemplary science teachers' computer experience. When asked how many years they have been using computers for personal purposes, all 92 respondents reported more than six years of computer use. The percentage of teachers using computers more than 10 years was 92.5%. Only 5.4% of science teachers reported less than 10 years of personal computer use. The respondents had a range of 6 to 25 years of computer use in their classroom for professional purposes with a mean of 13.60.

Table 4-4. Participant Characteristics – Computer Experience (n=92)

Characteristics	n	%
Personal use of computers (n=90)		
6 to 9 years	5	5.4
10 to 19 years	49	53.3
20 to 29 years	34	37.0
30 to 35 years	2	2.2
Professional use of computers (n=90)		
0 to 9 years	20	21.7
10 to 19 years	54	58.7
20 to 25 years	16	17.4

Computer Access

The *Technology Use in Science Education Scale* asked for information about exemplary science teachers' access to computers in their home, in the science classroom/science lab, in the computer lab at school, and in the library/media center. Of all the respondents, 89 (97.8%) had access to computers in their home, 85 (96.6%) in their science classroom/science lab, 81 (93.1%) in computer lab at school, and 81 (97.6%) in the library/media center. Figure 4-1 presents the number of computers available in science classrooms/science labs, in computer labs at school, and in the library/media center. While 72.8% of teachers reported having more than three computers in their classroom, all of the teachers reported that six or more computers were available in computer labs at school.

When asked if they have Internet access and the speed of that access, 97.7% of the science teachers reported having Internet access at their home. Of those who have access to the Internet, 58.1% of them have high speed Internet access. Ninety-seven percent of science teachers reported having internet access in science classrooms/science labs, and 89.5% had high speed Internet connection in science classrooms/science labs. All the participants reported that computers in the computer lab were connected to the Internet, and 87.7% of them have a high speed connection. Ninety-eight percent of the respondents reported having Internet access in libraries/media centers, 87.7% of them having a high speed Internet connection.

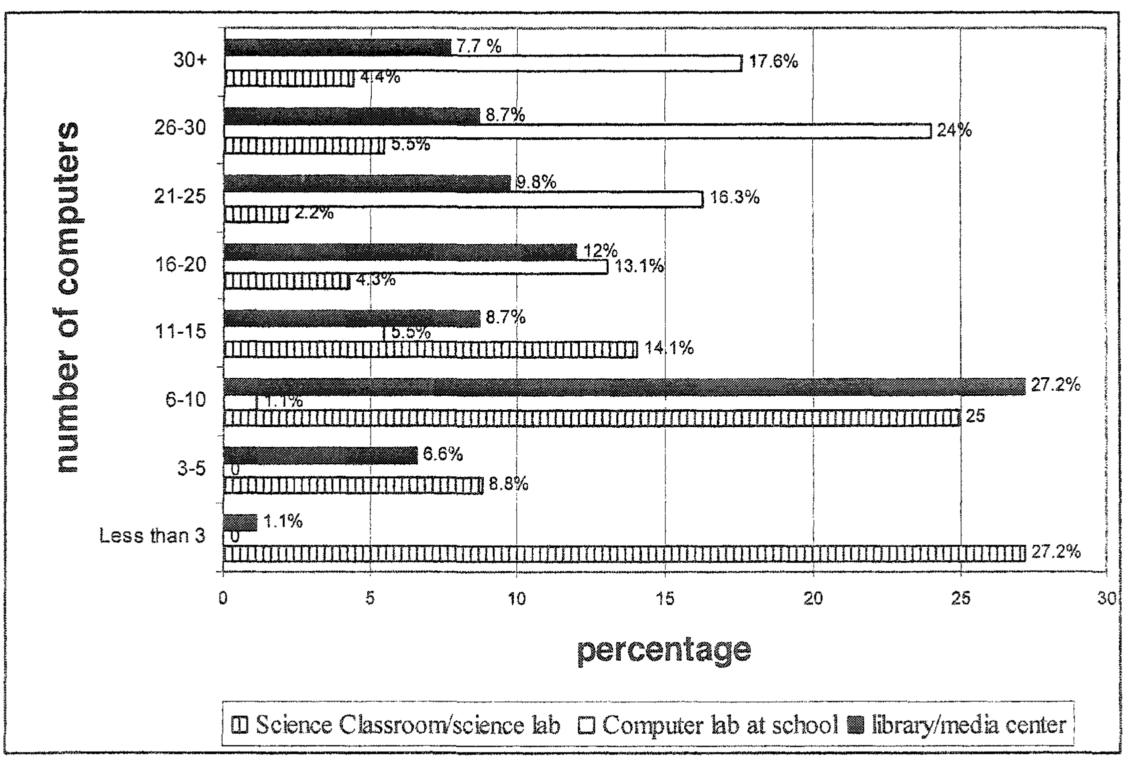

Figure 4-1. The number of computers available in science classrooms/science labs, computer lab at school, and in the library/media center

Source of Computer Knowledge

Exemplary science teachers indicated that they learned how to use technology through different professional development activities (see Table 4-5). Ninety-five percent of the exemplary science teachers reported that they learned how to use technology by themselves ("learned on my own"). Educator conferences and state/district/school level workshops also provided information on how to use technology (82% and 83.9%, respectively). Fifty-five percent of the respondents indicated university coursework helped them learn how to use technology.

Table 4-5. Percent of Teachers Reporting Participating in Professional Development Activities (n=92)

Professional Development Activities	Frequency	Percent (%)
Educator conference	72	82.0
University course work (for credit)	48	55.1
State/district/school level workshop	73	83.9
Non-school sponsored workshop	48	55.2
Private vendors	30	34.4
Learned on my own	83	95.4
Web-based instruction	35	40.2

Exemplary science teachers were asked what they considered the best source of professional development in learning how to use technology. "Learned on my own" was identified by 39.1% of the exemplary science teachers as the best source of learning. Twenty-one percent of science teachers reported educator conferences as the best source (Table 4-6).

Science teachers' responses varied when asked how many hours of professional development related to the use of the computers during the last five years. Teacher responses ranged from 1 to 100 hours with a mean of 22 hours.

Table 4-6. Percent of Teachers reporting the best source of professional development (n=92)

Professional Development Activities	Frequency	Percent
Educator conference	20	21.8
University course work (for credit)	7	7.6
State/district/school level workshop	19	20.6
Non-school sponsored workshop	6	6.6
Private vendors	3	3.3
Learned on my own	36	39.1
Web-based learning	1	1.1

Exemplary science teachers were asked to indicate their present level of knowledge/skills in using the specified technology. Science teachers rated their level of knowledge/skills [i.e., "0", none; "1", a little; "2", moderate; "3" high; "4", expert] in two sections of the survey. Nineteen items covered specific computer applications for science instruction, and 15 items covered use of the Internet for science instruction (see Table 4-7).

Results of the study showed that science teachers are most proficient in: information retrieval via the Internet (M= 3.31); presentation tools (M = 3.1); online communication (e-mail) between teacher and students (M= 3.27); digital cameras (M=2.76); data collection probes (M=2.62); and encyclopedias and other references on

Table 4-7. Science Teachers' Present Level of Knowledge/Skill in Using Specific Computer Applications for Science Instruction

	None	A little	Moderate	High	Expert		
	0	1	2	3	4	M	S.D.
1. Digital cameras		7.7	29.7	41.8	20.9	2.76	0.87
2. Digital video cameras	14.4	17.8	31.1	25.6	11.1	2.01	1.21
3. Video editing software (e.g., Video Maker, iMovie)	39.3	18.0	27.0	10.1	5.6	1.25	1.24
4. Graphing Calculators	14.4	13.3	34.4	23.3	14.4	2.1	1.24
5. Presentations (e.g., PowerPoint, KidPix)	1.1	3.4	24.7	1.1	44.9	3.1	0.97
6. Graphing software	8.9	14.4	24.4	30.0	22.2	2.42	1.24
7. Databases (e.g., Access, record keeping)	6.6	18.7	30.8	22.0	22.0	2.34	1.2
8. Statistical programs (e.g., SPSS)	51.1	25.6	14.4	4.4	4.4	0.86	1.11
9. Spreadsheets (e.g., Excel)	4.4	14.4	31.1	31.1	18.9	2.46	1.09
10. Encyclopedias and other references on CD-ROM	7.7	6.6	30.8	26.4	28.6	2.62	1.19
11. Web page authoring software (e.g., Front Page)	24.2	23.1	23.1	17.6	12.1	1.7	1.34
12. Concept mapping software (e.g., Inspiration)	33.0	24.2	15.4	14.3	13.2	1.51	1.42
13. Simulations (e.g., ExploreScience, Frog Dissection, etc.)	21.1	13.3	28.9	23.3	13.3	1.94	1.33
14. Drill and practice programs (e.g., GeoSafari Animals, Brain Quest)	31.9	25.3	24.2	11.0	7.7	1.37	1.25
15. Individualized instruction-tutorials (e.g., ChemTutor, Science For Kids, The Learn About)	34.1	25.3	19.8	13.2	7.7	1.35	1.29
16. Problem solving software (e.g., Botanical Gardens, Thinkin' Science ZAP!)	54.4	21.1	16.7	3.3	4.4	0.82	1.11
17. Modeling Software (e.g., Model It)	60.7	19.1	11.2	9.0	0	0.69	1
18. Educational Games (e.g., VisiFrog)	46.7	24.4	16.7	6.7	5.6	1	1.19
19. Data Collection probes and computers (e.g., Vernier, PASCO, Texas Instrument)	4.5	13.5	25.8	28.1	28.1	2.62	1.16

Table 4-7-continued. Science Teachers' present Level of Knowledge/Skill in Using Internet for Science Instruction

	None	A little	Moderate	High	Expert		
	0	1	2	3	4	M	SD
20. online communication **(e-mail)** between teacher and students	1.1	5.5	11.0	29.7	52.7	3.27	.94
21. online communication **(online discussions board)** between teacher and students	29.7	11.0	23.1	19.8	16.5	1.82	1.47
22. online communication between students (e.g. online discussion board)	18.9	17.8	18.9	16.7	27.8	2.17	1.49
23. online communication between students and science Experts/ Mentors/ Scientists (e.g., Ask a Scientist)	22.5	19.1	22.5	19.1	16.9	1.89	1.40
24. video conferencing with others	47.8	17.8	17.8	10.0	6.7	1.10	1.29
25. information retrieval via the Internet	1.1	2.2	12.1	34.1	50.5	3.31	.85
26. collect real-time data (e.g. Whale Watch)	27.0	22.5	20.2	18.0	12.4	1.66	1.37
27. analyze online science data	21.1	23.3	27.8	17.8	10.0	1.72	1.26
28. access online databases (e.g., test locator database)	29.7	23.1	23.1	15.4	8.8	1.51	1.30
29. access to online journals (e.g., education weekly)	15.6	17.8	16.7	24.4	25.6	2.27	1.42
30. conduct web-based Internet labs	26.1	19.3	27.3	12.5	14.8	1.70	1.37
31. online simulations	20.9	12.1	35.2	15.4	16.5	1.95	1.34
32. take virtual science trips to museums, zoos, science centers, etc.	33.7	20.2	19.1	11.2	15.7	1.55	1.45
33. use remote Web Cam to observe distant location	46.7	15.6	16.7	10.0	11.1	1.23	1.41
34. Webquests	34.4	15.6	21.1	13.3	15.6	1.60	1.47

CD-ROM (M= 2.62). These findings show that most of the exemplary science teachers have little or moderate level of knowledge/skills in using specific computer applications for science instructions. While 44.9% of science teachers reported their level of knowledge/skills in using presentation tools as "expert," they reported not having any knowledge/skills on: modeling software (60.7%); problem-solving software (54.4%); statistical programs (51.1%); educational games (46.7%); individualized instruction tutorials (34.1%); concept mapping software (33%); and drill and practice programs (31.9%). While more than half of the science teachers reported that their level of knowledge/skills in information retrieval via the Internet and online communication as expert, they reported not having any knowledge/skills on video conferencing with others (47.8%) and use of the remote Web Cam to observe distant locations (46.7%). Only 34.5% of the exemplary science teachers reported that they have high/expert level of knowledge on collecting real-time data. While 15.6% of the science teachers reported that their level of knowledge/skills in Webquest as an expert, 34% of them reported not having any knowledge/skills in Webquest. While 27.3% of the science teachers reported that their knowledge/skills in conducting web-based Internet labs as high/expert, 26% reported not having any knowledge/skills in conducting web-based Internet labs.

