Use of Digital Technologies in Graphic Communication Education

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(ABSTRACT)

This study investigated the use of digital technologies in secondary and post-secondary graphic communication education. Specifically it investigated: 1) the extent to which graphic communication educators utilized digital technologies in conjunction with instruction; 2) how selected factors affected graphic communication teachers' implementation of digital technologies in their instruction; and, 3) how selected factors affected teacher and learner-centered instructional practices.

The *Levels of Technology Implementation* (LoTi) and "Technology Use Survey" instruments were administered to secondary and post-secondary graphic communication educators via the Web to assess: 1) the frequency of use of 17 different digital technologies; 2) the nature and level of digital technology implementation; 3) current instructional practices; and 4) demographic characteristics.

Graphic communication educators (*n* = 191) responding to the survey utilized a wide variety of digital technologies as part of their instruction. The data indicated that most students in graphic communication classes use computers, page layout software, and the Internet (for accessing digital content) "almost daily." Most graphic communication students were creating and/or editing vector and raster graphics "several times a week." Most graphic communication teachers reported student use of digital still cameras, digital instructional tutorials and the Internet (to solve technical problems) was limited to "several times a month," while most students were creating digital multimedia projects only "several times each year." Most respondents chose "never" to describe students' use of: digital video cameras, digital drawing tablets, creating and/or editing Web pages with a WYSIWYG or HTML editors, digital spreadsheets, digital databases, and digital animations. Findings from this study further indicate graphic communication educators demonstrate high to extremely high skill levels using computers for personal use and implement digital technologies in ways that begin to shift the learning environment from teacher-centered to student-centered, but may not be effectively updating their curriculum to reflect current graphic communication industry workforce needs.

DEDICATION

As I ponder this dedication, many thoughts come to mind. This dissertation has been a very long process and it is hard to thank all those that have helped along the way. First and foremost I want to thank my wife Tracy. She has been a pillar of support for me, and I am very lucky to call her my wife. I also want to thank all of my family and friends who have supported me along this very long journey. Finally I want to dedicate this to the best dog a person could ever ask for, Beeker. While she did not make it to see this completed, she was there for most of it and I am sure she is barking in joy as I write this.

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CHAPTER ONE

Introduction

Computer technology has been a component of American secondary school instruction for more than 20 years. In the early 1990s, there was only one instructional computer available for every 20 students; now, the majority of primary and secondary schools in the United States have more than one instructional computer for every five students. Moreover, by 2002, 99% of schools in America were connected to the Internet (National Center for Education Statistics, 2002, p. 233). Students in today's schools regard computers, the Internet, and the World Wide Web as necessary parts of their school lives, (Maddox, Johnson, & Willis, 2001).

Current trends in secondary classrooms are leading to technology becoming further imbedded in the student experience. At the same time, some teachers are maintaining very tight control over technology use and allowing students little freedom, while others are allowing them nearly full reign when it comes to making technology decisions (Judson, 2006, p. 582). Digital technologies[1] have reached the classrooms of America, but that does not mean they are being utilized in a beneficial manner.

Bransford, Brown, and Cocking (1999) concluded new technologies provide opportunities for creating learning environments offering new possibilities, while extending the possibilities of older but still useful technologies such as books, blackboards, and one-way linear communication. New technologies also have the ability to hinder learning if used in inappropriate applications (Bransford, Brown, & Cocking, 1999).

Various technologies are used in the secondary classroom: teachers use presentation software to enhance lectures; students routinely use computers to word process school papers (Strickland & Nazzal, 2005); teachers and students use the Internet to gather information and source material (Bull & Bull, 2003-2004; Shiveley, 2005); and digital cameras, camcorders, scanners, and software applications are regularly used as part of the instructional process. While these are powerful tools, it is not clear whether they are always – or are even generally – being used in positive ways to enhance student learning.

Burton (2001) generalized the effect of digital technologies on education:

> Electronic technology promises to be one of the most decisive and far-reaching dimensions of education in the next century. It will affect every aspect of art education from artistic technique and content (graphic media), to unlimited access to resources (from the Web), to new instructional techniques (like PowerPoint), to the nitty-gritty of administrative duties and grading, to the very way instruction is organized (constructivist approaches). (Burton, 2001, pp. 142-143)

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[1] For the purposes of this study, "technology" and "technologies" refer to digital technologies. In the graphic communication classrooms investigated for this study, digital technologies take multiple forms, including: computers, scanners, "office" software, digital cameras, digital camcorders, graphic communication software, digital imaging systems, etc.

The dispersion of digital technologies into virtually every school in America continues to change the way teachers teach and students learn. “Whether one is excited, challenged, or frightened by the influx of technology in schools, the fact remains that emerging technologies are increasingly being infused in school cultures and do have a major effect on teaching and learning” (Rogers, 2000, p. 455). Digital technologies offer the potential for enhancing traditional teacher-centered instruction with additional learner-centered approaches to instruction.

Statement of the Problem

While computers are now ubiquitous in education, there is considerable evidence that their use has not benefited teaching and learning in a constructive manner (Barron, Kemker, Harmes, & Kalaydjian, 2003; California Technology Assistance Project, 2002; Judson, 2006; Maddox et al., 2001; Rakes, Fields, & Cox, 2006; Russell, O'Dwyer, Bebell, & Miranda, 2004). However, computers and digital technologies *may* be used to create effective learning environments that enhance teaching and learning; nevertheless, they may also be used ineffectively. National, state, and local agencies together with educators are working to bring digital technologies into classrooms, but it is unclear if these technologies are fostering greater academic achievement.

The problem of this study was threefold: (1) to identify the extent to which each of a wide variety of digital technologies were utilized in conjunction with graphic communication instruction; (2) to identify how selected factors affected the extent to which graphic communication educators implement digital technologies as part of their classroom instruction; and, (3) to examine how selected factors affected the point at which graphic communication educators’ instructional practices intersect the Teacher-Centered/Learner-Centered (TCLC) continuum.

A key factor leading to the use of technology in the secondary classroom is the Federal Government’s “No Child Left Behind” (NCLB) legislation (2003). The federal program clearly identifies the use of digital technology as a priority for all classrooms by mandating its primary goal as improving student achievement through the use of technology in schools (United States Department of Education, 2005).

Another important factor is the National Education Technology Standards (NETS) for Teachers established by the International Society for Technology in Education (ISTE). These are based on the effective use of technology in the classroom. The NETS have clear definitions for science and social studies content areas, but do not include standards for technology use in the graphic communication classroom. “Through the ongoing use of technology in the schooling process, students are empowered to achieve important technology capabilities. The key individual in helping students develop those capabilities is the classroom teacher,” (International Society for Technology in Education, 2002, p. 4).

In 2004, the National Technology Education Plan from the United States Department of Education stressed the importance of technology use, but also took into account that technology may not have been used to its full potential. “The problem is not necessarily lack of funds, but lack of adequate training and lack of understanding of how computers can be used to enrich the learning experience," (United States Department of Education, 2004, p. 9).

From the NCLB legislation to the National Technology Education Plan of 2004, it is clear that standards are in place, and that money is being spent on technology. However, it remains unclear how and if teachers are effectively using technology to enhance the learning environment of their classroom.

In addition to educational standards, other factors affect the continued use and adoption of technology. Educational standards were not studied as part of this research, but other demographic factors were, including: number of years teaching; age; gender; level of education; number of computers available for instructional use in the classroom; direct access to the Internet in the classroom; frequency of computer use in the classroom; technology-related training; perceived obstacles; and personal computer use.

The central learning theory for this study was learner-centered practices.

