

EXEMPLARY SCIENCE TEACHERS' USE OF TECHNOLOGY

Meral Hakverdi-Can

Hacettepe University, College of Education, Department of Elementary Education
Division of Science Education, 06532 Beytepe/ ANKARA/TURKIYE
meralh@hacettepe.edu.tr

Thomas M. Dana

University of Florida, College of Education, Gainesville, FL, USA

ABSTRACT

The purpose of this study is to examine 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, how often they required their students to use those applications in or for their science class and factors influencing their decisions in using technology in the classroom. The sample of this study includes middle and high school science teachers who received the Presidential Award for Excellence in Science Teaching Award. 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.

1. INTRODUCTION

Although Benchmarks for Scientific Literacy (AAAS, 1993), the National Science Education Standards (NCR, 1996), Project 2061: Science for All Americans (Rutherford & Ahlgren, 1989), the National Educational Technology Standards (NETS) (ISTE, 2000), the International Society of technology in Education (ISTE, 2008) and British Educational Communications and Technology Agency (BECTA) (2010) 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. *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 the computer use and access in the secondary science classrooms. Research suggests that inadequate access to computers is not a limiting factor for integration of computers in teaching. 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 (Becker, 1999; Chen, 2008; Cuban, 2001; Dickson & Irvin, 2002; German & Barrow, 1996; Lehman, 1994; Niederhauser & Lindstrom, 2006; OTA, 1995).

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). While some of the teachers use technology in an exemplary way, some other teachers does not using them. The characteristics of exemplary technology-using teachers have already examined to understand how those teachers differ from other teachers by many researchers (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 (Hadley & Sheingold, 1993). They are enthusiastic and confident about using computers themselves, as well as seeing their students using computers for learning. Exemplary science teachers share the same characteristics of exemplary technology using teachers (Bonnstetter, Penick, & Yager, 1983; Fraser & Tobin, 1989; Penick & Yager, 1993; Tobin & Fraser, 1987; Treagust, 1991; Waldrup & Fisher, 1999; Weiss & Raphael, 1996). However there is no research study that examined the how exemplary science teachers use technology in the classroom and how their students use technology in the classroom. This study focuses mainly on exemplary science teachers not exemplary technology-using teachers. This study examined 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, how often they required their students to use those applications in or for their science class and factors influencing their decisions in using technology in the classroom. Thus, the following guiding questions were created:

1. What are the exemplary science teachers' knowledge/skills in using specific computer applications for science instruction?
2. How exemplary science teachers use the computer-related applications/tools during their instruction?
3. How often are exemplary science teachers require their students to use computer-related applications/tools in or for their science class
4. What kinds of factors influence their decisions in using technology in the classroom?

2. THEORETICAL FRAMEWORK

2.1. Computer 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) (Anderson & Maninger, 2007; Delcourt & Kinzie, 1993; Wang, Ertmer & Newby, 2004). 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). 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).

Findings from research studies revealed that computer use is correlated with computer self-efficacy (Compeau & Higgins, 1995; Compeau, Higgins, & Huff, 1999; Hasan, 2003; Marakas, Yi & Johnson, 1998; Pamuk & Peker, 2009; Potosky, 2002; Wilfong, 2006). However, literature on the effects of computer self-efficacy on exemplary science teachers is not found. Exemplary science teachers should already 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.

2.2. 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 Enoch, 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.

2.3. 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 is organized as the sum of all computer-related events in this study. 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.