Science teachers reported how often they used the specific computer applications/tools in their instruction (see Table 4-8). Science teachers rated their use of the specific computer applications/tools in science instruction [i.e., "0," none; "1," less than six times a year; "2," one to three times a month; "3," more than once a week] in two sections of the survey. The most frequently used computer applications/tools are: information retrieval via the Internet (M=2.16); online communication (M=1.71);

Table 4-8. Science Teachers' Use of the Specific Computer Applications/Tools in Science Instruction

	0	1	2	3	M	S.D.
1. Digital cameras	16.7	46.7	27.8	8.9	1.65	0.85
2. Digital video cameras	48.3	32.6	15.7	3.4	0.74	0.85
3. Video editing software (e.g., Video Maker, iMovie)	66.7	24.1	5.7	3.4	0.46	0.76
4. Graphing Calculators	36.0	24.7	15.7	23.6	1.27	1.18
5. Presentations (e.g., PowerPoint, KidPix)	9.0	41.6	24.7	24.7	1.65	0.95
6. Graphing software	21.6	39.8	27.3	11.4	1.28	0.93
7. Databases (e.g., Access, record keeping)	42.2	28.9	12.2	16.7	1.03	1.11
8. Statistical programs (e.g., SPSS)	75.0	20.5	4.5		0.3	0.55
9. Spreadsheets (e.g., Excel)	23.6	42.7	24.7	9.0	1.19	0.9
10. Encyclopedias and other references on CD-ROM	28.9	46.7	17.8	6.7	1.02	0.86
11. Webpage authoring software (e.g., Front Page)	61.1	18.9	10.0	10.0	0.69	1.01
12. Concept mapping software (e.g., Inspiration)	65.2	18.0	14.6	2.2	0.54	0.83
13. Simulations (e.g., ExploreScience, Frog Dissection, etc.)	37.5	40.9	18.2	3.4	0.88	0.83
14. Drill and practice programs (e.g., GeoSafari Animals, Brain Quest)	65.6	24.4	8.9	1.1	0.46	0.71
15. Individualized instruction-tutorials (e.g., ChemTutor, Science For Kids, The Learn About)	63.3	21.1	14.4	1.1	0.53	0.78
16. Problem solving software (e.g., Botanical Gardens, Thinkin' Science ZAP!)	75.3	16.9	7.9		0.33	0.62
17. Modeling Software (e.g., Model It)	80.7	13.6	5.7		0.25	0.55
18. Educational Games (e.g., VisiFrog)	74.7	19.5	3.4	2.3	0.33	0.66
19. Data Collection probes and computers (e.g., Vernier, PASCO, Texas Instrument)	21.1	35.6	25.6	17.8	1.4	1.01

Table 4-8-continued. Science Teacher's Use of the Internet for Science Instruction

	0	1	2	3	M	S.D.
20. online communication (e-mail) between teacher and students	18.9	25.6	21.1	34.4	1.71	1.13
21. online communication (online discussions board) between teacher and students	66.7	20.0	5.6	7.8	0.54	0.91
22. online communication between students (e.g., online discussion board)	53.4	21.6	9.1	15.9	0.88	1.12
23. online communication between students and science Experts/ Mentors/ Scientists (e.g., Ask a Scientist)	47.2	38.2	12.4	2.2	0.70	0.77
24. video conferencing with others	82.0	12.4	4.5	1.1	0.25	0.59
25. information retrieval via the Internet	4.4	15.6	40.0	40.0	2.16	0.85
26. collect real-time data (e.g. Whale Watch)	53.9	30.3	14.6	1.1	0.63	0.77
27. analyze online science data	53.4	30.7	14.8	1.1	0.64	0.78
28. access online databases (e.g., test locator database)	64.0	25.8	10.1		0.46	0.68
29. access to online journals (e.g., education weekly)	42.7	32.6	15.7	9.0	0.91	0.97
30. conduct web-based Internet labs	55.2	26.4	14.9	3.4	0.67	0.86
31. online simulations	34.8	42.7	18.0	4.5	0.92	0.84
32. take virtual science trips to museums zoos, science centers, etc.	63.2	29.9	5.7	1.1	0.45	0.66
33. use remote Web Cam to observe distant location	73.0	22.5	4.5		0.31	0.56
34. Webquests	59.6	28.1	9.0	3.4	0.56	0.80

presentation tools (M=1.65); digital cameras (M=1.65) and data collection probes (M=1.40). The least frequently used computer applications/ tools are: modeling software (M=0.25); video conferencing with others (M=0.25); problem-solving software (M=3.33); and statistical programs (M=3.3). Findings of the study reveal that science teachers do not frequently use technologies in teaching science. While 80% of the science teachers never used the modeling software in teaching science, 75 % never used problem-solving software and educational games in science instructions. The most commonly used computer applications/tools are presentation tools. Twenty-four percent of the science teachers used presentation tools more than once a week. Information retrieval via the Internet is the most commonly used application for science instruction. Forty percent of the science teachers used the Internet for information retrieval more than once in a week. Thirty-four percent of the science teachers used online communication more than once. On the other hand, 73% of the science teachers never used remote Web Cam to observe distance location. More than 50% of the science teachers never used: online communication (online discussion board) between teacher and students; online communications between students; or video conferencing with others. Fifty percent never: collected real time data; accessed online data bases; conducted web-based Internet labs; took virtual trips to museums, zoos, science centers; used remote Web Cam to observe distance locations; and Webquest. Study findings revealed that online communication and information retrieval are the most commonly used Internet applications by exemplary science teachers. Study findings also revealed that only few exemplary science teachers used the new forms of Internet application in teaching science more than once a week. More than half of the exemplary science teachers never used 10 out of 15 Internet applications/tools in teaching science.

Science teachers reported how often they required their students to use technology applications/tools in or for their classroom (see Table 4-9). Science teachers rated their students' use of the specific computer applications/tools in science instruction [i.e., "0", none; "1," less than six times a year; "2," one to three times a month; "3," more than once a week] in two sections of the survey. Students' technology use indicated the most often used: information retrieval via the Internet (M=2.20); online communications between teacher and students (M=1.61); graphing calculators (M=1.45); data collection probes (M=1.39); graphing software (M=1.31); and presentations (M=1.28). Study findings revealed that student use of technology was limited to the few computer applications/tools in science lessons. Thirty-two percent of the exemplary science teachers reported that their students used graphing calculators in or for their science class more than once a week. Seventy-seven percent of the exemplary science teachers reported that their students used data collection probes and computers more than once a year. On the other hand, more than 60% of the exemplary science teachers reported that their students never used: concept mapping software; video editing software; statistical programs; webpage authoring software; drill and practice programs; individualized instruction-tutorials; problem-solving software; and modeling software. While 84% of the exemplary science teachers reported that their students never used video conferencing with others as part of science lesson, 47% of them never used online communication between students and science experts/mentors/scientists. More than 50% of the exemplary science teachers reported that their students: never used online

Table 4-9. Student Use of Computer Applications/Tools

	0	1	2	3	M	S.D.
1. Digital cameras	24.4	45.3	22.1	8.1	1.14	0.1
2. Digital video cameras	50.0	36.0	11.6	2.3	0.66	0.08
3. Video editing software (e.g., Video Maker, iMovie)	73.7	15.8	6.6	3.9	0.41	0.09
4. Graphing Calculators	33.3	20.2	14.3	32.1	1.45	0.14
5. Presentations (e.g., PowerPoint, KidPix)	16.5	48.2	25.9	9.4	1.28	0.09
6. Graphing software	15.5	47.6	26.2	10.7	1.32	0.1
7. Databases (e.g., Access, record keeping)	55.8	29.1	12.8	2.3	0.62	0.09
8. Statistical programs (e.g., SPSS)	79.1	18.6	2.3		0.23	0.05
9. Spreadsheets (e.g., Excel)	25.0	50.0	20.2	4.8	1.05	0.09
10. Encyclopedias and other references on CD-ROM	25.6	47.7	19.8	7.0	1.08	0.09
11. Web page authoring software (e.g., Front Page)	65.1	26.7	3.5	4.7	0.48	0.08
12. Concept mapping software (e.g., Inspiration)	65.1	24.4	8.1	2.3	0.48	0.08
13. Simulations (e.g., ExploreScience, Frog Dissection, etc.)	38.8	40.0	17.6	3.5	0.86	0.09
14. Drill and practice programs (e.g., GeoSafari Animals, Brain Quest)	62.8	27.9	7.0	2.3	0.49	0.08
15. Individualized instruction-tutorials (e.g., ChemTutor, Science For Kids, The Learn About)	64.0	24.4	8.1	3.5	0.51	0.09
16. Problem solving software (e.g., Botanical Gardens, Thinkin' Science ZAP!)	76.5	17.6	5.9		0.29	0.06
17. Modeling Software (e.g., Model It)	81.0	14.3	4.8		0.24	0.06
18. Educational Games (e.g., VisiFrog)	74.1	22.4	1.2	2.4	0.32	0.07
19. Data Collection probes and computers (e.g., Vernier, PASCO, Texas Instrument)	23.3	32.6	25.6	18.6	1.40	0.11

Table 4-9-continued. Student Use of the Internet in or for Science Class

	0	1	2	3	M	S.D.
20. online communication (e-mail) between teacher and students	20.9	25.6	23.3	30.2	1.63	0.12
21. online communication (online discussions board) between teacher and students	67.4	18.6	5.8	8.1	0.55	0.10
22. online communication between students(e.g., online discussion board)	45.2	19.0	13.1	22.6	1.13	0.13
23. online communication between students and science Experts/Mentors/ Scientists (e.g., Ask a Scientist)	47.1	44.7	5.9	2.4	0.64	0.08
24. video conferencing with others	84.5	11.9	2.4	1.2	0.20	0.06
25. information retrieval via the Internet	2.4	18.8	35.3	43.5	2.20	0.09
26. collect real time data (e.g. Whale Watch)	57.6	27.1	12.9	2.4	0.60	0.09
27. analyze online science data	55.8	30.2	11.6	2.3	0.60	0.08
28. access online databases (e.g., test locator database)	67.4	24.4	8.1		0.41	0.07
29. access to online journals (e.g., education weekly)	51.2	33.7	12.8	2.3	0.66	0.09
30. conduct web-based Internet labs	57.1	26.2	10.7	6.0	0.65	0.1
31. online simulations	39.5	43.0	11.6	5.8	0.84	0.09
32. take virtual science trips to museums, zoos, science centers, etc.	67.1	28.2	3.5	1.2	0.39	0.07
33. use remote Web Cam to observe distant location	75.6	22.1	2.3		0.27	0.05
34. Webquests	58.8	28.2	9.4	3.5	0.58	0.09

communications between teacher and students; video conferencing; collected real-time data; analyzed online science data; accessed online science databases; accessed to online journals; conducted web-based Internet labs, took virtual trips to museums, zoos, science centers, used remote Web Cam to observe distance locations, and Webquests. Study findings revealed that there is a consistency between science teachers' level of knowledge/skills and their use of that technology or their students' use of that technology in or for their science class.

Correlation

Table 4-10 reports the descriptive statistics for two subscales of *The Microcomputer Utilization in Teaching Efficacy Beliefs Instrument* (MUTEBI): personal self-efficacy; outcome expectancy; pupil control ideology scale; level of computer use; science teachers' level of knowledge/skills in using specific computer applications for science instruction; science teachers' use of computer-related applications/tools during their instruction; and their students' use of computer applications/tools in or for their science class.