> A primary classroom where learner-centered teaching practices are being used might be described as one in which (a) teachers generally provide a range of instructional activities that are relevant to children's lives and tailored to fit different developmental levels, (b) teachers provide support for learning by way of frequent interactions with children that allow for careful monitoring of their development and progress, as well as individualized help when needed, and (c) teachers make efforts to create positive relationships with children and address their socioemotional, as well as academic, needs. (Daniels & Perrry, 2003, p. 102)

Another important facet of this study is the manner in which digital technologies are actually being implemented in the classroom. "The ways that we use technologies in schools should change from technology-as-teacher to technology-as-partner in the learning process. Technologies can engage and support thinking when students learn *with* technology," (Jonassen, Howland, Moore, & Marra, 2003, p. 11). This use of technology lends itself to learner-centered classrooms and moves away from a teacher-centered approach. Unfortunately, technology use can also lend itself to merely making instruction easier by providing tutorials for students to follow, computers to use the Internet, and digital projectors to display traditional lecture material.

Research Questions

This study investigated graphic communication educators' perceived adoption and use of digital technologies. Specifically, it examined educators' perceptions of their use of digital technologies in graphic communication assignments, their learner-centered teaching practices, and the frequency of use of various digital technologies as part of graphic communication assignments. This study was guided by the following research questions:

1. How frequently do students use each of a wide variety of digital technologies in conjunction with graphic communication instruction? (*Technology Use Survey* (TUS))

2. At what level of the *Levels of Technology Implementation* (LoTi) Scale do graphic communication educators implement digital technologies? (LoTi Scale)

3. Which selected demographic factors predict graphic communication educators' implementation of digital technologies as part of their instruction? (LoTi Scale, LoTi *Personal Computer Use* (PCU) Scale, demographic questions)

4. Where along the Teacher-Centered/Learner-Centered continuum do graphic communication educators' instructional practices fall? (LoTi CIP Scale)

5. Which selected demographic factors predict where graphic communication educators' instructional practices fall along the Teacher-Centered/Learner-Centered continuum? (LoTi CIP, LoTi PCU Scale, demographic questions)

Significance of the Study

Despite increased access to the Internet and the availability of computers in the classrooms, it is clear that technology has not fully transformed or possibly even enhanced the learning process. In 2008, classrooms were still very similar to those of five years ago. The ten-year Apple Classroom of Tomorrow (ACOT) project was launched in 1985 to help educators create learner-centered teaching environments which employed computers (Apple Computer, 1995; Dwyer, 1994). Unfortunately, in the more than 20 years since this program was launched, educators have still not utilized digital technologies to their greatest potential.

Mandell, Sorge, and Russell (2002) concluded:

> Teachers have the opportunity and the obligation to lead the much needed reform of the current educational system in this country. Technology will play a big part in that reform. It is not the availability of technology that will make the difference. It is the teachers' effective use of the technology that will make the difference. The teacher is the most important ingredient for success when using technology. (Mandell, Sorge, & Russell, 2002, p. 39)

Judson (2006) investigated teachers' beliefs and attitudes toward digital technology adoption in the classroom. Results showed educators might define their teaching beliefs as constructivist, but in reality, their instructional practices were not learner-centered (Judson, 2006). Li (2007) surveyed teachers and students, and reported that their beliefs about technology were very different. The students held more positive attitudes toward the technology than teachers did; and teachers had a fear that, if technology were truly incorporated into the classroom, their jobs might be replaced. Many of the teachers were clearly aware of their student's love of technology and that it was the manner in which their students learnt information, but they refused to adopt it as part of their instruction (Li, 2007).

Research regarding graphic communication educators' use of digital technologies, particularly in regard to their teaching practices, is severely limited. They are utilizing digital technology in their classrooms, but it is uncertain how often, to what extent, and where these practices fall with regard to learner-centered and teacher-centered classroom practices.

This study attempted to create a foundation for future research by examining current practices of graphic communication educators in relation to digital technologies and their use in the graphic communication classroom.

Definition of Terms

The following is a list of terms and their meanings in the context of this study:

Browser: computer software developed to allow a graphical representation of World Wide Web pages. It provides users with a point-and-click hypertext environment on the Internet (Lewin, 2001).

Computer Managed Instruction (CMI): computer applications designed to perform tasks or combinations of tasks, such as organizing student data; monitoring student progress; testing student mastery and prescribing further instruction or remediation; recording student progress; testing student mastery; and selecting the order of instructional modules to be completed (Maddox et al., 2001).

Database: software designed to create an electronic filing system using preexisting data or data collected for a specific application or project (Maddox et al., 2001).

Desktop Publishing: software developed for integrating text and graphics in a variety of page formats and layouts (Maddox et al., 2001).

Digital Divide: the implication that minority schools have less Internet capability than those schools not identified as minority.

Digital Technologies: software or hardware built upon digital, components, (e.g., Adobe Photoshop, Macintosh computer, and Spectrophotometer).

Drill and Practice Software: software designed to allow the student to practice an already acquired skill (Maddox et al., 2001).

Graphic Communication: the study of all areas of media and mass communication involving the creation, production, and distribution of images for advertising, marketing, books, magazines, newspaper, catalogs, packages, and other media in printed and digital form (Cal Poly, 2009).

Graphics Programs: software developed to enhance, modify, or manipulate digital images.

Hypertext: term for the ability to link different Web pages together through quick and easy movements around the Web (Lewin, 2001).

Hypermedia: media that are linked; e.g., a CD-ROM that includes text, images, sound, and video (Maddox et al., 2001).

Internet: the worldwide network of computers connected by cables, wires, and wireless connection devices.

Learner-Centered: "the perspective that couples a focus on individual learners (their heredity, experiences, perspectives, backgrounds, talents, interests, capacities, and needs) with a focus on learning (the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest levels of motivation, learning, and achievement for all learners" (McCombs & Whisler, 1997, p. 9).

Prepress: "the production steps that are carried out prior to printing" (Prust, 2003, p. 580).

Raster Graphics: "images that use a grid of small squares (pixels) to represent graphics" (Prust, 2003, p. 582)

Simulations: computer experiences which recreate experiences otherwise unavailable in the classroom; e.g., a flight simulator (Maddox et al., 2001).

Smartboard: an interactive whiteboard used in the classroom that is capable of interactively working with a computer and projection system.

Spreadsheet: software designed to organize numerical data and automate calculations and comparisons of various pieces of data that have been collected (Maddox et al., 2001).

Educational Standard: educational "benchmark" student learning outcomes.

Technology: for the purposes of this study, see "Digital Technologies" above.

Tutorial Software: software designed to teach a student a skill that has not already been learned; e.g., a keyboarding tutorial (Maddox et al., 2001).

Type I Educational Computer Application: technology applications that serve the function of making work on the computer easier and more convenient, (Maddox et al., 2001).

Type II Educational Computer Application: technology applications that involve the use of technology to foster innovative teaching and learning (Maddox et al., 2001).

Vector Graphics: "mathematical descriptions of images and their placement" (Prust, 2003, p. 589).

Virtual Tour: a tour of a plant, museum, or similar location that is conducted using the Web and a computer.

Web Portal: a single entry point on the Web that leads to a range of related sources and information links (Keel, 2000).

WebQuest: a learning activity in which some of the information needed to complete the activity is located on the Internet (Maddox et al., 2001).

World Wide Web (Web): the graphical interface based on the Internet that allows users to access other computers and websites.

WYSIWYG: "What You See Is What You Get" in relation to Web page creation.

Limitations of the Study

1. Participants for this study were graphic communication educators registered with one of five available sources; thus, the results should not be generalized to the entire population of graphic communication educators.