Based on a review of the literature, significant factors influencing teachers' use of computers include: personal self-efficacy in teaching with computers (Compeau & Higgins, 1995; Compeau, Higgins, & Huff, 1999; Hasan, 2003; Marakas, Yi & Johnson, 1998; Pamuk & Peker, 2009; Potosky, 2002); outcome expectancy; pupil control ideology (Cicmanec, Johanson, & Howley, 2001; Enochs et al., 1995; Hoy & Woolfolk, 1990; Niederhauser & Perkmen, 2010); age (Becker, 1999; Jennings & Onweuegbuzie, 2000; Weiss, Smith, and Malzahn, 2001), gender (Akkoyunlu & Orhan, 2003; Ayersman & Reed, 1996; Busch, 1995; Cassidy & Eachus, 2002; Chua, Chen, & Wong, 1999; Durndell & Haag, 2002; Isilsal & Askar, 2003; Jennings & Onweuegbuzie, 2001; Karsten & Roth, 1998; Loyd & Gressard, 1984b; Murphy, Coover, & Owen, 1989; Ropp, 1999; Rosell & Gardner III, 2000; Rosen & Maguire, 1990; Roussos, 2007; Sam, Othman, & Nordin, 2005; ; Smith & Necessary, 1996; Torkzadeh & Koufteros, 1994; Torkzadeh, Pflughoeft, & Hall, 1999; Whitley, 1997), teaching experience; personal computer use; professional computer use; and science teachers' level of knowledge/skills in using specific computer applications/tools for science instruction. As evident from the literature, it's important to examine exemplary science teachers' knowledge/skills in using specific computer applications for science instruction, their use of computer-related applications/tools during their instruction, how often they required their students to use those applications in or for their science class and factors influencing their decisions in using technology in the classroom.

3. METHODOLOGY

3.1. Selection of the Participants

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 from all 50 states and U.S territories are the sample of this study. When the study completed, 355 middle and high school science teachers (grades 7 through 12) have been awarded by the PAEST.

3.2. Data Collection and Survey Responses

The main instrument of the study was a web-based questionnaire. In the data collection process, e-mail or a letter about the survey (with a return envelope) was sent to all award winning science teachers. The survey instruments posted online and e-mail message was sent to all of the award winning science teachers who provide their e-mail addresses (n=293) requesting to participate in the study by following the included URL address to access the web-based survey. After one week, another e-mail message was sent to the all of the science teachers who did not respond to the survey. At the end of the second contact with the science teachers, 82 award winning science teachers responded. Of those, 72 (28.6%) science teachers' surveys were valid. Not the entire award winning science teachers provided their e-mail addresses (n=62). A total of 103 packets of survey instrument with a postage-paid return envelope were mailed via U.S. postal service to the science teachers who did not provide e-mail address (n= 62) and to the science teachers whose e-mail addresses were returned as invalid (n=41). A total of 20 responses were received from those science teachers. A total of eleven envelopes were returned as undeliverable. Of the total 334 award winning science teachers, usable responses to the survey instrument is a total of 92 science teachers that makes a response rate of 27.5%.

3.3. Description of the Participants

Of the 92 respondents, 35 (38%) were male and 55 (59.8 %) were female. Two respondents did not report their gender. 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.

3.4. Instrumentation

Instruments used in this study include *Microcomputer Utilization in Teaching Efficacy Beliefs Instrument (MUTEBI)* (Enochs, Riggs, & Ellis, 1993), the *Level of Computer Use* assessment (Marcinkiewicz & Welliver, 1993), *The Pupil Control Ideology (PCI)* (Willower, Eidell and Hoy, 1973) and the *Technology Use in Science Education Scale (TUSES)* (developed for this study) and demographic information. 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 1.

Table 1. List of number of items, reliability and source of each scale

Description	#of Items	Reliability Coefficient	Source
Self-efficacy in Teaching with Computers (MUTEBI)	21		Enochs, Riggs, & Ellis, 1993
Outcome expectancy	7	.84	
Personal self-efficacy	14	.92	
Levels of Computer Use (LCU)	4	.95	Marcinkiewicz & Welliver, 1993
Technology Use in Science Education Scale (TUSES)	34		Researcher-created
Teachers' level of knowledge/skills in using specific computer applications for science instruction	34	.96	
Science teachers' use of computer related application/tool during their instruction	34	.90	
Their students' use of computer applications/tools in or for their science class	34	.92	
Pupil Control Ideology Scale (PCI)	10	.75	
Demographic Information	17		Researcher- created

3.4. 1. Instrument development procedures for the *Technology Use in Science Education Scale (TUSES)*

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.