Correlations were computed among the teachers' level of knowledge/skills in using specific computer applications for science instruction, the teachers' use of computer-related applications/tools during their instruction, the students' use of computer-related applications/tools in or for their science class; science teachers' personal efficacy; science teachers' outcome expectancy; pupil control ideology; age; teaching experience; how long they have been using computers for personal use; how long they have been using computers in their classroom for professional purposes; and how many hours of professional development related to the use of computers they participated within the last five years and number of computers in their science classroom/science labs (see Table 4-10).

Table 4-10. Descriptive statistics of explanatory and outcome variables

	N	Min score	Max Score	Mean	Std. Dev.	Reliability
Level of computer use (LCU)	89	4	8	6.4	1.81	0.95
Personal self-efficacy (SE)	90	21	69	57.3	1.04	0.92
Outcome expectancy (OE)	90	9	33	20.9	0.54	0.84
Pupil control ideology (PCI)	90	10	35	21.1	0.58	0.75
Teachers' knowledge/skills	92	0.21	3.68	1.87	0.086	0.96
Teachers' instructional use	92	0.09	2.06	0.81	0.046	0.90
Student use of technology	92	0.09	1.97	0.76	0.045	0.92

Exemplary science teachers' level of computer use and exemplary science teachers use of computer related applications/tools in their instruction were positively correlated (r =.278, p =.009). Exemplary science teachers' level of computer use was also correlated with science teachers' personal efficacy (r = .330, p=0.002), and how long they have been using computers in their classroom for professional purposes (r = .215, p=.048). Exemplary science teachers' level of computer use was not correlated with their level of knowledge/skills in using specific computer applications for science instruction and the number of computers in the science classroom/science lab.

At the 0.01 level of significance, science teachers' level of knowledge/skills in using specific computer applications for science instruction was correlated with: the frequency of use of computer-related applications/tools in their instruction (r =.715, p= 0.00); how often they required their students to use computer-related applications/tools in or for their science class (r = .621, p=0.00); and science teachers' personal efficacy (r = .576, p=0.00). At the 0.05 level of significance, science teachers' level of knowledge/skills in using specific computer applications for science instruction

Table 4-11. Pearson Product –Moment Correlation between Outcome Variables and Explanatory Variables

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Level of computer use (LCU)	1.000	.199	**.278****	.199	**.333****	0.189	-.063	-.009	-.040	**.215***	.154	.019	.181
2	Teachers' knowledge/skills		1.000	**.715****	**.621****	**.576****	**.256****	-.076	-.179	-.200	.146	.144	.126	.147
3	Teacher's instructional use			1.000	**.912****	**.437****	**.315****	-.006	.064	.021	**.220***	**.295****	**.252***	.135
4	Students' use of technology				1.000	**.366****	**.214****	-.088	.060	-.013	.185	**.275***	.156	.164
5	Personal efficacy					1.000	.208	**-.263***	-.132	-.081	.175	.195	-.015	.147
6	Outcome expectancy						1.000	.082	.010	.092	.072	.189	.089	-.117
7	Pupil Control Ideology							1.000	.099	.146	-.172	**-.219***	.063	**-.247***
8	Age								1.000	**.729****	**.337****	**.278***	-.047	-.023
9	Teaching experience									1.000	**.250***	**.287****	.017	-.005
10	Personal computer use										1.000	**.620****	.056	.064
11	Professional computer use											1.000	.085	.005
12	Professional development												1.000	.082
13	Number of computers													1.000

Note. **p*< .05, ** *p*< .001 N= 87

was correlated with science teachers' outcome expectancy (r = .256, p=0.017).

Correlation did not exist between science teachers' level of knowledge/skills in using specific computer applications for science instruction and their pupil control ideology, age, and teaching experience. There is also no correlation between science teachers' level of knowledge/skills in using specific computer applications for science instruction and how long they have been using computers for personal purposes, how long they have been using computers in their classroom for professional purposes, and how many hours of professional development related to use of computers they participated.

Science teachers' frequency of computer-related applications/tools use in their instruction was statistically significant with: how often they required their students to use computer-related applications/tools in or for science class (r = .912, p=0.00); science teachers' personal efficacy (r = .437, p=0.00); science teachers' outcome expectancies (r = .315, p=0.003); how long they have been using computers in their classroom for professional purposes (r = .295, p=.006); how many hours of professional development related to use of computers they participated (r = .252, p=0.028); and how long they have been using computers for personal purposes (r = .220, p=.045). Correlation did not exist between science teachers' frequencies of computer-related applications/tools use in their instruction with their pupil control ideology, age, and teaching experience.

How often they required their students to use computer-related applications/tools in or for their science class was correlated with: the teachers' personal efficacy (r = .336, p=.001); the teachers' outcome expectancies (r = .214,

p=.048); and how long they have been using computers in their classroom for professional purposes (r = .275, p=.011).

Science teachers' personal efficacy was negatively correlated with their pupil control orientation (r = -.263, p=.014). The age of science teachers significantly correlated with: their teaching experience (r = .729, p=.00); how long they have been using computers for personal purposes (r = .337, p= .002); and how long they have been using computers in their classroom for professional purposes (r = .278, p=.010).

Regression Analysis

A multiple regression analysis was conducted to examine the degree of association between the outcome variables (teachers' levels of computer use, teachers' level of knowledge/skills in using specific computer applications for science instruction; teachers' use of computer-related applications/tools during their instruction; students' use of computer-related applications/tools in or for their class); and the explanatory variables (personal efficacy; outcome expectancy; pupil control ideology; level of computer use; age; gender; teaching experience; personal computer use; professional computer use; and use of computer related applications/tools during class). Four regression models were tested to investigate the influence of explanatory variables on each of the outcome variables. Analysis was performed by using SPSS REGRESSION. Results of the evaluation of the assumptions for linear regression analysis led to deletion of the variable "Teaching Experience" to reduce the multicollinearity. Five cases with missing data were deleted from the regression analysis, n= 87 for each analysis.

The first regression model consisted of six explanatory variables and the outcome variable--"the science teachers' level of computer use". Results showed that R^2 of .210 was statistically significant, $F(6, 68) = 3.020, p = .011$. This model indicates that the explanatory variables are jointly associated with 21% of the teachers' level of computer use.

Table 4-12 reports the unstandardized regression coefficients (*b*), the standardized regression coefficients (β), and the observed t-values (*t*). One of the six variables was statistically significant at 0.05 level: personal self-efficacy.

Table 12 indicates that personnel self-efficacy related with the exemplary science teachers' level of computer use ($p < .022$). In this regression equation, no other variable was significant at the $p < .05$ level. This observation is interpreted to mean that as exemplary science teachers' personal self-efficacy increased, it is likely that teachers' level of computer use increased as well.

Table 4-12. Regression Analysis Summary for Teachers' Level of Computer Use

Variable	*b*	*β*	*t*-values	*p*-values
Constant	0.602		0.321	0.749
MPE	6.698E-02	0.321	2.335	0.022*
MO	5.290E-02	0.149	1.329	0.188
PCI	2.216E-02	0.068	0.580	0.564
Number of comp. in science class	4.710E-02	0.214	1.852	0.068
Gender	0.685	0.187	1.576	0.120
Teachers' knowledge/skills (TKnow)	-0.195	-0.084	-0.624	0.535

Note. $R^2 = .210$ (n= 87, $p = .011$)
*$p < .05$.

The second regression model consisted of nine explanatory variables and the outcome variable--"teachers' level of knowledge/skills in using specific computer applications for science instruction." Results showed that R^2 of .639 was statistically significant, $F(9, 73) = 12.866, p = .000$. This model indicates that the explanatory variables are jointly associated with 63.9% of the teachers' level of knowledge/skills.

Table 4-13 reports the unstandardized regression coefficients (*b*), the standardized regression coefficients (β), and the observed t-values (*t*). Four of the nine variables were statistically significant at 0.05 level: personal self-efficacy, age, gender, and teachers' use of computer-related applications/tools during class.

Table 4-13. Regression Analysis Summary for Teachers' Level of Knowledge/Skills in Using Specific Computer Applications for Science Instruction

Variable	*b*	β	*t*-values	*p*-values
Constant	0.583		0.935	0.353
MPE	2.063E-02	0.251	3.001	0.004*
MO	-3.656E-03	-0.024	-0.309	0.758
PCI	1.056E-02	0.073	0.965	0.338
Level of computer use (LCU)	-4.405E-02	-0.104	-1.353	0.180
Age	-1.973E-02	-0.187	-2.414	0.018*
Gender	0.260	0.166	2.257	0.027*
Personal computer use (PerCU)	1.712E-02	0.116	1.221	0.226
Professional computer use (ProCU)	-1.387E-02	-0.096	-1.021	0.310
Teacher Instructional use (TInstUse)	1.173	0.655	7.808	0.000*

Note. $R^2 = .639$ (N= 87, $p = .000$)
$^*p < .05$.

Table 4-13 indicates that teachers' use of computer-related applications/tools during class, teachers' personal self-efficacy, age, and gender are highly related with the outcome measure of teachers' level of knowledge/skills in using specific computer applications for science instruction

($p <$ .000, $p <$ .004, $p <$ .018 and $p <$ .027, respectively). In this regression equation, no other variable was significant at the $p <$ .05 level. This observation is interpreted to mean that as teachers' use of computer-related applications/tools during class and teachers' personal efficacy increased, it is likely that teachers' level of knowledge/skills in using specific computer applications for science instruction increased as well. Female science teachers have a higher level of knowledge/skills in using specific computer applications for science instruction. As exemplary science teachers get older, it is likely that their knowledge/skills in using specific computer applications for science instruction decreased.

A third multiple regression analysis was conducted to examine the degree of association between the outcome variable (teachers' use of computer related applications/tools during their instruction) and the explanatory variables (personal self-efficacy; outcome expectancy; pupil control ideology; level of computer use; age gender; personal computer use; professional computer use; and science teachers' level of knowledge/skills in using specific computer applications for science instruction). Results showed that R^2 of .618 was statistically significant, $F(9, 73) = 13.105, p = .000$. This model indicates that the explanatory variables are jointly associated with 61.8% of science teachers' use of computer-related applications/tools during their instruction.

Table 4-14 reports the unstandardized regression coefficients (b), the standardized regression coefficients (β), and the observed t-values (t). Two of the 10 variables were statistically significant at 0.05 level: "science teachers' level of knowledge/skills in using specific computer applications for science instruction and gender."

Table 4-14 indicates that teachers' level of knowledge/skills in using specific computer applications for science instruction and gender are related with the outcome variable measuring science teachers' use of computer-related applications/tools during class instruction ($p < .000$ and $p < .020$, respectively). In this regression equation, no other variable was significant at the $p < .05$ level. This observation is interpreted to mean that as teachers' level of knowledge/skills in using specific computer applications for science instruction increased, it is likely that teachers' use of computer-related applications/tools during class increased as well. Male science teachers more often used computer-related applications/tools during class.

A fourth multiple regression analysis was conducted to examine the degree of association between the outcome variable (students' use of computer-related applications/tools in or for their science class) and the explanatory variables (personal efficacy; outcome expectancy; pupil control ideology; level of computer use; age, gender; personal computer use; professional computer use; science teachers' level of knowledge/skills in using specific computer applications for science instruction; and numbers of computers in science classroom/science labs). Results showed that R^2 of .504 was statistically significant, $F(10, 63) = 6.389$, $p = .000$. This model indicates that the explanatory variables are jointly associated with 50.4% of students' use of computer-related applications/tools in or for their science class.

Table 4-14. Regression Analysis Summary for Use of Computer Related Applications/Tools During Class.

Variable	*b*	*β*	*t*-values	*p*-values
Constant	-0.808		-2.321	0.023
MPE	8.723E-04	0.019	0.208	0.836
MO	1.029E-02	0.119	1.534	0.129
PCI	3.201E-04	0.004	0.051	0.960
Level of computer use (LCU)	3.214E-02	0.136	1.730	0.088
Age	8.720E-03	0.148	1.825	0.072
Gender	-0.158	-0.180	-2.385	0.020*
Personal computer use (PerCU)	-5.447E-03	-0.066	-0.671	0.504
Professional computer use (ProfCU)	1.277E-02	0.158	1.653	0.103
Teachers' knowledge/skills (TKnow)	0.388	0.695	7.808	0.000*

Note. R^2 = .618 (N= 87, p = .000)
*p< .05.