2. Results of this study were derived from a teacher self-report instrument, rather than researcher observations. Therefore, the study was limited by the accuracy of the respondents' responses to the survey instrument.

3. Further limitations include the validity and reliability of the instrumentation, possible respondent bias, and the percentage of respondents, which was less than the number to whom the survey was distributed.

Delimitations of Study

1. This study was delimited to graphic communication educators registered with one of the following: Graphic Arts Technical Foundation, International Graphic Arts Educators Association, Graphic Arts Technical Association of Illinois, Print Ed Certified Teachers, and the GRAPHIC COMM CENTRAL Listserv.

2. This study was delimited to the questions on the *Technology Use Survey* and to the scales created by the *Levels of Technology Implementation* instrument.

CHAPTER TWO

Literature Review

This chapter begins with a review of literature regarding graphic communication and continues with a review of literature related to: learner-centered theory literature, the integration of digital technologies in education, the use of digital technology in the classroom, educational standards, factors leading to the adoption of digital technology in the classroom, and a review of various research instruments that examine the use of digital technology in the classroom. The chapter concludes with a review of associated literature on the *Levels of Technology Implementation* research instrument that is used in this study.

Graphic Communication

During a review of recent *Visual Communications Journals* (VCJ), it was evident little research has been completed related directly to this study. The VCJ is the only peer-reviewed journals for the field of graphic communication.

Nearly all of the articles published in the VCJ (Which is read by and published for graphic communication *educators*) are focused on technical issues and the printing industry, rather than on research relating to instruction. For example the spring 2007 VCJ issue included the following articles: *A Comparison of Waterless Litho with Conventional Litho on Productivity, Eco-Friendliness, and Technical Skills Needed* (Mehta, 2007, Spring), "*A Cube Model for Planning Technological Change in the Printing Industry – Influences from within the Industry and External Environment* (Levenson, 2007, Spring), *Does Access to Communication Technologies Outside the Classroom Have Significance in Student Learning* (Blue, 2007, Spring), *Printing Industry Guidelines for Print Students Part Two: Printing Process Control and Color Separation* (Waite & Hutcheson, 2007, Spring).

Dissertations relating to graphic communication education were also reviewed. These dissertations have generally focused on technical and industry-related issues. The following recent dissertation titles illustrate this trend. "A study of important content for undergraduate graphic communications programs" (Hao, 2001), "Graphic communication industry training: A critical comparison of knowledge gained and satisfaction of learners between on-site delivery and Web-based delivery" (Osmond, 2002), "Current status of graphic communications technology education in the mountain states and its impact on the graphic communications industry" (Dharavath, 2002), and "Apparent quality of alternative halftone screening when compared to conventional screening in commercial offset lithography" (Oliver, 2007).

Learner-Centered Learning Theory

The theory behind this study is learner-centered learning. This form of learning puts the focus on the pupil, and moves it away from the traditional teacher-centered learning practices. In a learner-centered classroom, the students are active participants, and the learning process is ever changing, both from the teacher's and students' perspectives.

An early study of learner-centered teaching theory was conducted by Sund and Trowbridge (1974). They examined its role in relation to discovery and inquiry. Discovery is the process by which a learner, or student assimilates concepts and principles, and is able to observe, classify, measure, predict, describe and infer. Inquiry follows a process of problem origination, hypotheses formulation, investigative design, testing, synthesizing, and attitude development. A learner-centered classroom uses both of these concepts. If a classroom teacher is heavily slanted towards only one of these, the learner is not gaining the benefits from both (Sund & Trowbridge, 1974).

In 1990, the American Psychological Association (APA) created a special Presidential Task Force with two purposes: (1) to ascertain the steps in which the psychological knowledge base related to learning, motivation, and individual differences that could directly contribute to the improvement of student achievement; and, (2) to provide guidance in redesigning educational systems that supported individual student learning and achievement (McCombs & Whisler, 1997). This task force worked to create a framework for intended school redesign and reform.

Seven years after the Presidential Task Force was formed, the APA adopted 14 learner-centered psychological principles, and these helped to guide learner-centered research and practice (McCombs & Miller, 2007). The 14 principles are broken into four domains: Cognitive and Metacognitive Factors; Motivational and Affective Factors; Developmental and Social Factors; and Individual Difference Factors. "The four domains holistically describe the factors that must be attended to in facilitating learning for all learners, (McCombs & Miller, 2007, p. 25). The 14 principles are shown in Table 1.

Table 1

Learner-Centered Psychological Principles, (American Psychological Association, 2008).

Cognitive and Metacognitive Factors

1. Nature of the learning process. *The learning of complex subject matter is most effective when it is an intentional process of constructing meaning from information and experience.*
2. Goals of the learning process. *The successful learner, over time and with support and instructional guidance, can create meaningful, coherent representations of knowledge.*
3. Construction of knowledge. *The successful learner can link new information with existing knowledge in meaningful ways.*
4. Strategic thinking. *The successful learner can create and use a repertoire of thinking and reasoning strategies to achieve complex learning goals.*
5. Thinking about thinking. *Higher order strategies for selecting and monitoring mental operations facilitate creative and critical thinking.*
6. Context of learning. *Learning is influenced by environmental factors, including culture, technology, and instructional practices.*

Motivational and Affective Factors

7. Motivational and emotional influences on learning. *What and how much is learned is influenced by the learner's motivation. Motivation to learn, in turn, is influenced by the individual's emotional states, beliefs, interests and goals, and habits of thinking.*
8. Intrinsic motivation to learn. *The learner's creativity, higher order thinking, and natural curiosity all contribute to motivation to learn. Intrinsic motivation is stimulated by tasks of optimal novelty and difficulty relevant to personal interests, and providing for personal choice of control.*
9. Effects of motivation and effort. *Acquisition of complex knowledge and skills requires extended learner effort and guided practice.*

Developmental and Social Factors

10. Developmental influences on learning. *As individuals develop, there are different opportunities and constraints for learning. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account.*
11. Social influences on learning. *Learning is influenced by social interactions, interpersonal relations, and communication with others.*

Individual Differences Factors

12. Individual differences in learning. *Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity.*
13. Learning and diversity. *Learning is most effective when differences in learners' linguistic, cultural, and social backgrounds are taken into account.*
14. Standards and assessment. *Setting appropriately high and challenging standards and assessing the learner as well as learning progress including diagnostic, process, and outcome assessment are integral parts of the learning process.*

Lambert & Macombs (1998) concluded: "the principles are intended to deal holistically with learners in the context of real-world learning situations. Thus, they are best understood as an organized set; no principle should be viewed in isolation." (p. 16) The principles are also intended to be applied to all learners, including children, teachers, administrators, and parents, (Lambert & McCombs, 1998).

McCombs and Whisler (1997) identified five premises to the learner-centered model of teaching: (1) each learner is unique and distinct; (2) each learner has unique differences when it comes to learning styles and rates, as well as developmental stages, abilities, talents, feelings and other various needs; (3) learning occurs best when it is constructive and is meaningful and relevant to the learners and the learners are engaged in creating their own knowledge and relating what is being learned to prior knowledge and experiences; (4) the best environment for learning is one that contains positive relationships and interactions, and in which the learner feels appreciated, acknowledged and respected during the learning process; and, (5) learning is a natural process, and learners are inherently curious and interested in learning.

When teachers followed these premises, learners were included in the educational decision-making process; the diverse perspectives of learners were encouraged and valued; the differences among learners' cultures, abilities, styles, stages of development and needs were accounted for and respected; and learners were treated as co-creators in the teaching and learning process, and as individuals with ideas and issues that deserve attention and consideration (McCombs & Whisler, 1997).