3.4. 2. 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 a 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 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 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) and the Florida Association of Science Teachers Conference (n=59) (14 paper version and 45 web-version). 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 2. 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 2. Reliability – Cronbach’s Alpha values

Cronbach’s alpha	
Section 1-Professional use of computers in science education	
Teachers’ knowledge/skills	0.95
Teachers’ professional use	0.86
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

3.5. Data Analysis Techniques

This was a descriptive study of an exploratory in nature. As stated by Creswell (2003) when “not much has been written about the topic or the population being studied” (p. 30), exploratory studies provide more information and has many advantages. Descriptive statistics of frequency, percentages, means and standard deviations were reported. This study aimed to focus on exemplary science teachers’ use of technology. To determine the relationship between each of independent variables and teachers use of technology correlation analysis was conducted. Furthermore, independent sample t-test analysis was carried out to explore whether there was a significant differences between limited students’ use of computer applications/tools and higher students’ use of computer applications/tools on exemplary science teachers’ self-efficacy, outcome expectancy and pupil control ideology.

4. RESULTS

4.1 Description of the participants

The number of years served as a science teacher ranged from 8 to 41 years with a mean of 22.13 years. 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 3 represents the demographic information of participants.

Table 3. Some demographic characteristics of the participants (n=92)

Characteristics	n	%
Teaching experience (n=90)	1-9	2.2
	10-19	35.6
	20-29	41.1
	30-39	20.0
	40-41	1.1
Computer experience Personal use of computers (n=90)	6 to 9 years	5.4
	10 to 19 years	53.3
	20 to 29 years	37.0
	30 to 35 years	2.2
Professional use of computers (n=90)	0 to 9 years	21.7
	10 to 19 years	58.7
	20 to 25 years	17.4

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 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.

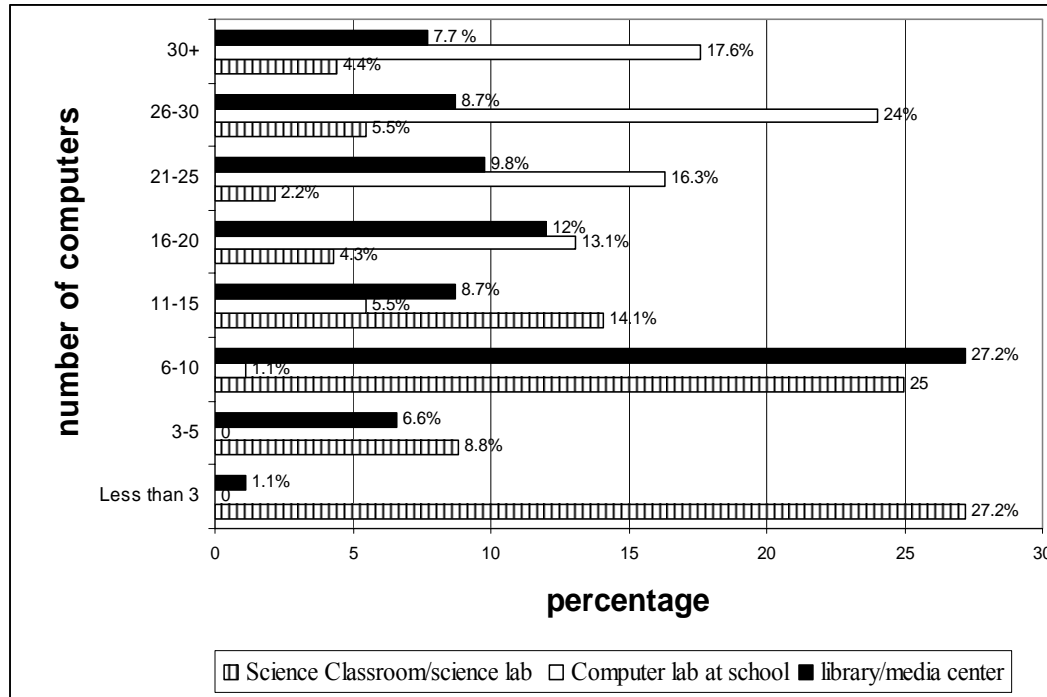


Figure 1. The number of computers available in science classrooms/science labs, computer lab at school, and in the library/media center

Exemplary science teachers indicated that they learned how to use technology through different professional development activities (see Table 4). 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. 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.

4.1. Exemplary science teachers’ knowledge/skills in using computer applications

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. Some of the items were provided at the Table 5.

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 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.

4.2. Exemplary science teachers' use of computer applications/tools in their instructions

Science teachers reported how often they used the specific computer applications/tools in their instruction. 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); 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.