Table 4-15 reports the unstandardized regression coefficients (*b*), the standardized regression coefficients (*β*), and the observed t-values (t). Two of the 10 variables were statistically significant at 0.05 level: "science teachers' level of knowledge/skills in using specific computer applications for science instruction and gender."

Table 4-15 indicates that teachers' level of knowledge/skills in using specific computer applications for science instruction and gender related with the outcome variable measuring students' use of computer-related applications/tools in or for science class ($p <$ .000 and $p <$ .019, respectively). In this regression equation, no other variable was significant at the $p <$ .05 level. This observation is interpreted to mean that as teachers' level of knowledge/skills in using specific computer applications for science instruction increased, it is likely that students' use of computer related applications/tools increased as well. The negative effect in gender reveals that male teachers are more likely than female teachers to require their students to use computer applications/tools.

Table 4-15. Regression Analysis Summary for Students' Use of Computer Related Applications/Tools

Variable	*b*	β	*t*-values	*p*-values
Constant	-0.327		-0.769	0.445
MPE	1.533E-03	0.031	0.267	0.790
MO	6.809E-03	0.084	0.872	0.387
PCI	-8.083E-03	-0.104	-1.057	0.295
Level of computer use (LCU)	2.841E-02	0.122	1.221	0.227
Age	4.252E-03	0.075	0.745	0.459
Gender	-0.204	-0.241	-2.418	0.019*
Personal computer use (PerCU)	-2.515E-03	-0.031	-0.261	0.795
Professional computer use (ProfCU)	1.134E-02	0.139	1.200	0.235
Teachers' knowledge/skills (TKnow)	0.337	0.621	5.499	0.000*
Number of computers in science class	1.108E-04	0.002	0.022	0.982

Note. $R^2 = .494$ (N= 87, $p = .000$)
*$p < .05$.

Further Analyses

Study findings revealed that while some exemplary science teachers reported that their students use certain applications/tools, others reported that their students do not use them at all. For this reason, the researcher decided to look at the characteristics of the science teachers whose students use technology often and those who do not use this technology often.

This study used 34 items measuring students' use of computer-related applications/tools in or for their science class. Science teachers rated their students' use of the specific computer applications/tools in science instruction [i.e., "0," none;"1," less than six times a year; "2," one to three times a month; "3," more than once a week] in the survey. Teachers' responses to each of the applications/tools were summed. If the total value was less than 34, it was accepted as limited students' use of computer-related applications/tools (LSU). If the total value was higher than 34, it was accepted as higher students' use of computer-related applications/tools (HSU).

The following three additional hypotheses were investigated in further analyses.

H_{01}: There will be no significant difference between LSU and HSU groups on exemplary science teachers' personal self-efficacy.

H_{02}: There will be no significant difference between LSU and HSU groups on exemplary science teachers' outcome expectancy.

H_{03}: There will be no significant difference between LSU and HSU groups on exemplary science teachers' pupil control ideology.

Analysis

H_{01}: There will be no significant difference between LSU and HSU groups on exemplary science teachers' personal self-efficacy.

The independent-samples t-test analysis indicates that the 65 low level of students' use of computer-related applications/tools had a mean of 65.0 total points in personal self-efficacy; the 22 high level of students' use of computer-related applications/tools had a mean of 61.36 total points in personal self-efficacy. There was a statistically significant difference between the conditions (t=-2.292, df =85, p=.024, two-tailed). This means that exemplary science teachers who a reported higher level of students' use of computer-related applications/tools have higher personal self-efficacy. The results are found in Table 4-16.

Table 4-16. Personal Self-efficacy

	N	Mean	SD	*t*	DF	*P*
LSU	65	56.0000	10.1458	-2.292	85	.024
HSU	22	61.3636	7.1083			

H_{02}: There will be no significant difference between LSU and HSU groups on exemplary science teachers' outcome expectancy.

The independent-samples t-test analysis indicates that the 65 low level of students' use of computer-related applications/tools had a mean of 20.55 total points in outcome expectancy; the 22 high level of students' use of computer-related applications/tools had a mean of 21.86 total points in outcome expectancy. There was no statistically significant difference between the conditions (t=-2.053, df =85, p=.295, two-tailed). This result means that outcome expectancy of the exemplary science teachers is not different in both high and low level of students' use of computer-related application/tools. The results are found in Table 4-17.

Table 4-17. Personal Outcome Expectancy

	N	Mean	SD	*t*	DF	*P*
LSU	65	20.55	4.98	-2.053	85	.295
HSU	22	21.86	5.25			

H_{03}: There will be no significant difference between LSU and HSU groups on exemplary science teachers' pupil control ideology.

The independent-samples t-test analysis indicates that the 65 low level of students' use of computer-related applications/tools had a mean of 21.37total points in pupil control ideology; the 22 high level of students' use of computer-related applications/tools had a mean of 20.72 total points in pupil control ideology. There was no statistically significant difference between the conditions (t=-2.053, df =85, p=.636, two-tailed). This result means that exemplary science teachers' pupil control ideology is not different in both high and low level of students' use of computer-related application/tools. The results are found in Table 4-18.

Table 4-18. Pupil Control Ideology

	N	Mean	SD	t	DF	P
LSU	65	21.37	5.44	.474	85	.636
HSU	22	20.72	5.62			

Summary

A total of 334 award-winning science teachers were contacted. Of the 334 exemplary science teachers, responses were received from 92 science teachers making a response rate of 27.5%. The data provided information about characteristics of exemplary science teachers. Multiple regression analysis was used to determine significant relationships between outcome variables and explanatory variables. Conclusions drawn from this data analysis, implications of the study, and recommendations for future study are presented at Chapter 5.

CHAPTER 5
FINDINGS, CONCLUSIONS, IMPLICATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The use of the technology in teaching and learning has been the focus of many national organizations, major state curriculum projects, and educational policy reports (Cajas, 2001). In particular, the *National Science Education Standards* (National Research Council [NRC], 1996) set forth teaching standards that expect science teachers to select teaching and assessment strategies that include applications of technology that can support the development of student understanding and nurture a community of science learners. Many researchers have already examined the characteristics of exemplary technology-using teachers to understand how they differ from other teachers (Becker, 1994; Berg, Benz, Lasley & Raisch, 1997; Ertmer, Gopalakrishnan & Ross, 2001; Hadley & Sheingold, 1993; Zhao,et al., 2001). This study focuses mainly on exemplary science teachers not exemplary technology-using teachers. This study examined exemplary science teachers' knowledge/skills in using technology and factors influencing their decisions in using technology in the science classroom. Specifically, the research addressed the following questions:

1. Are exemplary science teachers' levels of computer use associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, computer access in the classroom, gender, and science teachers' level of knowledge/skills in using specific computer applications/tools for science instructions?

2. Are exemplary science teachers' level of knowledge/skills in using specific computer applications for science instruction associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, personal

computer use, professional computer use and teachers' use of computer related applications/tools during class?

3. Are exemplary science teachers' use of computer related applications/tools during their instruction associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, personal computer use, professional computer use and science teachers' level of knowledge/skills in using specific computer applications for science instruction?

4. Are exemplary science teachers' students use of computer applications/tools in or for their class associated with the following explanatory variables: personal self-efficacy in teaching with computers, outcome expectancy, pupil control ideology, level of computer use, age, gender, personal computer use, professional computer use, computer access in the classroom and science teachers' level of knowledge/skills in using specific computer applications for science instruction?

Findings and Conclusions

This study provides information on exemplary science teachers' level of computer use, their knowledge/skills in using specific computer applications for science instruction, their use of computer-related applications/tools during their instruction, and how often they required their students to use those applications in or for their science class. This study is the first known study to examine exemplary science teachers' level of knowledge and their practice in using computer-related technologies in science teaching. Those teachers are already recognized as exemplary in teaching their subject areas by virtue of winning a Presidential Award. This study examined about their practice in using technology and what factors influence their use of technology in teaching science. Conclusions drawn from these results are discussed in relation to the research questions.

Characteristics of exemplary science teachers

The age of exemplary science teachers in this study ranged from 33 to 65 years with a mean of 49 years. The number of years served as a science teacher ranged from 8 to 41 years with a mean of 22.13 years. Sixty-two percent of exemplary science teachers have taught for at least 20 years. By 2000, on a national scale only 31% of secondary science teachers nationally had that much teaching experience. Findings of the study revealed that the Presidential Award for Excellence in Science Teaching recipients had more teaching experience than the average reported for their national counterparts in the literature (e.g., Weiss, Smith, & Malzahn, 2001).

Ninety-two percent of the exemplary science teachers have a degree beyond the bachelor's degree. Ninety-two percent of the exemplary science teachers have been using a computer more than 10 years. All 92 respondents reported more than six years of computer use in their classroom for professional purposes. Findings from this study revealed that exemplary science teachers are already familiar with the computer and computer-related technologies, and they are using computers both personally and professionally.

Most exemplary science teachers indicated they improved their technology skills by working on those technologies on their own. This finding is consistent with the findings of the Berg et al. (1997) study. Berg et al. found that 95% of the exemplary technology-using teachers indicated some of their technology-related skills had been learned on their own. Educator conferences and state/district/school level workshops also provided information on how to use technologies. During the last five years, exemplary science teachers have participated in an average of 22 hours of professional development related to the use of computers.

Computer access

More than 70% of exemplary science teachers reported they have more than three computers available in their science classrooms/science labs and all have access to computer labs at school. Findings from the study revealed there is no significant correlation between the number of computers and teachers' level of computer use, and their students' use of computer-related applications/tools in science lessons. Access to technology does not seem to influence their decision to use that technology in the classroom. Availability of the technology in the classroom and the number of the computers do not have any effect on the teachers' level of use in the classroom (Windshitl & Shal, 2002).

Knowledge/skills in using computer applications

Exemplary science teachers have a variety of knowledge/skills in using computer related applications. The most commonly used computer applications/tools are information retrieval via the Internet, online communication, presentation tools, and data collection probes. Dickson and Irving (2002) mentioned the Internet enables science teachers to find resources on their topic, lesson plans, and other curricular materials, and through the Internet they enhance their science teaching. Data from the survey revealed exemplary science teachers have less knowledge of computer applications/tools related to the use of the Internet for science instruction such as video conferencing, taking virtual trips to museums and zoos, and science centers, Webquest, use of the WebCam to observe distant locations, accessing online databases, and collecting real-time data. Use of the Internet provides a broad range of information to the science classroom. Wallace (2004) reported that use of the Internet might cause some problems for science teachers who do not feel comfortable answering students' questions about unfamiliar content. Although this issue may not a problem for exemplary science teachers, use of Internet-related computer applications by exemplary science teachers responding to this study's survey are less than other computer-related applications/tools.

Teachers' use of computer applications/tools in their instructions

Exemplary science teachers are fairly proficient in some of the computer technologies. Most of the exemplary science teachers are familiar with common educational technologies although their proficiency levels are different. The most frequently used computer applications/tools are presentation tools, information retrieval via the Internet, online communication, digital cameras, and data collection probes. The least frequently used computer applications/tools are modeling software, video conferencing, problem-solving software and statistical programs. Findings from the study revealed that science teachers do not frequently use technologies in teaching science. The most commonly used computer applications/tools are presentation tools. Twenty-four percent of the science teachers used presentation tools more than once a week. Information retrieval via the Internet is the most commonly used Internet tool for science instruction.

Class interaction between teacher and students and also between students and students may be synchronous or asynchronous through the use of e-mail, online discussions board, websites and listservs. Data from the surveys revealed limited use of online communication between exemplary science teachers and students and among students. The lack of these live telecommunication technologies may be explained by a possible fear of losing control of their students (Wallace, 2004). To improve teachers' knowledge and skill in using those telecommunication tools, workshops targeting the effective use of this specific technology should be offered.