Huba and Freed (2000) further identified eight hallmarks of learner-centered teaching and assessment: (1) learners are actively involved and receive feedback on their learning; (2) learners apply knowledge to enduring and emerging issues and problems; (3) learners integrate discipline-based knowledge and general skills with learning; (4) learners understand the merits of excellent work; (5) learners become increasingly sophisticated; (6) educators coach and facilitate, intertwining teaching and assessing with learning; (7) educators understand they were learners, too; and (8) learning is interpersonal. These hallmarks did not specifically relate to the use of digital technologies, but could be applied to any learning environment in which the student was at the center, and the educator is practicing learner-centered teaching.

Building upon these hallmarks, Weimer (2002) noted five types of change that took place when teaching environments moved from being teacher-centered to being learner-centered. (1) There is a shift in the balance of power; this is now shared between the students and the teacher. (2) The function of content changes in order to establish a knowledge base and to foster learning. In traditional settings, content is the center of the teaching practice; while in a learner-centered environment, content is a focal point, but is not the most important variable in the learning process. (3) The role of the teacher adjusts dramatically. In a learner-centered classroom, the teacher helps guide and facilitate the learning, not as the center of the instruction, but as a part of it, and shares the learning experience with the students. (4) The responsibility for learning moves to the students. These changes can be facilitated because of the environment the teacher creates, but the students have to take an active role in the learning process and understand that learning is their responsibility. (5) The purpose and process of evaluation is transformed. Assessments are created to help foster learning and to help students understand the learning process. Assessment should also incorporate more formative feedback mechanisms that allow the students to receive constructive feedback, thus enabling them to perform better on future assessments(Weimer, 2002). These changes were also applied to technology-rich instruction and were not limited to classrooms without digital technologies.

Thirty-two teachers participated in a study conducted by Judson (2006) that used the Conditions that Support Constructivist Uses of Technology (CSCUT) to measure the teachers' beliefs and attitudes toward the adoption of digital technologies in the classroom. The results showed that, while teachers defined themselves as having constructivist teaching philosophies, this did not have a significant correlation to their classroom practice. Teachers claimed to use learner-centered instruction in the classroom, but actual observation by the researcher did not document this. Digital technology use is not inherently constructive; technology is a tool and can be used to enable students to gain a deeper understanding through learner-centered teaching environments (Judson, 2006).

Learner-centered instruction has been a part of education for many years, but it is only in the last 10 years that the true benefits of learner-centered instruction have been examined. Traditional teacher-centered instruction does not offer the advantages of a classroom in which the learning is centered upon the learner. Technology lends itself to leaner-centered instruction, but it is unclear if the benefits of using technology in this manner have truly reached the classroom.

Integration of Digital Technology in Education

Various studies have examined the use or lack of use of digital technologies in the classroom. The following studies illustrate a range of research that has been conducted over the last 20 or so years. These studies provide a basis for research on the use of digital technologies in the classroom.

The ten-year Apple Classroom of Tomorrow (ACOT) project was first launched in 1985. This was a time when computer technology was very new to the classroom and when very few teachers actually used computers on a daily basis. ACOT gave each participating student and teacher two computers, one to use at home and one to use in the classroom, thereby allowing the students and the teachers constant access to the technology (Apple Computer, 1995; Dwyer, 1994). Upon completion of the study, the results showed that the teachers in ACOT classrooms moved from a traditional teacher-centered environment to a learner-centered environment. Students developed from listeners and learners into collaborators and, sometimes, experts. Knowledge concepts moved from accumulation to transformation, and the learning emphasis changed from fact and replication to relationship and inquiry (Apple Computer, 1995).

Marcinkiewicz (1993) examined the growing use of computers in schools in the early 1990s. The study specifically looked at why most teachers at an elementary school would not adopt the use of computers in their classrooms. Likening the installations of computers to the introduction of a new hybrid corn to farmers, Marcinkiewicz pointed out that some farmers accepted this new higher-yielding corn immediately, while it took other farmers ten years to adopt it. “The findings of this research showed that teachers were largely underutilizing computers even though computers were available in their schools” (Marcinkiewicz, 1993, p. 233).

The Boulder Valley Internet Project (Sherry, Lawyer-Brook, & Black, 1997) tracked a five-year period, beginning in 1992, in which the project leaders introduced telecommunications to the classrooms in the Boulder Valley School District. An initial group of 26 teachers was trained in the use of the Internet, the local area network (LAN), and the Web for research and communication. These teachers then went out into the school system to share their newfound knowledge and skills with their colleagues. As the teachers became more adept at using the Web and LANs, their peer network slowly expanded beyond the confines of their buildings to include new colleagues from all over the world. Over the next five years, with the help of teachers involved in the project, the Internet diffused throughout the school district. At the end of the period, not only had the teachers evolved, but also had the Internet into graphical browsers such as Netscape. This type of Internet diffusion is common throughout the country, and, while the majority of schools in America are now wired for the Internet, it is not evident how many teachers are actually using it as part of their normal class period.

In 2001, the Use, Support, and Effect of Instructional Technology ("USEiT") study began in the state of Massachusetts. This project was undertaken to better understand how educational technology was being used in the classroom, what factors influenced its use, and how it affected student learning. The study focused on teachers and students in grades 5, 8, and 11 (Russell et al., 2004). It found that of all the educators studied, science teachers had the greatest access to various technologies, such as computers and television monitors with video recorders and players. Among all teachers, the overhead projector was found to be the most frequently used technology. English and social studies teachers reported less confidence in using computers than mathematics and science teachers. All educators were frequently using computers to make handouts for students, and to create tests, quizzes, or assignments. Educators across all disciplines reported that problems with incorporating technology into lessons were not quickly resolved.

A national survey of secondary art educators in 2001 revealed that the majority of art teachers were using electronic technology in some manner. Fifty-one percent used the technology to create handouts and other materials for students, while 26% responded that they used very rarely other electronic technology. Fifty-one percent reported frequently using electronic technology for assessment and grading. Direct instruction using electronic technology was used less often. Fifty-six percent reported very rare or no use of electronic technology for direct instruction (Burton, 2001).

The summary of the 2002 statewide technology survey in California (California Technology Assistance Project, 2002) calculated that 99% of Californian high schools, and 94% of the individual classrooms were connected to the Internet. At the high school level, the student-computer ratio was 4 to 1. The study also showed that only 11% of surveyed science and social studies teachers used technology on a daily basis, while 36% of reading/language arts teachers used it daily. Most science and social studies teachers reported using it between once a week and monthly.

Barron, Kemker, Harmes, and Kalaydjian (2003) surveyed one of the largest school districts in the United States as part of research examining technology integration and its relationship to the National Technology Standard. The 2156 respondents represented a broad range of educational backgrounds, a variety of disciplines, and a diverse set of experiences in teaching. Results indicated elementary teachers were twice as likely to use computers as a problem-solving tool as high school teachers. Science teachers were three times as likely as mathematics teachers were and twice as likely as English teachers were to integrate computers as a research tool in their classroom. Science teachers were also three times as likely as English teachers were to use computers as problem solving tools. "This study provides data that indicate many teachers are implementing technology as a tool for research, communication, productivity, and problem-solving; however, the goal of technology integration across all subject areas and grade levels is yet to be reached," (Barron et al., 2003, p. 505).