Table 5. Science teachers' present level of knowledge/skill in using specific computer applications for science instruction and using internet for science instruction

	None 0	A little 1	Moderate 2	High 3	Expert 4	M	S.D.
1. Digital cameras		7.7	29.7	41.8	20.9	2.76	0.87
2. Video editing software (e.g., Video Maker, iMovie)	39.3	18.0	27.0	10.1	5.6	1.25	1.24
3. Graphing Calculators	14.4	13.3	34.4	23.3	14.4	2.1	1.24
4. Presentations (e.g., PowerPoint, KidPix)	1.1	3.4	24.7	1.1	44.9	3.1	0.97
5. Statistical programs (e.g., SPSS)	51.1	25.6	14.4	4.4	4.4	0.86	1.11
6. Spreadsheets (e.g., Excel)	4.4	14.4	31.1	31.1	18.9	2.46	1.09

7.	Concept mapping software (e.g., Inspiration)	33.0	24.2	15.4	14.3	13.2	1.51	1.42
8.	Simulations (e.g., ExploreScience, Frog Dissection, etc.)	21.1	13.3	28.9	23.3	13.3	1.94	1.33
9.	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
10.	Problem solving software (e.g., Botanical Gardens, Thinkin' Science ZAP!)	54.4	21.1	16.7	3.3	4.4	0.82	1.11
11.	Modeling Software (e.g., Model It)	60.7	19.1	11.2	9.0	0	0.69	1
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
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 and science Experts/ Mentors/ Scientists (e.g., Ask a Scientist)	22.5	19.1	22.5	19.1	16.9	1.89	1.40
23.	video conferencing with others	47.8	17.8	17.8	10.0	6.7	1.10	1.29
24.	analyze online science data	21.1	23.3	27.8	17.8	10.0	1.72	1.26
25.	access online databases (e.g., test locator database)	29.7	23.1	23.1	15.4	8.8	1.51	1.30
26.	conduct web-based Internet labs	26.1	19.3	27.3	12.5	14.8	1.70	1.37
27.	take virtual science trips to museums, zoos, science centers, etc.	33.7	20.2	19.1	11.2	15.7	1.55	1.45
28.	use remote Web Cam to observe distant location	46.7	15.6	16.7	10.0	11.1	1.23	1.41
29.	Webquests	34.4	15.6	21.1	13.3	15.6	1.60	1.47

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

Science teachers reported how often they required their students to use technology applications/tools in or for their classroom. 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 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.

4.4. Descriptive statistics and correlation

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 are listed in Table 6.

Table 6. Descriptive statistics of the variables and their reliabilities

	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

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 7).

Table 7. Pearson Product –Moment correlation between 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

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 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 ($r = .278, p=.010$).

5. 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.

5.1. Results for further 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 reported higher level of students' use of computer-related applications/tools have higher personal self-efficacy. The results are found in Table 8.

Table 8. Personal self-efficacy

	N	Mean	SD	<i>t</i>	DF	<i>p</i>
LSU	65	56.0000	10.1458	-2.292	85	.024
HSU	22	61.3636	7.1083			

H₀₂: 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 9.

Table 9. Personal outcome expectancy

	N	Mean	SD	<i>t</i>	DF	<i>p</i>
LSU	65	20.55	4.98	-2.053	85	.295
HSU	22	21.86	5.25			

H₀₃: 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 21.37 total 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 10.

Table 10. Pupil control ideology

	N	Mean	SD	<i>t</i>	DF	<i>p</i>
LSU	65	21.37	5.44	.474	85	.636
HSU	22	20.72	5.62			

6. DISCUSSION, CONCLUSIONS AND RECOMMENDATION

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.

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.

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 uses 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.

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 explain 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 (Hooper & Reiber, 1995). 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.

Further analyses of this study revealed that exemplary science teachers who reported higher level of student's use of computer related application/tools have higher personal self-efficacy. This finding is consistent with other findings that found that computer self-efficacy has been identified as one of the key factors among the various factors (Marakas, Yi, & Johnson, 1998; Potosky, 2002). Outcome expectancies and pupil control ideology of the exemplary science teachers are not different in both high and low level of students' use of computer -related application/tools. Although researchers mentioned that teachers' classroom management orientation is related to their use of computer in the classroom (Bean, 1988; Honey & Moelly, 1990; Sandholtz, Ringstaff, & Dwyer, 1997), this study revealed that exemplary science teachers does not have problem in pupil control on computer use in the classroom.