Exemplary science teachers were not using the Internet as engaging research activities. This finding is consistent with the previous studies (Becker, Ravitz, & Wong, 1999; Songer, Lee, & Kam, 2002). Findings of the study revealed that science teachers should be informed about instructional uses of the Internet through professional development courses or workshops. The purpose of the professional development courses and workshops should be to show different Internet sites, how to become involved in collaborative projects, how to collect real-time data, how to access online databases, how to conduct web-based Internet labs, and how to use to virtual libraries. Internet-oriented workshops would give science teachers an opportunity to experience how the Internet can be part of their instruction. Most of the Internet sites were not created for instructional purposes. Hence, it becomes the teachers' responsibility to create the lessons by using the information from that site (Wallace, 2004). Providing the webpage address of the Internet sites that are appropriate to integrate science instruction is not sufficient enough for science teachers to use in their lessons. Lesson plans and appropriate pedagogies should be provided with that user information through workshops or other professional development efforts.

Students' use of computer applications/tools in or for their science class

Teachers in this study reported that student use such as information retrieval via the Internet, online communications between teacher and students, graphing calculators, data collection probes, graphing software, and presentations are most often used. Study findings revealed student use of technology is limited to a few computer applications/tools in science lessons. More than 60% of exemplary science teachers reported their students never used concept mapping software, video editing software, statistical programs, webpage authoring software, drill and practice programs, individualized instruction-tutorials, problem-solving software, and modeling software.

Science teachers' use of technology is higher than their students' use of computer-related applications and tools. This provides evidence that science teachers first experienced the technology in the classroom before they required their students to use that technology in or for their science class. Effective integration of technology in the classroom will be determined by some factors such as the degree to which teachers practice their skills in the science classroom as part of their daily profession (Lewis, 1999) and their ability to learn science themselves using the technology before actually trying to teach with it (Friedrichsen, Dana, Zembal-Soul, Munford, & Tsur, 2001). Some studies suggest that teachers need specific training to infuse technology in their curriculum (Ogle, 2000).

Seventy-three percent of the award-winning science teachers reported their students use data collection probes during their science class. This finding is consistent with the Weiss, Smith and Malzahn (2001) study that found 70% of the award-winning teachers reported their students collect data using sensors or probes. The same study found that only 49% of the national sample of secondary science teachers use probes to collect data. In the current study, sixty percent of the award-winning science teachers reported their students never use computers for drill and practice. This finding is higher than the Weiss et al. (2001) study and possibly reflective of the fact that exemplary science teachers may have a greater repertoire of instructional strategies and rely less on drill and practice activities.

Correlation of variables

A review of exemplary science teachers' characteristics for this study revealed participating science teachers had higher personal computer self-efficacy, which is slightly above the average outcome expectancy, and they leaned toward a humanistic end of pupil control orientation. Personal computer self-efficacy correlated with science teachers' level of knowledge/skills in using specific computer applications, frequency of science teachers' use of computer-related applications/tools in their instruction and their students' use of computer applications in or for their science class. Findings from this study are consistent with the previous studies. Previous research has found that teachers' self-efficacy predicted the teachers' technology use (Albion, 1999; Becker & Anderson, 1998; Maracas, Yi, & Johnson, 1998). Teachers' level of computer use also is correlated with their personal self-efficacy. Personal self-efficacy is also one of the significant factors that explains the variance in teachers' level of computers use. If science teachers do not have higher self-efficacy, we might expect that teachers think that computer technology is indispensable for their teaching. Their low level of personal self-efficacy might inhibit their progress through the five stages of the Hooper-Reiber Model of Technology Adoption in the Classroom. Personal computer self-efficacy beliefs do not correlate with the teachers' teaching experience, personal or professional computer use, and participating in professional development related to computer use. Hasan (2003) found significant relationships between computer experience and computer self-efficacy. He cited that previous research supports the idea that computer experience is the precursor of self-efficacy. This study did not find any relationship between an exemplary science teacher's computer experience and his or her personal computer self-efficacy.

This study found negative correlation between teachers' personal computer self-efficacy and their pupil control orientation. Consistent with the previous literature, exemplary science teachers with higher computer self-efficacy scores also had more a humanistic orientation toward pupil control ideology ($r = -263$; $p < 0.05$). This can be interpreted in the following ways: If an exemplary science teacher believes in his own abilities to use computer technology for teaching science, he is also more likely to believe his students would be more responsible in the classroom. Woolfolk and Hoy (1990) found the same correlation between pre-service teachers' general teaching efficacy and pupil control orientation. Similarly, Enochs, et al., (1995) found significant correlation between pre-service elementary school science teachers' personal science teaching self-efficacy beliefs and their pupil control orientations.

Prior research indicates that computer self-efficacy is positively correlated with an individual's willingness to participate in computer-related activities (Compeau & Higgins, 1995; Murphy, Cover, & Owens, 1989). This study did not find any correlation between exemplary science teachers' computer self-efficacy and their participation in professional development activities related to the use of computers.

An exemplary science teacher's knowledge/skills in using specific computer applications in science instruction is correlated with how often that teacher uses computers in his instruction and requires his students to use those applications/tools in or for their science class. There is no significant correlation between exemplary science teachers' level of knowledge/skills and their participation in professional development activities related to the use of computers. One reason for this result might be self-training in learning how to use technology as the best source of knowledge for exemplary science teachers. Self-training and risk-taking are the characteristics of exemplary teachers (Beisenherz, 1993). Science teachers' use of computer applications/tools in their instruction is correlated with their participation in professional development activities related to the use of computers. This study suggests that exemplary science teachers might improve their knowledge using computer applications/tools by themselves, but they need help in learning how to use those technologies in the classroom. Self-training is not enough to use those technologies in the classroom. If teachers do not know about new available technologies in science teaching, we cannot expect them to use those technologies in the classroom. Professional development activities might help them to become informed about new technologies and help them learn different ways of using those instructional technologies in the science classroom.

Results of this study revealed students' use of technology in or for their science classroom is highly correlated with the frequency of the science teachers' use of computer applications/tools in their instruction. Students' use of computers in science classrooms is also correlated with the number of years of teachers' use of computers in the classroom for professional purposes. There is no significant correlation between duration of teachers' use of computer for personal purposes and students' use of technology in science teaching. This study suggested if teachers have more experience with technology in the classroom, there is a higher chance they will require their students to use computer-related applications/tools in their class.

Regression analysis

To evaluate the relationship between exemplary science teachers' current level of knowledge/skills in using specific computer applications for science instruction and nine explanatory variables, a regression analysis was run. The result of the regression analysis yielded significant relationships with the outcome variables. This model indicates that the explanatory variables are jointly associated with 63.9% of teachers' level of knowledge/skills. The regression equation for exemplary science teachers' current level of knowledge/skills in using specific computer application for science teaching included four significant variables: exemplary science teachers' use of computer applications/tools in their instruction (beta= 1.173); teachers' personal computer self-efficacy (beta = 0.02); age (beta= -.002); and gender (beta= 0.260). This study finding suggests that as teachers' use of computer related applications/tools for science instruction increased, it is likely that teachers' level of knowledge/skills in using specific computer applications/tools for science instruction increased as well. The increased personal computer self-efficacy can be expected to positively influence the amount of teachers' knowledge/skills in using specific computer applications for science instruction. Male exemplary science teachers can be expected to have a lower level of knowledge/skills in using specific computer applications for science instruction. Age has a significant negative contribution to the model. Negative effects in age reveal that younger exemplary science teachers are more likely to have more knowledge/skills with technology. It may be important to give additional assistance to older science teachers to improve their level of knowledge/skills in computer applications/tools.

This study did not show any significant relationship between exemplary science teachers' level of knowledge/skills in using specific computer applications and personal computer use, professional computer use in their classroom for professional purposes, and their participation in the professional development related to the use of computers.

Those variables do not have a significant contribution to the model. The lack of a significant relationship between teachers' experience and knowledge level of computers may be due to the lack of differences between the teachers' experience. Participants in this study are recipients of the Presidential Award for Excellence in Science Teaching. These award winners have more teaching experience than the national science teachers (Weiss, Smith, & Malzahn, 2001). This might influence the result of the study. With a more diverse group of science teachers, the result of the study might be different.

To evaluate the relationship between exemplary science teachers' use of specific computer applications/tools for science instruction in their instruction and nine explanatory variables, a regression analysis was run. The result of the regression analysis yielded significant relationships for the outcome variable measure. This model indicates the explanatory variables are jointly associated with 61.8% of the teachers' use of specific computer applications/tools for science teaching in their instruction. The regression equation for exemplary science teachers' use of specific computer applications for science teaching included two significant variables: exemplary science teachers' level of knowledge/skills in using computer applications/tools in their instruction (beta= 0.39) and gender (beta= - 0.140). Findings from the study suggested that as the teacher's level of knowledge/skills in using computer applications for science instruction increased, it is likely that the teacher's use of computer-related applications/tools during class increased as well. This finding is consistent with Inoue's study (1998). Inoue found that knowledge of Computer Assisted Instruction (CAI) is the only variable that indicated a significant direct effect as to whether or not the teacher was using CAI. Males were associated with more frequent use of computer applications/tools for science instruction.

This finding is consistent with other studies that found more male teachers use computers in teaching than female teachers (Becker, 1994; Chiero, 1997, Durndell, Haag, 2002). Becker, and Hadley and Sheingold (1993) found more male teachers were represented as the exemplary technology-using teachers. Gender differences are a significant predictor of the teachers' use of technology in the classroom for teaching science.

To evaluate the relationship between students' use of computer-related applications/tools and 10 explanatory variables, a regression analysis was run. The results of the regression analysis yielded a significant relationship with the outcome variable. This model indicates that the explanatory variables are jointly associated with 50.4% of the students' use of computer-related applications/tools. The regression equation for students' use of computer related applications/tools in or for their science class included two significant variables: teachers' level of knowledge/skills in using specific computer applications for science instruction and gender. In this regression equation, no other variable was significant at the $p < .05$ level. This observation is interpreted to mean that as teachers' level of knowledge/skills in using specific computer applications for science instruction increased, it is likely that students' use of computer-related applications/tools in or for their class increased as well. The negative effect in gender reveals that male teachers are more likely than female teachers to require their students to use computer applications/tools in or for their science class.

Implications and Suggestions for Future Study

The findings of this study have implications that should be considered by teacher educators, classroom teachers, administrators, and researchers who study factors influencing teachers' integration of computers in science teaching. This study also provides information to those who wish to better understand the beliefs and practices of exemplary science teachers.

The Presidential Awards candidates are judged by the National Science Foundation using criteria such as:

> Subject matter competence; sustained professional growth in science and mathematics and in the art of teaching; an understanding of how students learn science and mathematics; ability to engage students through a variety of teaching strategies; ability to foster curiosity and to generate excitement about the uses of science and mathematics; a conviction that all students' can learn science and mathematics and a sensitivity to the needs of all students linguistics, learning, and social uniqueness; an experimental and innovative attitude in their approach to teaching; and professional involvement and leadership. (Weiss & Raphael, 1996, p. 1)

Although the use of technologies in teaching and learning is recommended in the National Science Education Standards (National Research Council [NRC], 1996), Project 2061: Science for All Americans (Rutherford & Ahlgren, 1989), and the National Educational Technology Standards (NETS) (ISTE, 2000), the use of the technology is not mentioned as a criteria of the National Science Foundation. It is obvious that the use of technology is not considered an important characteristic for selecting exemplary science teachers. If technology use is expected from all science teachers to enhance students' science learning, it should be the part of the criteria. Although study findings revealed award winners use computer related technologies in teaching science at different levels, it is suggested that "the appropriate use of technologies to enhance science teaching and learning" be added as another criteria for selection of Presidential Awardees.