In 2004, the National School Boards Association surveyed technology specialists, teachers, administrators, and school board members. They found that 45% of respondents noted that integrating technology into the classroom was their biggest technology-related challenge, while 47% said it was technology funding, and 6% believed that it was closing the digital divide. Sixty-eight percent stated that new teachers were better prepared than in the past to integrate technology effectively into the classroom, and 90% indicated that the use of technology increased educational opportunities for students by helping them engage in learning, providing a stronger ability to communicate, and improving critical learning skills. Seventy percent of the respondents also noted that home Internet access was a serious problem for low-income students in their school districts (State Educational Technology Directors Association, 2007). NetDay's 2005 Speak Up Event, a national survey of students and teachers, found that 62% of the teachers surveyed classified themselves as average or beginner technology users. Over 90% stated that their schools provided a computer for classroom use, and 93% indicated that they were using desktop computers for professional activities. Thirty-six percent of the teachers also reported using digital cameras for professional activities. The number one obstacle facing teachers using technology was reported to be the lack of time in the school day (57%). Other obstacles were the lack of computers (46%) and those that did not work regularly (29%). The teachers indicated that technology was making their jobs easier (74%), and that students' learning experiences were richer because of information from the Internet and multimedia technology opportunities (47%), (Project Tomorrow 3, 2006).

The 2004 Consortium for School Networking survey of 455 district school technology makers reported that 62% of school leaders noted that the technology budgets in their schools remained unchanged or decreased. Additionally, 18% reported significant decreases in technology budget outlays. The survey also showed that 56% of respondents identified integrating technology into the classroom as the top challenge. Fifty-six percent also cited teacher professional development as a major obstacle. Only 1% stated that technology integration was not a problem, and 2% reported that inadequate professional development created no barriers to technology adoption (Consortium for School Networking, 2004).

In 2006, the Teachers Talk Tech survey found that technology is bridging the gap between 21st century skills and core curricula. It also found that the teaching process is fundamentally changing as teachers move from simply learning how computers work to utilizing technology to change their teaching manner, and are thus transforming the way students learn. This survey found the number one obstacle to teachers' use of technology was access to computers (55%). Others included time (48%), budgets (48%), and class sizes (30%). Seventeen percent also indicated that a set curriculum was an obstacle to technology use (CDW-Government, 2006).

After reviewing technology-integration studies from the past 25 years, it is clear technology is being integrated into American classrooms. Starting with the Apple Classrooms of Tomorrow to the current studies, it is evident that technology is being used in various manners in the classroom, but it is also clear that many obstacles make it difficult for educators to integrate technology to the degree desired.

Use of Digital Technology in the Classroom

Teachers and students use digital technology every day in the classroom. This use can be as simple as a digital projection system or as complex as a multimedia presentation that includes images, voice-overs, movies, and sound. Digital technology comes in various forms in different schools and classrooms, but is present in all of them.

Graphic communication educators have always used technology in the classroom as the technology allows the students to learn the process of printing and design. The traditional equipment used in the graphic communication classroom has changed to incorporate more digital technologies, and this technological movement is a focus of this study.

In addition to journal articles, this review examined multiple books on technology use in the classroom. These include *Teaching with Technology: Creating Student-Centered Classrooms* (Sandholtz, Ringstaff, & Dwyer, 1997), *Educational Computing: Learning with Tomorrow's Technologies* (Maddox et al., 2001), *Using Technology in the Classroom* (Bitter & Person, 2002), *Technology Applications in Education* (O'Neil & Perez, 2003), *Learning to Solve Problems with Technology: A Constructivist Perspective* (Jonassen et al., 2003), *Computers for Twenty-First Century Educators* (Lockard & Abrams, 2004), and *Integrating Technology: A Practical* Guide (Lengel & Lengel, 2006). These books provided overall ideas for technology integration into the learning process and provided a basis for possible article review.

A 20-year review of articles published in *Computers in the Schools* showed a definitive trend of computer use moving from tutor and tutee to tool usage (Wentworth & Earle, 2003). While many early articles focused on computer-aided instruction, in which students used drill-and-practice programs, others included using the computer for simple tutorial exercises and evaluating students on correct answers. Computers were not seen as having the ability to understand ideas, and this type of conceptual computer exercise was not encouraged. Later articles focused on using the computer as a tool to enhance learning in traditional settings and subject areas. These uses included word processing, spreadsheets, databases, presentation software, Geographic Information System (GIS), and the use of the Internet for research and communication. These later articles helped to establish technology-enhanced classrooms as collaborative learner-centered environments; they also established the need for teachers to change their classrooms into learner-centered environments. Another focus of later articles was the increased role of technology in teacher–education programs (Wentworth & Earle, 2003).

Hooper and Rieber (1995) made the distinction between technology in education and educational technology. On the surface, both terms appear to be the same, but there is a difference. Technology in education is usually perceived as the number of computers or videocassette players in a classroom and the ways these technologies might be used to support traditional classroom activities. Educational technology, however, involves applying new ideas to instruction and changing the classroom to meet the opportunities provided by technology. In order for teachers to adopt educational technology philosophies, they must move from familiarization and simple uses of technology to its actual integration as part of the educational process. Teachers must evolve and reconceptualize their traditional roles in the classroom (Hooper & Rieber, 1995).

The underutilization of the Internet was quickly coming to an end by 2001:

> Integration of technology use in educational institutions has received unprecedented attention within the last decade. The Internet has lately become the focus of attention, especially with regard to its significance as an instructional tool, and has become a top priority for educators and policy makers (Ali & Franklin, 2001, p. 57)

Ali and Franklin (2001) conducted a study of 22 students to examine Internet integration in classrooms and its effect on students' learning and teacher-student relationships. The results revealed both positive and negative influences on the students' learning. The positive aspects grouped around four themes: (1) access to better sources of information; (2) more independent and individualized learning; (3) more in-depth understanding; and (4) greater motivation. The negatives were also in four areas: (1) interference with student concentration; (2) more time-consuming activity; (3) access to questionable resources; and (4) dependence on the Internet for information.

Maddox and Johnson (2001) indicated that drill-and-practice computer applications were overused in the classroom, while computer applications that stress higher-order thinking skills were underutilized. Their research identified two types of technology applications for use in the classroom. Type I is the most basic use of technology and is designed to make it easier, faster, and more efficient in order to continue teaching subjects in the same manner in which they always have been. The second level of technology application is identified as Type II, which supports new and better ways of teaching and learning. Furthermore, Type I applications rely on the passive involvement of the user (student) and do not require a high degree of intellectually active involvement. Type I applications allow users to respond, but they do not generally include higher-order complex cognition. Type II applications generally stimulate active intellectual involvement on the part of the user (student). They also put the user in charge of almost every event that happens, and the user has a great deal of control over the interaction between user and machine (Maddox et al., 2001). This classification of digital technologies allows the educator to understand how and why it might be useful to use technology in the classroom.

The recent diffusion of digital cameras along with the spread of the Internet has led language arts educators to combine both of these technologies into a user-centered activity referred to as "digital storytelling". Technology is placed in the hands of the students and can provide a voice to struggling writers and readers who might not otherwise find an authentic means of expression (Bull & Bull, 2003-2004). Technology allows the students to tell stories in ways that were previously not possible.

Virtual reality technology has been shown to create a learner-centered classroom at the Military College of South Carolina, the Citadel (DeRoma & Nida, 2004). Threedimensional or virtual environments help to engage the students in active learning by placing the student at the center of the instruction. These activities also provide collaborative opportunities between the students and the teachers. “Technology has changed our lives because it is designed to help tasks get done more quickly, and the Citadel faculty members have discovered that technology can speed up the top-priority task in our department and our institution: student learning,” (DeRoma & Nida, 2004, p. 41).

Heafner (2004) used a descriptive and exploratory case study to examine the integration of technology for social studies instruction. Results illustrated that “technology empowers students by engaging students in the learning process” (p. 47). Furthermore, technology use motivated students and increased their interest in the work because they were familiar with the technology. The study also recommended that teachers incorporate instructional practices reflecting a learner-centered approach rather than a teacher-centered approach.