7. IMPLICATIONS AND SUGGESTIONS

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.

Further validation of the Technology Use in Science Education Scale with regular science teachers in United States of America and, in other 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 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.

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.

On the basis of finding of this study, professional development activities suggested. 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.

The use of the computer and related technologies whether required students to use of those technologies are depending on the teachers decisions. This study revealed that teachers' beliefs influence their level of knowledge/skills in use of technologies which in turn influence their teachers' decisions to use technologies in the classrooms. This study examined only some of the factors. Other factors might influence science teachers' decision to integrate technology while they are teaching. Those factors should also be studied to better understand the exemplary science teachers.

REFERENCES

- Akkoyunlu B. & Orhan, F. 820039 Bilgisayar ve Öğretim Teknolojileri Eğitimi (BÖTE) Bölümü Öğrencilerinin Bilgisayar Kullanma Öz Yeterlik İnancı İle Demografik Özellikleri Arasındaki İlişki, *Turkish Online Journal of Educational Technology* 2(3) Article 11.
- Albion, P. R. (1999). Self-efficacy belief as an indicators of teachers' preparedness for teaching with technology. *Technology and Teacher Education Annual 1999*, (Society for Information Technology & Teacher Education). Charlottesville, VA
- Anderson, S. E., & Maninger, R. M. (2007). Preservice teachers' abilities, beliefs, and intentions regarding technology integration. *Journal of Educational Computing Research*, 37(2), 151–172.
- Ayersman, D. & Reed, W. M. (1996). Effects of learning styles, programming and gender on computer anxiety. *Journal of research on Computing Education*. 28, 148-161.
- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191-215.
- Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, 37, 122-147.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- Bean, B. L. (1988). *Microcomputers: Developing teacher confidence and management skills*. Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 5-9, 1988)
- Becker, H. J. (1994). How exemplary computer using teachers differ from other teachers: implications for realizing the potential of computers in schools. *Journal of Research on Computing in Education*, 26(3), 292-321.
- Becker, H. J. (1999). Internet use by teachers: Conditions of professional use and Teacher directed student use (Teaching, Learning, and Computing -1998 National Survey, Report #1). Retrieved May 3, 2004, from <http://www.crito.uci.edu/TLC/findings/Internet-Use/startpage.htm>
- Becker, H. J. & Anderson, R. E. (1998). Teaching, learning, and computing: 1998, A national survey of school and teachers describing their best practices, teaching philosophies, and uses of technology.
- Becker, H. J., Ravitz, J. L., & Wong, Y. (1999). Teacher and teacher-directed student use of computers and software (Report No. 3). Irvine, CA: Center for research on Information Technology and organizations, University of California, Irvine.
- Beisenherz, B. C. (1993). "E" is for exemplary- Yes! You, too, can be an exemplary science teacher. *Science and Children* 31(1), 22-24.
- Berg, S., Benz, C. Lasley, T. & Raisch, C. D. (1997); The Coordinators and the Teachers: A description of exemplary use of technology in elementary Classrooms. Paper presented at the annual meeting of the Mid-western Educational research Association Annual Meeting. Chicago, IL, October, 1997. (Eric Document reproduction service No. ED414 877).
- Bonnstetter, R.J., Penick, J. E., & Yager, R. E. (1983). *Teachers in exemplary programs: How do they compare?* Washington, DC: National Science Teachers Association.
- British Educational Communications and Technology Agency (BECTA). (2010). *Leading next generation learning*. Retrieved on April 2010, from <http://www.education.gov.uk>
- Busch, T. (1995). Gender differences in self- efficacy and attitudes toward computers. *Journal of Educational Computing research*, 12, 147-158.
- Bybee, R. W. (1993). *Reforming Science Education*. New York: NY: Teachers college Press.
- Cassidy, S., & Eachus P.(2002). Developing the computer user self- efficacy (CUSE) scale: Investigating the relationship between computer self-efficacy, gender and experience with computers. *Journal of Educational Computing Research*, 26(2), 133-153.
- Chen, C. H. (2008). Why do teachers not practice what they believe regarding technology integration? *The Journal of Educational Research*, 102(1), 65–75.
- Chua, S. L. , Chen, D., & Wong, A. (1999). Computer anxiety and its correlates: A meta-analysis. *Computers in Human Behavior*, 15(5), 609-623.
- Cicmanec, K. M., Johanson, G. & Howley A. (2001). High school mathematics teachers: Grading Practice and Pupil Control Ideology. Paper presented at the Annual Meeting of the American Educational Research Association (Seattle, WA, April10-14, 2001)
- Clark, C. M. & Peterson, P. L. (1985). Teachers' thought process. In M. C. Wittrock (Ed.), *Handbook of Research on Teaching* (pp. 255-296). New York: Macmillan
- Compeau, D. & Higgins, C. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 1989-211.
- Compeau, D., Higgins, C. A. & Huff, S. (1999) Social cognitive theory and individual reactions to computing technology: a longitudinal study, *MIS Quarterly*, 23(2), 145-158.