Further validation of the *Technology Use in Science Education Scale* with regular science teachers in United States of America and, in other contexts such as Turkey, is necessary. This scale provides substantial information on science teacher's level of knowledge and their use of specific computer applications for science instruction. This survey instrument can be used to gather information on in-service science teachers' level of knowledge and their practice. This study instrument was created on the basis of extensive research on technology use in science teaching. If technology use is expected by science teachers, pre-service science teachers programs must create an environment to help future science teachers in improving their knowledge and skills in using new technologies appropriate for science instruction. Pre-service science teachers could improve their knowledge on specific computer applications/tools through technology and science methods courses. Before pre-service science teachers graduated from their program, they should have knowledge on each specific computer applications/tools for science instruction. Items in the instrument can be used as in both formative and summative ways in the Pre-service Science Education Program.

Exemplary science teachers identified "learned on my own" as the best source of their learning about technology. This study showed that learning on your own does not seem to result in extensive use of technology in teaching by teachers and their students. It is obvious that learning new technologies by yourself might help you to learn some basics of that technology. However, science teachers need help in learning how to integrate those technologies in their teaching in ways that strongly support student learning. If a teacher does not know new technologies exist, we can not expect them to learn how to use those technologies in science teaching. Professional development activities on new technologies are necessary for science teachers to improve their knowledge and learn how to use those technologies in support of student learning. Professional development activities on technology use specifically for science teaching appear to be not common. Since science-specific technologies and their integration in science teaching is different from other subject areas, professional development activities specifically for science teachers might be more helpful than general professional development opportunities. During the professional development activities, teacher might be provided with databases of exemplary technology integrated activities and some scientific websites for teaching science concepts. Knowing the available sources might be helpful for science teachers to explore those resources and integrate them in their instruction.

Professional development activities can be arranged in four levels. The first step is to inform the science teachers about available technologies for science teaching. This section of the professional development activity might help science teachers become aware of new or unfamiliar technologies. They might not have those technologies right now. If they know that new technologies are available for them to use, they might want to obtain and use those technologies.

The second step is to create a positive learning environment for science teachers in learning how to use those new technologies. This might help them to ease their fear in using those technologies and see the benefits in learning science subject matter. Learning new technologies with other science teachers might create a learning environment with support and encouragement from each other. After they feel comfortable in using those technologies, a third step of the professional activity can be introduced to science teachers. At this point they can learn how to integrate new technology in science teaching. Samples of technology-integrated lesson plans linked to state science standards and their school's curriculum can be provided to the science teachers. Those lessons plans might help them explore new ways of using technology as a thinking tool in science teaching. Science teachers might be faced with many challenges during the integration process. Another part of the professional development activity should cover the challenges of the integration of technologies. By working through challenges, teachers can improve their confidence in their abilities to use new technologies and be free to think about ways that technology will successfully enhance their instruction and help their students develop richer and deeper understanding of science concepts. The fourth and last step of the professional development activity can be helping science teachers to create their own technology integrated lesson plans and help them to incorporate those lessons in their own science instruction. This way they might use these activities as a model in creating additional technology-integrated science lessons.

This study found female exemplary science teachers have more knowledge of computer applications/tools than male exemplary science teachers. On the other hand, study findings revealed female science teachers used technology in their classroom less than male science teachers. This contradiction between knowledge and use deserves further attention. Female science teachers should be strongly supported to help them gain confidence in using technology in their science classroom. This provides additional evidence of the need for training programs targeting female science teachers to not only improve their knowledge but also encourage them to develop implementation plans for technology use in their classrooms. Providing sample technology-integrated lessons for science instruction might help those female teachers in implementing such lessons. Further research is also necessary regarding gender differences. If a gender difference exists in additional studies, future research might be needed to examine the factors influencing female science teachers' decisions in using technology related applications/tools in science teaching.

One recommendation for this study would be to include follow-up interviews with exemplary science teachers as well as observations on how they integrate computer applications in their teaching. Deeper levels of understanding in their belief systems and practices may be gained through qualitative research techniques. Exemplary science teachers might be chosen on the basis of their level of knowledge/skills in using computer applications and tools, different levels of integration of computers in science teaching, and different levels of computer self-efficacy. Such a study would provide more in-depth information regarding the factors influencing their decisions on integrating technology in science teaching.

This study examined exemplary science teachers' knowledge practice at only one point in time. Longitudinal studies of exemplary science teachers may provide information on changes in their level of computer use and factors influencing those changes. Studies over time, which cover information on their knowledge and their practice, might provide information on how those changes influence their belief systems and their practice.

The results of this study should add information to the limited data available on exemplary science teachers' level of knowledge/skills in using computer applications/tools and their use of those technologies and their students' use of those technologies in or for their science class. Factors hindering science teachers' integration of computer applications/tools in science teaching were examined. Computer self-efficacy beliefs of exemplary teachers have a significant influence on their level of knowledge/skills in using computers. It is important to examine what factors influence science teachers' computer self-efficacy beliefs.

Teachers are the decision-makers about the use of computers in the classroom, and whether they will require students to use that technology in or for their science class. Their decisions are likely to be influenced by many factors. This study shows exemplary science teachers beliefs of their capability to use technology influence their level of knowledge/skills in using computer applications for science instruction. This in turn influences their use and their students' use of that technology in the classroom. Other factors might influence their decisions on the integration of technology in science teaching. Other factors should also be studied to understand the practice of exemplary science teachers.

Limitations

One of the limitations for this study is the accuracy of contact information for exemplary science teachers. These award-winning science teachers' e-mail addresses and contact information were obtained from the National Science Foundation website. It is common for award-winning science teachers to change their location after they receive the award and not update contact information on the NSF website. Award winners who did not have current contact information were excluded from this study.

The sample for this study is restricted to the award-winners (PAEST) who were willing to participate. It is possible that differences may exist between exemplary science teachers who are willing and unwilling to participate in this study. The response rate for this study is 27.5 %. If the response rate was higher, the results of this study might be different.

The low response rate might indicate that the sample for this study might be biased. To check this possibility, the participants of this study were compared with the existing literature. Weiss and Raphael (1996) and Weiss, Smith and Malzahn (2001) conducted studies on teachers who received the Presidential Award for Excellence in Science and Mathematics Teaching. Table 5.1 compares the findings of those studies and this study.

Table 5.1. Comparison of Existing Literature and Present Study

		Weiss and Raphael (1996)	Weiss et al. (2001)	Present study (2005)
Response rate (%)		82	83	27.5
Number of teachers		367	340	92
Sex (%)				
	Female	43	48	61
	Male	57	52	39
Age (%)				
	Less than 30		0	0
	31-40		4	10.9
	More than 40	NA	96	89.1
Teaching experience				
	1-9	4	3	2.2
	10-19	32	17	35.6
	more than 20	64	81	62.2
Degree beyond bachelor's				
		90	90	91.3
Teacher reported that students never use computers to do				
	Data collection probes	NA	30	23.3
	Drill and practice	NA	54	62.8
	Simulations	NA	36	30.8
	Games	NA	56	74.1

Table 5.1 provides demographic information about the Presidential Award for Excellence in Science and Mathematics Teaching for three studies. While previous studies contacted all of the awards winning science teachers, this study did not include the teachers who received the award prior to 1997. There is no actual information on gender of the Presidential award winners. While existing literature reported that almost half of the respondents were female, 61% of this study respondents were female. Over

representation of female award winning science teachers is possible for this study. It is clear all three study samples have similar representation of the age and the amount of teaching experience of Presidential Awardees. Data shows that 90% of the respondents for the three studies have education beyond a bachelor's degree.

Data for computer use is not available in the Weiss and Raphael's (1996) study. The Weiss et al. (2001) study covered only a few items to measure students' use of computer applications in science. The same items also were measured in this study. The Weiss et al. (2001) study reported that 30% of Presidential Awardees teachers reported their students never collected data using data collection probes, compared to 23.3% of this study. While 62.8% of the participants in this study reported that their students never used drill and practice software, 54 % of students never used drill and practice software in the Weiss et al. (2001). At the secondary level, both groups tend to use computers for simulation. However it was more common for awardees from Weiss et al. (2001) to use the computers for playing games. Although response rate of this study is lower than other two studies, demographic and other data suggest that this study's sample is representative of the Presidential Awardees.

The respondent in this study had a narrow range of age and experience. It is possible that the results of this study would have been different with regular science teachers who are not recognized as PAEST award winners and have wide range of age and teaching experience.

The survey instruments used in this study have 6 sections and 16 items for demographic information. The *Technology Use in Science Education Scale* consists of 35 items associated with a respondent's use of specific computer applications for science instruction. Each item is measured three different ways. The whole survey is long and covers detailed information; this might influence the response rate of the survey. Divisions of the study were suggested to get more information from the respondent. The first part of the study might include only *Technology Use in Science Education Scale* and demographic information. The second part of the survey might cover survey instruments for self-efficacy, pupil control ideology, and levels of computer use. After analyzing the first part of the study, the second part would be sent to all the teachers willing to participate in the second part of the study.

This study sample consisted of exemplary science teachers. Unfortunately, the sample was too homogeneous to generalize for a more traditional science teacher population, or to study factors particular to a more heterogeneous population. Future research should focus on a more diverse science teacher population in order to more broadly learn about technology use in science teaching.

The *Technology Use in Science Education Scale* is a new instrument. Although validity and reliability of the instrument were checked, additional research needs to be conducted to support this scale as a reliable and valid measure with all science teachers.

Conclusion

Findings of this study revealed that exemplary science teachers have a variety of knowledge/skills in using computer-related applications. Most exemplary science teachers have little or moderate level of knowledge/skills in using specific computer applications for science instructions. Furthermore, science teachers do not frequently use technologies in teaching science. Science teachers' use of technology is higher than their students' use of technology.

Findings from the study revealed that exemplary science teachers need assistance in learning and using technology in their science classes. Professional development activities might help them to improve their knowledge/skills. Literature shows that exemplary science teachers spend extra time in improving their knowledge/skills in teaching science. If those teachers have problems in using technologies, other teachers might have more problems. Another finding of this study is gender differences exist for exemplary science teachers' use of technology. Study findings revealed that female science teachers have more knowledge of computers than male science teachers have. On the other hand, male science teachers use computer-related applications/tools more often than female science teachers do. This study suggests that gender is an important factor in technology use. Further research is necessary to find what might cause this difference. This research study used a new instrument to measure the exemplary science teachers' level of knowledge and their use of those new computer applications/tools in their instructions. Findings of the study show that although the study instrument covers new computer applications/tool, exemplary science teachers have knowledge/skills in using most of them. This is a promising finding for other science teachers. Exemplary science teachers reported regular participation in professional development activities to enhance their knowledge and skills in science teaching. By creating professional activities specifically for science teachers, there appears to be a greater chance of not only improving their knowledge of science-specific technology applications but also help them to integrate this new technology in their science classes.

APPENDIX A
RESEARCH STUDY INFORMED CONSENT FORM

University of Florida Institutional Review Board

1. TITLE OF PROTOCOL: Factors influencing exemplary science teachers' levels of computer use.

2. PRINCIPAL INVESTIGATOR: Meral Hakverdi, Ph.D. student, College of Education, School of Teaching and Learning, Department of Curriculum and Instruction, 2403 Norman Hall, P.O.BOX 117048, Gainesville, FL 32611. 352 846-5274, meral@grove.ufl.edu.

3. SUPERVISOR (IF PI IS STUDENT): Thomas M. Dana, Professor and Director, School of Teaching and Learning, University of Florida, 2403 Norman Hall, PO BOX 117048, Gainesville, FL 32611-7048. 352.392.9191 x200, 352.392.9193 FAX, tdana@ufl.edu

4. DATES OF PROPOSED PROTOCOL: From August, 2004 to April, 2005.

5. SOURCE OF FUNDING FOR THE PROTOCOL: None

6. SCIENTIFIC PURPOSE OF THE INVESTIGATION: This study has two components. The purpose of the first part of the study is to check the reliability and validity of the "Technology Use in Science Education" instrument. The second purpose of this study is to investigate the extent to which the following factors relate the level of computer use by exemplary science teachers: self-efficacy in teaching with computers, pupil control ideology, computer experience, computer access, age and gender. The study aims to contribute to understanding the factors that affect exemplary science teachers' level of computer use. The data may also be used in academic presentations and articles for submission to scholarly journals and other publications.