The Web and the social studies classroom were the focus of Lombard (2004). Through the Web, students were able to engage in inquiry-based learning. Students were given a clear objective and then had to use the Web to achieve that objective. This inquiry-based learning allowed students to understand new information as well as to extend what they have already learned. The boundaries of the classrooms were extended to areas beyond the physical space.

An example of this would be a WebQuest. Students are the guiding force in a WebQuest; the teacher merely provides the objective. The Web also enables students to access sites that allow interactive learning and makes it possible for students to post their work online so that others might view and learn from it.

The rapid technological advancements from 1995 to 2005 sparked educators’ interest in using laptop computers as an instructional tool to improve student learning. Gulek & Demitras (2005) found that after one year in a laptop immersion program, students showed significantly higher achievement in nearly all measures of English language, Arts, Mathematics, Writing, and overall grade point average. By providing an additional visual representation of learning material, laptop computers also offered students with disabilities opportunities for success that may not have been previously available (Gulek & Demirtas, 2005).

During an examination of a methods course as part of a teacher education program, Powers and Blubaugh (2005) found that mathematics teachers would use technology appropriately and effectively if they were familiar with the available technology and if they had successfully integrated technology in an instructional setting. The methods course provided the teachers with the appropriate technology base to integrate it into their lesson plans. “Today’s middle school and high school students were born into a world with technology. Using technology during mathematics instruction is natural for them, and to exclude these devices is to separate their classroom experiences from their life experiences” (Powers & Blubaugh, 2005, p. 260).

Judson (2006) noted, "Today, it is commonplace to discover teachers using technology for a variety of purposes, including record-keeping, accessing lesson plans, creating study guides, and communicating with parents," (Judson, 2006, p. 581). Furthermore, some teachers may use technology only for presentation purposes, while others with the same resources and access allow the students to be directly involved in the use of technology. Its classroom use is linked not only to access, but also to the teachers' own feelings about the technology (Judson, 2006, p. 581).

Digital technologies are utilized for various means in the classrooms of today. Nearly all schools in America have direct access to the Internet, and the number of computers and other technologies has grown substantially over the past ten years. Technology in the classroom is not only a desktop computer; it is also a digital projection screen, an interactive computer tutorial, a digital camera, a digital scanner, and even a virtual reality environment.

Educational Standards

National as well as state and local standards have a direct impact on the use of technology in the classroom. While educational standards have always been a part of the American educational system, they have not focused as heavily on technology as they currently do.

The "No Child Left Behind" (NCLB) Act passed by the United States' Government in 2002 established federal standards for education. Since its inception, the face of education has dramatically changed. As part of NCLB, technology use in the classroom has been given priority.

> A shift has taken place in recent years from teaching students how to use technology to focusing on using technology to support content. Technology can no longer be looked at in isolation but rather as part of a carefully planned program of school change as it relates to student achievement. Technology can broaden the range of students' choices as they learn. Students routinely use technology tools to find information, collect, organize and interpret data, and present results. (Northeast & the Islands Regional Technology in Education Consortium, 2002, p. 2).

The Enhancing Education Through Technology (EETT) Act of 2001 requires that no less than 25% of its funding be used to provide sustained and intensive, high-quality professional development. This federal program is the only one dedicated to the integration of educational technology in K-12 schools. Its primary goal is to improve student academic achievement using educational technology. In the classroom, this can consist of either teachers' or students' use of computers as well administrative uses, curriculum development, communication, and data analysis (United States Department of Education, 2005).

National technology standards have also been created. The National Educational Technology Standards for Students (NETS) were created to help teachers provide technology-rich learning activities for their students. NETS provide teachers the opportunity to move from a traditional learning environment to one in which technology plays a key role. NETS's basic framework for students' technology use is divided into six broad categories: (1) basic operations and concepts; (2) social, ethical, and human issues; (3) technology productivity tools; (4) technology communication tools; (5) technology research tools; and (6) technology problem-solving and decision-making tools (International Society for Technology in Education, 2002). These categories center on student learning and not teacher use because it is the pupils who are the focus of the educational system, but it is up to the teacher to get them to reach these standards.

Another facet of NETS is the realization of the Federal Government that teachers in America need better and more appropriate access to technology. As part of NETS For Teachers – Preparing Teachers To Use Technology (International Society for Technology in Education, 2002), the Government acknowledged that there may be factors directly related to using and acquiring technology. To combat these factors, NETS clearly identifies areas of concern. These concerns include: a shared vision between teacher and administrator; access to computers and technology; skilled educators; ongoing professional development; technical assistance; community support; and policies that support technology in learning.

States have also implemented technology standards that are closely related to NETS, EETT, and NCLB as federal funding is directly related to how they enforce educational standards. Each state also has the opportunity to apply for two types of federal grants directly related to NCLB. The first is the formula grant. This is used to update infrastructure and technology inventories. The second type, the competitive grant, is focused on specific programmatic technology solutions. In 2002, the total amount of grant money issued to states was $595,194,993, while in 2005 the level of funding had decreased to $462,201,231 (State Educational Technology Directors Association, 2007).

Educational standards in the United States are driving schools and classrooms to adopt digital technology as part of daily instruction. It is yet to be determined if these standards have truly helped the learning process, but it is very clear they are shaping the way teachers teach and students learn.

Factors Leading to Technology Adoption in the Classroom

There are many factors affecting teachers' use of digital technologies in the classroom. These range from teachers' attitudes toward technology to their access to internet-ready computers. With the recent push for the use of technology by the United States Department of Education, it is important to note that, in today's climate, the main catalyst to adoption may no longer be as simple as the number of computers available to a teacher.

Gershner and Snider (2001) focused on the addition of Internet connectivity and the resulting change in attitudes and behaviors. In the spring of 1999, a small rural town in Texas received Internet connections in the classrooms for the first time. The resulting study of 49 teachers showed that a common concern was the need for more time with the Internet and that interaction between the teachers provided the best support and pressure for the acquisition of new technology. However, innovation may be limited if there is not sufficient technical support provided (Gershner & Snider, 2001).

Mumtaz (2000) reviewed research findings from 1980 to 2000 on the factors affecting teachers' use of information and communication technology. The review found three interlocking factors that affect teachers' technology use: the institution/school, the available resources, and the teachers themselves. There was a clear lack of time on the part of the teachers due to institutional restraints and policies that did not allow for time to learn the new technology. In addition, even if teachers were provided with up-to-date technology and a clear support network, there might not be enough enthusiasm on the part of an individual teacher to bring the technology into the classroom (Mumtaz, 2000).

Daley et al. (2001) explored the connections between learning and technology in a university setting. This was through an action research case study using students enrolled in one of five different universities. Findings of the study indicated that students' attitudes and perceptions toward technology have a major influence on their learning outcomes. "Students who viewed technology from a negative perspective did acquire and integrate knowledge, but most stopped short of extending and refining that knowledge or using that knowledge in a meaningful way" (Daley et al., 2001, p. 136). In contrast, if students had a positive perception of computer technology, their experience of computer-based instruction was also positive. How the students approached the technology had a direct impact on the learning environment, and the students' perceptions were directly related to how their instructors handled or encouraged the use of technology in the classroom.

Butler & Sellbom (2002) conducted a study at Ball State University that found four general categories of barriers to technology adoption in the classroom: (1) the unreliability of the technology; (2) the lack of time available to learn the technology; (3) the uncertainty that the use of technology is beneficial; and (4) the lack of support by the institution. "To successfully implement new technologies in teaching and learning, institutions must address these barriers to faculty adoption" (Butler & Sellbom, 2002, p. 28).