- Creswell, J. W. (2003). *Research design: qualitative, quantitative, and mixed methods approaches* (2nd ed.). Beverly Hills, CA: Sage Publications.
- Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge, MA: Harvard University Press.
- Delcourt, M. A., & Kinzie, M. B. (1993). Computer technologies in teacher education: The measurement of attitudes and self-efficacy. *Journal of Research and Development in Education*, 27(1), 35–41.
- Demmon-Berger, G. (1986). *Effective teaching: Observations from research*. Arlington, VA: American Association of School Administrators. ED274087
- Dickson, L. A. & Irving, M. M (2002). An internet survey: Assessing the extent Middle /high school teachers use the Internet to enhance science teaching. *Journal of Computer in Mathematics and Science Teaching* 21 (1), 77-97.
- Doyle, W. (1986). Classroom organization and management. In M. C. Wittrock (Ed.), *Handbook of Research on Teaching* (3rd ed., p. 392-431). New York: Mackmillan
- Durndell, A., & Haag, Z. (2002). Computer self-efficacy computer anxiety, attitudes toward the Internet and reported experience with the Internet, by gender, in an East European sample. *Computers in Human Behavior*, 18, 521-535.
- Enochs, L. G., Scharmann, L. C. Riggs, I. M. (1995). The relationship of pupil control to pre-service elementary science teacher self-efficacy and outcome expectancy. *Science Education*, 79(1), 63-75.
- Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development*, 47(4), 47-61.
- Ertmer, P. A., Gopalakrishnan S., & Ross, E.M. (2001). VisionQuest: Helping our future teachers envision and achieve technology integration. Paper presented at SITE conference.
- Evertson C. M. (1986). Do teachers make a difference? *Educational and Urban Society*, 18(2), 195-210.
- Fraser, B. J., & Tobin, K. (1989). Student perceptions of psychosocial environments in classrooms of exemplary science teachers. *International Journal of Science Education*, 11 , 19-34.
- Fredrichsen, P. M., Dana, T. M., Zembal-Saul, C., and Tsur, C. (2001). Learning to teach with technology model: Implementing in secondary science teacher education. *Journal of Computers in Mathematics and Science Teaching*, 20(4), 377-394.
- Hadley, M., & Sheingold, K. (1993). Commonalities and distinctive patterns in teachers' integration of computers. *American Journal of Education*, 101 , 281-315.
- Hasan, B. (2003). The influence of specific computer experiences on computer self-efficacy beliefs. *Computers in Human Behavior*, 19, 443-450.
- Honey, M., & Moeller, B. (1990). *Teachers' beliefs and technology integration: Different values, different understandings* (Technical Report 6). New York: Center for Technology in Education.
- Hoy, W. K., & Woolfolk, A. E. (1993). Teachers' sense of efficacy and the organizational health of schools. *The Elementary School Journal*, 93, 356-372.
- International Technology Education Association (ISTE), (2000). *Standards for Technological Literacy: Content for the Study of Technology*, Reston, Virginia:
- International Society of Technology Education (ISTE) Accreditation Committee (1992). *Curriculum Guidelines for Accreditation of Educational Computing and Technology Programs*. Eugene, Oregon: ISTE.
- International Society for Technology in Education (ISTE) (2000). *National education technology standards for teachers*. Eugene, OR: International Society for technology in Education (ISTE) NETS Projects. Available:<http://cnets.iste.org/index3.html>
- Isıksal, M., & Askar, P. (2003). İlköğretim öğrencileri için matematik ve bilgisayar öz-yeterlik algısı ölçekleri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 25, 109–118.
- Jennings, S. E., & Onweuegbuzie, A. J. (2001). Computer as a function of age, gender, math attitude, and developmental status. *Journal of Educational Computing Research*, 25(4), 367-384.
- Karsten, R., & Roth, M. R. (1998). The relationship of computer experience and computer self-efficacy to performance in introductory computer literacy courses. *Journal of Research on Technology Education*, 31(1), 14-24.
- Lehman, J.R. (1994). Secondary science teachers' use of microcomputers during instruction. *School Science and Mathematics* 94(8), 413-420.
- Loyd, B. H. & Gressard, C. (1984). The effect of sex, age, and computers experience on computer attitudes. *AEDS Journal*, 18, 67-77.
- Marakas, G. M., Yi, M. Y., & Johnson, R. D. (1998). The multilevel and multifaceted character of computer self-efficacy: Toward clarification of the construct and an integrative framework for research. *Information Systems Research*, 9(2), 126-163.
- Marcinkiewicz, H. R. (1991). The relationships of selected personological variables to the use of available microcomputers by elementary school teaches. Unpublished doctoral dissertation, he Pennsylvania State University, Pennsylvania.