7. DESCRIBE THE RESEARCH METHODOLOGY IN NON-TECHNICAL LANGUAGE. For the first part of the study, a pilot study, consisting of an on-line survey will be given to the members of Florida Science Teachers Associations. Expected sample size for the pilot study will be between 150 -300. For the second part of the study, the main study, an online survey will be given to nationally identified exemplary science teachers. Expected sample size of this study will be between 350 – 390. One week after the initial request a reminder e-mail will be sent to all exemplary science teachers who did not respond. The survey will request demographic information and scales for: the level of computer use, the self-efficacy in teaching with computers, pupil control ideology, and technology use in science education (see attachment).

8. POTENTIAL BENEFITS AND ANTICIPATED RISK. There are no risks and no direct benefits are anticipated as a result of participating in this study.

9. DESCRIBE HOW PARTICIPANT(S) WILL BE RECRUITED, THE NUMBER AND AGE OF THE PARTICIPANTS, AND PROPOSED COMPENSATION (if any):

For the first part of the study, the researcher will send an email to a selected list of listserv moderators to seek permission to send an email seeking study participants to the organization's listserv (see attachment). Once permission is given, the researcher will send an email to the listserv members, which includes an introduction to the study, informed consent documents, inclusion criteria, and a link to the online survey. No compensation will be provided for participants recruited through the listserv. In both data gathering procedures, a reminder email will be sent one and two weeks after the original email. The survey will take approximately 15 minutes to complete. No less than 150 and no more than 300 teachers will be recruited for the pilot study.

For the second part of the study, the sample is the award winning science teachers who have received The Presidential Award for Excellence in Science Teaching from White House and National Science Foundation between the year 1997 and 2003 from all 50 states. Expected sample size of this part will be approximately 350 - 390. The researcher will send email which includes an introduction to the study, informed consent documents, inclusion criteria, and a link to the online survey to list of exemplary science teachers which is obtained from the webpage of Presidential Award Winner Association. All study participants will be asked to complete an online survey that should take approximately 20 minutes to complete. Follow-up reminder e-mail will be sent to non-respondents one and two weeks after the initial requested survey.

10. DESCRIBE THE INFORMED CONSENT PROCESS. INCLUDE A COPY OF THE INFORMED CONSENT DOCUMENT (if applicable). Once the participants reach the online survey, they will be asked to read the informed consent (see attached informed consent 1 for first part of the study and informed consent form 2 for the second part of the study) and if they agree to participate, they will click on the "I have read the above document and agree to participate" box. They will then be taken to the online survey. Participants will not be able to reach the online survey unless they agree to participate via the informed consent. All participants will be informed that participation in this study is voluntary, they may skip any survey questions they do not wish to answer, and may withdraw without consequence. There are no anticipated risks, compensation, or other direct benefits to them as a participant in this study. All participants will be given information on how to contact the principal investigator, the supervisor, and the UFIRB if they have any questions or concerns (see attached informed consent letter.)

____
Principal Investigator's Signature

____
Supervisor's Signature

I approve this protocol for submission to the UFIRB:

____
Dept. Chair/Center Director Date

INFORMED CONSENT FORM (1)

Dear Science Teacher,

I am inviting you to participate in a research study regarding factors affecting science teachers' levels of computer use. This study is being conducted as part of my doctoral study in science education at the University of Florida.

I would appreciate your assistance in completing an online questionnaire and demographic questionnaire. The entire process should take approximately 15 minutes to complete.

Due to the nature of this research, all survey responses will be received and recorded anonymously. Your identity will be kept confidential to the extent provided by law. Your name will not be recorded on the survey and any linkage between your name and your responses will be kept secure.

Participation in this study is voluntary. You may skip any survey questions you do not wish to answer and withdraw from the study without consequence. There are no anticipated risks, compensation, or other direct benefits to you as a participant in this study. If you have any questions about this study, please contact me at (352) 846-5274 (meral@grove.ufl.edu), or my faculty supervisor, Dr. Thomas M. Dana, at (352) 392 9191 ext 200 (tdana@ufl.edu). Questions or concerns about your rights as a research participant may be directed to the University of Florida Institutional Review Board at P.O. Box 112250, University of Florida, Gainesville, FL 32611-2250, (352) 392-0433.

Thank you in advance for support of my doctoral research project.

Sincerely,

Meral Hakverdi

If you consent to participate in this research study and agree to the terms above, please click on the agree button below. Please print this page for your records and/or bookmark it for future reference.

*Note: Participant will not be allowed to go on to the survey without clicking on the button stating that the participant agrees with the terms of the informed consent.

Principal Investigator: Meral Hakverdi
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Doctoral Committee Chair Person: Thomas M. Dana, Professor and Director
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INFORMED CONSENT FORM (2)

Dear Exemplary Science Teacher,

My name is Meral Hakverdi and I am a doctoral candidate in Science Education at the University of Florida. I am conducting a research study that explores the factors influencing a middle/high school exemplary science teacher's level of computer use. As a former Presidential Award Winner for Excellence in Science Teaching, you have been identified as an "exemplary" science teacher so I would like to invite you to participate in this research study. Your response will contribute valuable data in an educational research effort to better understanding how technology is used in science teaching and the professional development needs of other science teachers. Your responses are valuable regardless of how much or little you use computers.

I would appreciate your assistance in completing this multipart online questionnaire including demographic information. The entire process should take approximately 15 minutes to complete. It is very important to this research project that you complete the entire questionnaire.

If you agree to participate this study, please click the link below to access to the survey.

http://plaza.ufl.edu/meral/sciencesurvey.htm

(When you complete the survey, Please click on the SUBMIT button. This will ensure I receive your responses).

If you are not comfortable with the web-based questionnaire but willing to participate please click the link below for further information.

http://plaza.ufl.edu/meral/sciencesurveypaper.htm

The first page of the survey explains your rights. You can access the web-based survey when you click on the "I have read the above document and AGREE to participate" link at the end of the page. If you have any problem during the process, please inform me.

I realize how many demands you have on your time and truly appreciate your help. I look forward to hearing from you.

Thank you in advance for support of my doctoral research project.

Sincerely,

Meral Hakverdi

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APPENDIX B
SURVEY INSTRUMENT

TECHNOLOGY USE IN SCIENCE EDUCATION

DEMOGRAPHIC INFORMATION

1. a. In what year did you receive your Presidential Award?

____ 2004	____ 2001	____ 1998	____ Before 1995
____ 2003	____ 2000	____ 1997	
____ 2002	____ 1999	____ 1996	

   b. Which state did you receive your Presidential Award? ______________

2. What is your highest degree of education?

Degree	Which area (specify)?
____ 4 year College Degree	________________________
____ Master's Degree	________________________
____ Educational Specialist Degree	________________________
____ Doctoral Degree	________________________
____ Other (specify) ____________	________________________

3. Which best describes your **Current primary** occupations?
   a. retired
   b. currently not employed
   c. employed in post-secondary education (e.g. college or university)
   d. employed in K-12 education:
   ___ i. employed as a K-12 classroom teacher, full or part-time
   ___ ii. employed as a teacher on special assignment (without regular teaching responsibility)
   ___ iii. employed as a school principal
   ___ iv. employed as a district-level science supervisor
   ___ v. employed in another K-12 education position
   (specify __________________)
   e. employed outside of a formal education setting:
   ___ i. occupation directly affects K_12 education
   ___ ii. Occupation does not directly affect K_12 education

4. If you are not employed as a K-12 science teacher, when was the last school year that you taught at K-12 level?

___ 2002-2003	___ 2000-2001	___ 1998-1999	___ 1996-1997
___ 2001-2002	___ 1999-2000	___ 1997-1998	___ 1995-1996

   (If you are not currently teaching, please fill this survey on the basis of your last year of experience.)*

5. Main Subject(s) Taught:__________________________
6. Current Grade Level (s) Taught: _____________________
7. Gender: ____Male   _____Female
8. Age:_________.
9. How many years have you been teaching?   _________ years.

10. How many years have you actively used computers for personal purposes? _______ years.
11. How many years have you used computers in your classroom for professional purposes? ________ years.
12. I have learned how to use technology through the following professional development activities. Check as many as are applicable.
    - ___ a. educator conference
    - ___ b. university course work (for credit)
    - ___ c. state/district/school level workshops
    - ___ d. non-school sponsored workshops
    - ___ e. private vendors
    - ___ f. learned on my own (reading, videos, individual help, etc)
    - ___ g. web-based instructions
    - ___ h. other (specify: _____________)

13. Of the above, which has **been the best source of professional development** for you? Select ONLY ONE. _______________.

14. How many hours of professional development related to the use of computers did you participate during the past five years? _____ hours.

15. In a **typical week**, during 2003-2004 school year, how much time did you spend using computers for: Personal use...................................: _____ hours
    Professional development...............: _____ hours
    Science teaching.............................: _____ hours
    Other (specify:______________________________): _____ hours

16. Do you have access to computers

	No	Yes	How many computers?	Computer Type (Circle)	Internet access?		Internet Type	
					NO	YES	High speed/ Low speed	
... at home?	N	Y		Apple/PC	N	Y	HSI	LSI
...in your science classroom/ science lab?	N	Y		Apple/PC	N	Y	HSI	LSI
... in computer lab at school?	N	Y		Apple/PC	N	Y	HSI	LSI
...in library/media center etc.	N	Y		Apple/PC	N	Y	HSI	LSI

☐	Please check this box if you would be willing to participate in further studies of using technology in science teaching. (Please provide contact information: name, e-mail address and mailing address)
	Contact information: Name: ____________________ e-mail address: ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ Mailing address: ______________________ ________________________
☐	Check this box if you would like to receive a copy of the findings of this study (Please provide below information).
	Contact information: Name: ____________________ e-mail address: ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ Mailing address: ______________________ ________________________

Thank you for completing demographic information.
Now begin the multipart technology questionnaire.

TECHNOLOGY USE IN SCIENCE EDUCATION

PART A.

The following is a set of four statements in different combinations.

Circle the answer (a. or b.) in each combination which best describes you and your opinion.

1.	a.	In my instruction, the use of the microcomputer is supplemental.
	b.	The microcomputer is critical to the functioning of my instruction.
2.	a.	The use of the microcomputer is not essential in my instruction.
	b.	For my teaching, the use of the microcomputer is indispensable.
3.	a.	The microcomputer is critical to the functioning of my instruction.
	b.	The use of the microcomputer is not essential in my instruction.
4.	a.	For my teaching, the use of the microcomputer is indispensable.
	b.	In my instruction, the use of the microcomputer is supplemental.

Part B: Specific computer applications for science instruction

Directions: Each statement should be rated in three different ways using three sets of numbers.

- **MY CURRENT Knowledge/ Skills**: The first set of numbers describes your **present level of knowledge/skill** in using the specified technology.
- **My instructional use in the class (frequency)**: The second set of numbers describes how often you used the following application/tool in **YOUR INSTRUCTION** during **2003-2004** school year (e.g., teacher demonstration, use of application/tool during lecture/presentation, etc.).
- **STUDENT use of technology (frequency)**: In the third column, indicate how often you require **YOUR STUDENTS** to use the following application/tool in or for your class during the most recent school year (e.g., using technology to complete assignment, classroom activity, etc.)