Moersch (2002a) also identified several variables relating to teachers' not implementing technology. One is the trickle-down effect, in which the ideal of effective technology use is transmuted from state and national standards to the actual work that is occurring in the classrooms. Various impractical or overly optimistic mandates and miscommunication among lawmakers, supervisors, and teachers can make for ineffective technology implementation at the student level. Another variable is inefficient staff development, in which the opportunities do not take into account the technology expertise of the individual teachers, but employ a blanket training that assumes each teacher is at the same level. Lack of strategic planning on the part of schools, and a shortage of computers also create barriers to digital technologies adoption (Moersch, 2002a).

An analysis of survey data collected from 3,665 teachers representing four geographically diverse American states exposed a clear factor related to digital technologies use – access. "One teacher in six had no computers in his or her classroom, and nearly two-thirds of respondents had no more than one computer to be shared among their entire classroom" (Norris, Sullivan, Poirot, & Soloway, 2003, p. 18). Less than five 5% of the respondents had five or more computers available for use in their classrooms.

Results from a study of 30 technologically savvy teachers identified several barriers to digital technology integration, even at their advanced experience level. Two key issues were that students did not have enough time in front of computers and that teachers needed extra time for planning digital technologies lessons. Other concerns were outdated hardware, lack of software appropriate to the class, technical difficulties, and student computer skill levels (Bauer & Kenton, 2005).

Kim and Bagaka (2005) examined the digital divide by studying student, teacher/classroom, and school characteristics. The study found that students' use of word processing, interactive technologies, and productivity tools was significantly lower in urban and rural areas than in suburban areas. Students in suburban schools also spent significantly more time on computers in school and at home than students did in urban or rural settings. In addition, even though digital technologies were present, teachers still had the choice to make use of them or not, and teachers' personal experience with digital technologies had an impact on how and why they used it in their classrooms (Kim & Bagaka, 2005).

Pre-service teachers were the focus of Wright and Wilson's (2005-2006) research. The data was collected by following them from the methods course experience through to student teaching and then from case studies of three first-year teachers. The methods course was heavily reliant on digital technologies and the majority of teachers continued to utilize them as part of their teaching after course completion. Barriers to digital technologies use during teaching and the first year of teaching included lack of access, inadequate resources, and administrative difficulties. One teacher noted another factor was that some of the teachers' education faculties did not embrace the use of digital technologies and that many students failed to utilize digital technologies to their full potential because of the lack of interest by their professors. Those enrolled in teacher education classes that were rich in digital technologies emulated their use in their post-graduation teaching practices (Wright & Wilson, 2005-2006).

Teachers' attitudes were one of the factors against computer use in the classroom in a survey of 764 Canadian elementary and secondary teachers (Wozney, Venkatesh, & Abrami, 2006). Results indicated that teachers needed to believe in the successful implementation of computer use. They also needed to be convinced of the value of digital technologies as a tool to supplement and help improve traditional classroom practice. "Teachers who believe that they have the skills to implement computers successfully and who valued the outcomes associated with integration were more likely to be at the high end of the digital technologies user" (Wozney, Venkatesh, & Abrami, 2006, p. 202).

Access to computers and the Internet has constantly been a factor when it comes to instructional digital technologies use, but, according to the National Center for Education Statistics (2006), that factor is now much less pronounced. In a 2005 survey of 1,205 public schools in the 50 states and the District of Columbia, nearly 100% of all public schools in the United States had access to the Internet. This was compared to 35% in 1994. This access was overwhelmingly by broadband connection (97%), and 45% of the reporting schools used wireless connections. The ratio of students to instructional computers with Internet access also continues to shrink. In 1998, there were 12.1 students for every instructional computer, while in 2005, there were 3.8 students for every 1 (National Center for Education Statistics, 2006).

Franklin (2007) surveyed elementary teachers and found their three greatest factors against computer use in the classroom were too much curriculum to cover, lack of time in their daily schedule, and high-stakes testing. "The elementary teachers in this study felt quite prepared to use digital instructional technology in their teaching, and they overwhelmingly indicated that computers had considerable potential for allowing students to discover or construct ideas for themselves" (Franklin, 2007, p. 278). Six support factors were also identified: (1) leadership; (2) access and availability; (3) incentives; (4) personnel support; (5) external constraints; and (6) philosophy and preparation. These factors had a direct affect on computer adoption by the teachers.

Technology integration to the curriculum is not merely placing computers into a classroom and expecting teachers to use them for instruction. Various factors have a direct impact on how and why digital technology is or is not adopted. These factors include: the number of Internet-connected computers: lack of time on the part of the teacher to learn the technology; administrative policies that restrict what is to be taught, and how it is to be taught; teacher and student perceptions on the digital technology; standardized testing; and the lack of support and training given to teachers.

Digital Technology Research Instruments

Various instruments have been developed to research the use of digital technologies in the classroom. Some examine the number of computers, others assess teacher and student attitude, and a few investigate teacher and student learning styles in comparison to digital technologies integration. The catalyst for the development of many of these instruments is the need for "stringent measures for accountability and evaluation of federally funded programs," (Moersch, 2002b, p. 11). The NCLB Act requires research-based evidence of effectiveness of instructional interventions relating to digital technologies standards. Examples include: the 2001 Massachusetts *Use, Support, and Effect of Instructional Technology* (*"*USEiT*")* study (Bebell, Russell, & O'Dwyer, 2004), the *Levels of Technology Implementation* (LoTi) instrument (Moersch, 2001), *Taking a Good Look at Instructional Technology* (TAGLIT), *iAssessment, enGauge, and Profiler* (Moersch, 2002b). The *Levels of Technology Implementation* will be discussed further as this was used in this study.

The Levels of Technology Implementation (LoTi) Instrument

The *Levels of Technology Implementation* (LoTi) instrument was selected for use in this study. Created and distributed by Loticonnection.com, the LoTi instrument is a proprietary instrument comprised of 50 questions (See Appendix D). It was used in this study along with 10 demographic questions (See Appendix E) and 17 new questions (See Appendix F). The LoTi instrument examines teachers' use of digital technologies by utilizing three different scales: the Level of Technology Implementation scale (Appendix A); the Current Instructional Practice (CIP) scale (Appendix B); and the *Personal Computer Use* (PCU) scale (Appendix C). These scales help to ascertain the technology implementation level of the educator taking the survey as well as the instructional practices and personal computer use of the educator.

The LoTi instrument was specifically selected because the scales, or profiles, relate directly to research questions #2, 3, 4, and 5, as discussed in Chapter One. The LoTi instrument was created in 1995 (Moersch, 1995) and incorporates the "Concerns-Based Adoption Model" along with the findings of the "Apple Classrooms of Tomorrow" research (Moersch, 2001). This instrument examines the changing levels of technology implementation, current instructional practices, and personal computer use by assigning each level a category. For example, at level 4A and above on the LoTi scale, technology implementation is categorized as promoting higher-order thinking skills. Level 4A and above are also the levels at which instruction begins to shift from a teacher-centered environment to a learner-centered environment. (Moersch, 2002a).

Having been adopted by 10 states, including Texas, Florida, Wisconsin, Kansas, and New Hampshire, the LoTi instrument has become a tool to measure teachers' technology implementation at the state level. School districts all over the United States have also used LoTi to help survey teachers' levels of technology integration and implementation, and to provide positive feedback to the teachers in hopes that the integration of digital technologies will be beneficial to classroom instruction (Guhlin, 2008).