- Marcinkiewicz, H. R. (1993). *The relationships of personological variables to computers use by elementary school teachers: Report of phase one – base line data*. Paper presented at the Convention of the Association for Educational Communications and Technology, Washington.
- Marcinkiewicz, H. R., & Grabowski, B. L. (1992). *The relationships of personological variables to computer use by elementary school teachers: Report of phase data*. Paper presented at the Convention of the Association for Educational Communications and Technology, Washington.
- Marcinkiewicz, H. R., & Welliver, P. (1993). *Procedures for assessing teachers' computer use based on instructional transformation*. 5th Annual proceedings of Selected Research Presentations at National Convention of the Association of Educational Communications and technology (New Orleans, LA)
- Murphy, C. A., Coover, D., & Owen, S. V. (1989). Development and validation of the computer self efficacy scale, *Educational and Psychological measurement*, 49, 893-899.
- National Research Council (1996). *National Science Education Standards*. Washington,DC: National Academy Press.
- National Board for Professional Teaching Standards (1999). *Guide to national certification*. Washington, DC: Author
- Niederhauser, D. S., & Perkmén, S. (2010). Beyond self-efficacy: Measuring pre-service teachers' instructional technology outcome expectations. *Computers in Human Behavior*, 26, 436–442.
- Niederhauser, D. S., & Lindstrom, D. L. (2006). Addressing the NETS for students through constructivist technology use in K-12 classrooms. *Journal of Educational Computing Research*, 34(1), 91–128.
- Office of Technology Assessment. U.S. Congress (1995). *Teachers and Technology: Making the Connection*. Washington, DC: U.S. Government print production
- Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 307-332
- Pajares, F. (2009). Overview of social cognitive theory and of self-efficacy. Retrieved December 10, 2009, from <http://www.emory.edu/EDUCATION/mfp/eff.html>.
- Pamuk, S., & Peker, D. (2009). Turkish pre-service science and mathematics teachers' computer related self-efficacies, attitudes, and relationship between these variables. *Computers & Education*, 53, 454–461.
- Paraskeva, F.; Bouta H.; Papagianni, A. (2008). Individual characteristics and computer self-efficacy in secondary education teachers to integrate technology in educational practice *Computers & Education*; 50, 1084–1091.
- Penick, J., & Yager, R. (1993). The search for excellence in science education. *Phi Delta Kappan*, 64(9), 621-623.
- Potosky, D. (2002). A field study of computer efficacy beliefs as an outcome of training: the role of computer playfulness, computer knowledge, and performance during training. *Computers in Human Behavior*, 18(3), 241-255.
- Potosky, D., & Bobko, P. (1998). The computer understanding and experience scale: a self-report measure of computer experience. *Computers in Human Behavior*, 14(2), 337–348.
- Rieber, L.P., and Welliver, P.W. (1989). Infusing Educational Technology into Mainstream Educational Computing. *International Journal of Instructional Media*, 16(1). 21-32.
- Ropp, M.M. (1999). Exploring individual characteristics associated with learning to use computers in pre-service teacher preparation. *Journal of Research on Computing in Education*, 31(4), 402-424.
- Rosell, E. J. & Gardner III, W. L. (2000). Cognitive, motivation, and affective process associated with computer-related performance: a patch analysis. *Computers in Human Behavior*, 16, 199-222.
- Rosen, L. R. & Maguire, P. (1990). Myths and realities of computerphobia: A metaanalysis. *Anxiety Research*, 3, 175-191.
- Rosenshine, B. (1979). Content, time, and direct instruction. In A. Walbert, & P. Peterson (Eds.) *Research on Teaching: Concepts, Findings, and Implications*. Berkeley, CA: McCutchan.
- Roussos, P. (2007). Greek computer attitude scale: Construction and assessment of psychometric properties. *Computers in Human Behavior*, 23(1), 578-590.
- Sam, H. K., Othman, A. E. O., & Nordin, Z. S. (2005). Computer self-efficacy, computer anxiety and attitudes toward the Internet: A study among undergraduates in Unimas. *Educational Technology and Society*, 8(4), 205–219.
- Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1997). *Teaching with Technology: Creating Student-Centered Classrooms*. New York: Teachers College Press.
- Schrage, F. (1995). Teachers accountability: A philosophy view. *Phi Delta Kaplan*, 76(8). 642-644.
- Smith, B. L., Caputi, P., Crittenden, N., Jayasuriya, R., & Rawstorne, P. (1999). A review of the construct of computer experience. *Computers in Human Behavior*, 15, 227-242.
- Songer, N. B., Lee, H.S. & Kam, R. (2002). Technology-rich inquiry science in urban classrooms: What are the barriers to inquiry pedagogy? *Journal of Research in Science Teaching*, 39(2), 128-150.