My CURRENT Knowledge/Skills	MY Instructional Use in class during 2003-2004 (Frequency)	STUDENTS use of Technology during 2003-2004 (Frequency)
0= None 1= A little 2= Moderate 3= High 4= Expert	0= None 1= Less than 6 times a year 2= One to three times a month 3= More than once a week	0= None 1= Less than 6 times a year 2= One to three times a month 3= More than once a week

Specific computer applications for science instruction	My CURRENT Knowledge/Skills *Select one answer*	MY Instructional Use in class (Frequency)	STUDENTS use of Technology (Frequency)
1. Digital cameras	0 1 2 3 4	0 1 2 3	0 1 2 3
2. Digital video cameras	0 1 2 3 4	0 1 2 3	0 1 2 3
3. Video editing software (e.g., Video Maker, iMovie)	0 1 2 3 4	0 1 2 3	0 1 2 3
4. Graphing Calculators	0 1 2 3 4	0 1 2 3	0 1 2 3
5. Presentations (e.g., PowerPoint, KidPix)	0 1 2 3 4	0 1 2 3	0 1 2 3
6. Graphing software	0 1 2 3 4	0 1 2 3	0 1 2 3
7. Databases (e.g., Access, record keeping)	0 1 2 3 4	0 1 2 3	0 1 2 3
8. Statistical programs (e.g., SPSS)	0 1 2 3 4	0 1 2 3	0 1 2 3
9. Spreadsheets (e.g., Excel)	0 1 2 3 4	0 1 2 3	0 1 2 3
10. Encyclopedias and other references on CD-ROM	0 1 2 3 4	0 1 2 3	0 1 2 3
11. Web page authoring software (e.g., Front Page)	0 1 2 3 4	0 1 2 3	0 1 2 3
12. Concept mapping software (e.g., Inspiration)	0 1 2 3 4	0 1 2 3	0 1 2 3
13. Simulations (e.g., ExploreScience, Frog Dissection, etc.)	0 1 2 3 4	0 1 2 3	0 1 2 3
14. Drill and practice programs (e.g., GeoSafari Animals, Brain Quest)	0 1 2 3 4	0 1 2 3	0 1 2 3
15. Individualized instruction-tutorials (e.g., ChemTutor, Science For Kids, The Learn About)	0 1 2 3 4	0 1 2 3	0 1 2 3
16. Problem solving software (e.g., Botanical Gardens, Thinkin' Science ZAP!)	0 1 2 3 4	0 1 2 3	0 1 2 3
17. Modeling Software (e.g., Model It)	0 1 2 3 4	0 1 2 3	0 1 2 3
18. Educational Games (e.g., VisiFrog)	0 1 2 3 4	0 1 2 3	0 1 2 3
19. Data Collection probes and computers (e.g., Vernier, PASCO, Texas Instrument)	0 1 2 3 4	0 1 2 3	0 1 2 3

My CURRENT Knowledge/Skills	MY Instructional Use in class during 2003-2004 (Frequency)	STUDENTS use of Technology during 2003-2004 (Frequency)
0= None 1= A little 2= Moderate 3= High 4= Expert	0= None 1= Less than 6 times a year 2= One to three times a month 3= More than once a week	0= None 1= Less than 6 times a year 2= One to three times a month 3= More than once a week

Specific computer applications for science instruction	My CURRENT Knowledge/Skills *Select one answer*					MY Instructional Use in class (Frequency)				STUDENTS use of Technology (Frequency)			
Use of the Internet for Science Instruction													
20. online communication (**e-mail**) between teacher and students (e.g. Email, online discussion board)	0	1	2	3	4	0	1	2	3	0	1	2	3
21. online communication **(online discussions board)** between teacher and students	0	1	2	3	4	0	1	2	3	0	1	2	3
22. online communication between students (e.g. online discussion board)	0	1	2	3	4	0	1	2	3	0	1	2	3
23. online communication between students and science Experts/ Mentors/ Scientists (e.g., Ask a Scientist)	0	1	2	3	4	0	1	2	3	0	1	2	3
24. video conferencing with others	0	1	2	3	4	0	1	2	3	0	1	2	3
25. information retrieval via the Internet	0	1	2	3	4	0	1	2	3	0	1	2	3
26. collect real time data (e.g. Whal Watch)	0	1	2	3	4	0	1	2	3	0	1	2	3
27. analyze online science data	0	1	2	3	4	0	1	2	3	0	1	2	3
28. access online databases (e.g., tes locator database)	0	1	2	3	4	0	1	2	3	0	1	2	3
29. access to online journals (e.g., education weekly)	0	1	2	3	4	0	1	2	3	0	1	2	3
30. conduct web-based Internet labs	0	1	2	3	4	0	1	2	3	0	1	2	3
31. online simulations	0	1	2	3	4	0	1	2	3	0	1	2	3
32. take virtual science trips to museums, zoos, science centers, etc.	0	1	2	3	4	0	1	2	3	0	1	2	3
33. use remote Web Cam to observe distant location	0	1	2	3	4	0	1	2	3	0	1	2	3
34. Webquests	0	1	2	3	4	0	1	2	3	0	1	2	3
35. Other (please specify)_______________	0	1	2	3	4	0	1	2	3	0	1	2	3

You have finished Part B. Part C will take a shorter amount of time.

Part C- MUTEBI SCALE					
Please indicate the degree to which you agree or disagree with each statement below by selecting the appropriate box to the right of each statement. ***Respond to each item with respect to science teaching.***					
SD= Strongly Disagree A= Agree UN= Uncertain D= Disagree SD= Strongly Agree					
1. When a student shows improvement in using the computer, it is often because the teacher exerted a little extra effort.	SD	D	UN	A	SA
2. When students' attitude toward using computers improves, it is often due to their teacher having used the classroom computer in more effective ways.	SD	D	UN	A	SA
3. If students are unable to use the computer, it is most likely due to their teachers' ineffective modeling.	SD	D	UN	A	SA
4. The inadequacy of a student's computer background can be overcome by good teaching.	SD	D	UN	A	SA
5. The teacher is generally responsible for students' competence in computer usage.	SD	D	UN	A	SA
6. Students' computer ability is directly related to their teacher's effectiveness in classroom computer use.	SD	D	UN	A	SA
7. If parents comment that their child is showing more interest in computers, it is probably due to the performance of the child's teacher.	SD	D	UN	A	SA
8. I am continually finding better ways to use the computer in my classroom.	SD	D	UN	A	SA
9. Even when I try very hard, I do not use the computer as well as I do other instructional resources.	SD	D	UN	A	SA
10. I know the steps necessary to use the computer in an instructional setting.	SD	D	UN	A	SA
11. I am not very effective in monitoring students' computer use in my classroom.	SD	D	UN	A	SA
12. I generally employ the computer in my classroom ineffectively.	SD	D	UN	A	SA
13. I understand computer capabilities well enough to be effective in using them in my classroom.	SD	D	UN	A	SA
14. I find it difficult to explain to students how to use the computer.	SD	D	UN	A	SA
15. I am typically able to answer students' questions which relate to the computer.	SD	D	UN	A	SA
16. I wonder if I have the necessary skills to use the computer for instruction.	SD	D	UN	A	SA
17. Given a choice, I would not invite the principal to evaluate my computer based instruction.	SD	D	UN	A	SA
18. When students have difficulty with the computer, I am usually at a loss as to how to help them.	SD	D	UN	A	SA
19. When using the computer, I usually welcome student questions.	SD	D	UN	A	SA
20. I do not know what to do to turn students on to computers.	SD	D	UN	A	SA
21. Whenever I can, I avoid using computers in my classroom.	SD	D	UN	A	SA

Part D- PCI SCALE					
The next set of statements concern how you might feel about various aspects of classroom management. For each statement, select the answer, which indicates the strength of your agreement.					
SD= Strongly Disagree A= Agree UN= Uncertain D= Disagree SD= Strongly Agree					
1. Too much pupil time is spent on guidance and activities and too little on academic preparation.	**SD**	**D**	**UN**	**A**	**SA**
2. Being friendly with pupils often leads them to become too familiar.	**SD**	**D**	**UN**	**A**	**SA**
3. It is more important for pupils to learn to obey rules than that they make their own decisions	**SD**	**D**	**UN**	**A**	**SA**
4. School governments are good "safe value" but should not have much influence on school policy.	**SD**	**D**	**UN**	**A**	**SA**
5. Pupil can be trusted to work together without supervision	**SD**	**D**	**UN**	**A**	**SA**
6. If a pupil uses obscene or profane language in school, it must be considered a moral offense.	**SD**	**D**	**UN**	**A**	**SA**
7. A few pupils are just young hoodlums and should be treated accordingly.	**SD**	**D**	**UN**	**A**	**SA**
8. It is often necessary to remind pupils that their status in schools differs from that of teachers.	**SD**	**D**	**UN**	**A**	**SA**
9. Pupils cannot perceive the difference between democracy and anarchy in the classroom.	**SD**	**D**	**UN**	**A**	**SA**
10. Pupils often misbehave in order to make the teacher look bad.	**SD**	**D**	**UN**	**A**	**SA**

This is the end of part C. You are almost finished.

Thank you for completing this survey.
We appreciate your time and value your input.

APPENDIX C
CONTENT EXPERT REVIEW QUESTIONNAIRE

Content Expert Review Questionnaire

Dear Survey Review Content Expert,

Thank you for serving on this review panel for the Technology Use in Science Education Survey. As an expert in integrating technology into the teaching of science, you are asked to review the following questionnaire and provide your best professional judgment on the relevance, clarity, and appropriateness of each item and identify potential survey problems such as ambiguous or difficult questions, irrelevant items, missing items, terms that need to clarification, or survey format.

The Technology Use in Science Teaching Survey is a two section questionnaire. The first section is designed to measure science teachers' present level of knowledge/skills on specific computer applications and their use of these technologies for personal or professional activities other than instruction. The second section is designed to measure science teachers' present level of knowledge/skills on specific computer applications for science instruction. This section will explore how often teachers use each specific computer applications in their instruction and how often their students used specific computer applications in or for class during the most current academic year.

After reviewing the survey, please complete the attached evaluation form. You may add your comments directly on the printed survey. Please list any terms used in the survey that you believe need a specific definition so respondents will better understand the survey item.

The feedback you provided will be carefully considered when revising this survey instrument. This revision process will contribute toward increasing the validity of this survey. It is important that you return the complete evaluation form and survey draft by ....., ... 2004 to the address below or via email.

Participation in this study is voluntary and you may skip any survey questions you do not wish to answer or withdraw without consequence. There are no anticipated risks, compensation, or other direct benefits to you as a participant in this study. If you have any questions about this study, please contact me at (352) 846-5274 (meral@grove.ufl.edu), or my faculty supervisor, Dr. Thomas M. Dana, at (352) 392 9191 ext 200 (tdana@ufl.edu). Questions or concerns about your rights as a research participant may be directed to the University of Florida Institutional Review Board at P.O. Box 112250, University of Florida, Gainesville, FL 32611-2250, (352) 392-0433.

Your participation in this process truly benefits the integration of technology into science teaching and science education as a whole. Thank you very much for serving as a content expert for this study.
Sincerely,

Meral Hakverdi

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TECHNOLOGY USE IN SCIENCE EDUCATION SURVEY
Evaluation Form [……. , 2004]

1. Are the survey instructions clear?
_____ Yes _____ No - Please state how could they be improved.

2. Are the survey questions understandable?
_____ Yes _____ No - List the item number of any unclear survey questions and state how the question(s) could be improved.

3. Are the survey questions easy to answer?
_____ Yes _____ No - Identify questions/items that are difficult to answer and briefly explain why.

4. Is the format of the survey appropriate for the information being requested?
_____ Yes _____ No – Please comment on how the format could be improved.

5. Estimate the time needed to answer the complete survey._________ minutes

6. What additional questions or items would you include to accomplish the survey purpose?

7. What terms need to be defined?

8. Will the answers to this survey in the support of the survey's purpose?
_____ Yes _____ No – Please explain your reasons?

Please make additional comments on the survey and returned this form and survey by …../…../ 2004 to Meral Hakverdi.

Name:_________________________________ Date: ___________________

Thank you for serving as a Content Expert Survey Reviewer and for providing your critique of this survey. You comments will assist the researcher in validating this survey to measure science teachers' use of technology.

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BIOGRAPHICAL SKETCH

Meral Hakverdi was born in Ankara, Turkey. She received her B. A. degree in Biology Education from Middle East Technical University, Ankara, Turkey, and taught both middle school science and high school biology at Sema Yazar Anatolian High School in Kayseri, and Cagribey Anatolian High School in Ankara, Turkey for a total of four years.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Thomas Dana, Chair
Professor of Teaching and Learning

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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