- Szajna, B. & Mackay, J.M. (1995). Predictor of computer-user training environment: a path analytic study. *International Journal of Human-Computer Interaction*, 7(2), 167-185.
- Tobin, K., & Fraser, B. (1987). *Exemplary practice in science and mathematics education*. Perth, Western Australia: Curtin University of Technology.
- Torkzadeh, G. & Koufteros, X. (1994). Factorial validity of a computer self efficacy scale and the impact of computer training. *Educational and Psychological Measurement*, 54(3), 813-921.
- Torkzadeh, G., Pflughoeft, K. & Hall, L. (1999). Computer self efficacy, training effectiveness and user attitudes: An empirical study. *Behaviour and Information Technology*, 18(4), 299-309.
- Treagust, D. F. (1991). A case study of two exemplary biology teachers. *Journal of Research in Science Teaching*, 28, 329-342.
- Waldrip, B. & Fisher, D. (2001). Perception of students-teachers interactions in exemplary science teachers' classroom. Paper presented at Australian Association for Research in Education, Brisbane, Australia.
- Wallace, R. M. (2004). Framework for understanding teaching with the Internet. *American Educational Research Journal*, 41(2), 447-488.
- Wang, L., Ertmer, P.A., & Newby, T.J. (2004). Increasing preservice teachers' self-efficacy beliefs for technology integration. *Journal of Research on Technology in Education*, 36(3), 231-252.
- Weiss, I., & Raphael, J. (1996). *Characteristics of presidential awardees: How do they compare with science and mathematics teachers nationally?* Chapel Hill, NC: Horizon Research.
- Whitley, B. E. (1997). Gender difference in computer-related attitudes and behavior: A meta analysis. *Computers in Human Behavior*, 13(1), 1-22.
- Wilfong, J. D. (2006). Computer anxiety and anger: The impact of computer use, computer experience, and self-efficacy beliefs. *Computers in Human Behavior*, 22(6), 1001-1011.
- Willower, D., Eidell, T., & Hoy, W. (1973). *The school and pupil control ideology* (revised) University park, PA: Pennsylvania State University studies.
- Zhao, Y., Byers, J., Mishra, P., Topper, A., Chen, H., Enfield, M., Ferdig, R., Frank, K., Pugh, K. and Tan, S. H. (2001). What do they know? A comprehensive portrait of exemplary technology-using teachers. *Journal of Computing in Teacher Education*, 17(2), 25-37.