The LoTi instrument has also been the focus of journal articles (Middleton & Murray, 1999; Rakes et al., 2006) and the research instrument of choice for multiple dissertations (Corbin, 2003; Deacon, 1999; Feeney, 2001; Griffin, 2003; Larson, 2003; Schechter, 2000). The idea of promoting higher-level thinking through use of the LoTi is also the focus of Moersch's 2002 book entitled *Beyond Hardware: Using Existing Technology to Promote Higher-Level Thinking* (Moersch, 2002a).

CHAPTER THREE

Methodology

This descriptive study investigated graphic communication educators' implementation of digital technologies, instructional practices, and frequency of use of various digital technologies as part of instruction. In this chapter, the research methods and procedures as well as information on the participants, survey instruments, and data collection are presented.

Research Questions

This study investigated graphic communication educators' adoption and use of digital technologies and how this was perceived. Specifically, it examined educators' perceptions of their own use of digital technologies as part of instruction and learner-centered teaching practices as well as the types and frequency of use of various digital technologies. The following research questions guided this study:

1. How frequently do students use each of a wide variety of digital technologies in conjunction with graphic communication instruction? (*Technology Use Survey*)

2. At what level of the *Levels of Technology Implementation* Scale do graphic communication educators implement digital technologies? (LoTi Scale)

3. Which selected demographic factors predict graphic communication educator's implementation of digital technologies as part of their instruction? (LoTi Scale, LoTi *Personal Computer Use* Scale, and demographic questions)

4. Where along the Teacher-Centered/Learner-Centered continuum do graphic communication educators' instructional practices fall? (*Current Instructional Practices* Scale)

5. Which selected demographic factors predict where graphic communication educators' instructional practices fall along the Teacher-Centered/Learner-Centered continuum? (LoTi CIP, LoTi PCU Scale, and demographic questions)

To address research question #1, an original *Technology Use Survey* (TUS) instrument was developed specifically for this study to examine graphic communication educators' frequency of use of various digital technologies (Appendix F).

Research question #2 was answered by utilizing participant responses to the LoTi instrument (LoTi scale, Appendix A).

Research question #3 was answered by utilizing the participant responses to the LoTi instrument (LoTi & LoTi PCU Scales, Appendices A & C) and to the demographic questions (Appendix E).

Research question #4 was answered by utilizing participant responses to the LoTi instrument (LoTi CIP scale, Appendix B).

Research question #5 was answered by utilizing participant responses to the LoTi instrument (LoTi CIP & PCU Scales and Appendices B & C) and to the demographic questions (Appendix E).

Participants

Participants for this study were graphic communication educators identified from one or more lists provided by five different sources: (1) the Graphic Arts Technical Foundation (GATF); (2) the International Graphic Arts Education Association (IGAEA); (3) the Graphic Arts Technical Association of Illinois (GATAI); (4) the Print and Graphics Scholarship Foundation (PGSF); and (5) the GRAPHIC COMM CENTRAL Project. These five sources provided a robust list of graphic communication educators.

Each of the 5 sources were selected because of the following: 1) the GATF list provided a broad range of educators from throughout the United States; 2) the IGAEA list provided a second nationwide list of graphic communication educators; 3) the GATAI list provided a large regional list of educators from five states; 4) the PGSF list provided a third nationwide list of graphic communication educators; 5) the GRAPHIC COMM CENTRAL list provided access to a listserv of graphic communication educators.

After compiling the e-mail addresses and removing any duplicate entries as well as any entries containing obvious address errors, 1,241 graphic communication educators were identified.

Data Collection

Data were collected following procedures approved by the Virginia Tech Institutional Review Board (Appendix S). Following procedures outlined by Sue and Ritter (2007), each selected member of the study received a request to participate in the study with appropriate measures taken to ensure that participants responded only once (Sue & Ritter, 2007). Schonlau, Fricker, and Elliot (2002) found that, in the case of closed populations, such as the five samples of graphic communication educators used in this study, Internet-based surveys result in higher response rates than Internet-based surveys of the general population.

In their substantive analysis of three survey modes, Yun and Trumbo (2000) observed no significant influence on survey response in comparison to survey modes. These modes were traditional postal, e-mail, and the World Wide Web (the Web). Traditional postal surveys were mailed to each participant, and the participant mailed the survey back to the researcher. E-mail surveys, which the participant answered and e-mailed back to the researcher, were included within the body of an e-mail. Web surveys included direct links, allowing participants to access the survey through a secure website, and the participants answered the survey questions directly on the website, (Yun & Trumbo, 2000). Therefore, a Web-based survey was employed because it allowed the researcher to reach all members of the selected population through a secure website.

Possible shortcomings to Internet-based survey research were noted by Brest and Krueger (2004): (1) many people do not have access to the Internet; and (2) the variety of ways users can connect to the Internet can result in differences in the appearance of the instrument (Best & Krueger, 2004). In this study, all participants had an e-mail address registered with one of the five identified sources. Additionally, the survey instrument was tested on Macintosh and Windows platforms as well as using Internet Explorer, Firefox and Safari, and no significant difference in appearance was visible.

Glover and Bush (2005) concluded the electronic survey was a worthwhile means of securing opinions on process, content, and philosophical issues, but was less effective in securing more complex and very detailed quantitative data. In each case, participants were asked simple quantitative opinion questions and open-ended qualitative questions that did not rely heavily on complex or detailed quantitative data.

The procedure for conducting the study followed Dillman's Tailored Design Method (TDM). In accordance with the TDM, the researcher contacted the participants four times via e-mail (Dillman, 2000). The first contact was a pre-notice e-mail letter, informing the participants they would be receiving a survey in the next week and asking them to fill it out within five days of receiving it. The second contact was an e-mail with a direct link to the actual questionnaire with a detailed cover letter describing the survey, the reasons for the survey, and instructions on accessing the survey. The third contact was a thank you e-mail note that also acted as a reminder to complete the survey. The fourth contact, if necessary, was the sending out of replacement questionnaires (Dillman, 2000).

The timeline of the e-mail survey followed the TDM structure. The first e-mailing consisted of the pre-notice e-mail, followed by the e-mailing of the survey questionnaires link two days later. The follow-up thank you note was e-mailed five days following the e-mailing of the questionnaire link. A fourth contact was administered through e-mail if respondents requested to have the survey link sent to them again (Dillman, 2000). As part of the e-mail communication, respondents were also given an e-mail address and phone number for a contact person to send questions to if they had difficulty accessing the survey instrument.

All survey data were collected through the *LoTi Connection* website. The LoTi Web interface allowed participants to respond from an Internet-connected computer. The data were imported into SPSS for analysis. The researcher was able to access data collected by the LoTi Web interface directly.

Instrumentation

Data were gathered online with three survey elements: (1) demographic questions; (2) the *Levels of Technology Implementation* (LoTi) instrument; and (3) the *Technology Use Survey* (TUS) instrument.

Ten demographic questions were utilized as part of this study (Appendix E). These demographic attributes were selected based upon a review of literature and current practices in the graphic communication field. In terms of gender, men have traditionally dominated in the graphic communication classroom, but this trend has lessened as computers have become the technology of choice in the classroom. According to the United State Government, more than 99% of the classrooms in America are wired to the Internet (National Center for Education Statistics, 2006), but no study can be found analyzing the connections available in a graphic communication classroom. Educator location was unknown at the time of sending out the surveys, but where the educators responding to the survey were located was an important factor. Primary grade level, the number of years teaching, and age were also unknown attributes but important in relation to educator comparisons. The number of computers available to educators at secondary and post-secondary schools was also an unknown factor, but was an important finding in Norris Sullivan, Poirot, & Soloway (2003). Digital technology-related training was identified as a factor in technology integration in multiple studies including Mumtz (2000), Butler & Sellbom (2002), Moersch (2002a), and Franklin (2007) and was also included as a demographic attribute.

As discussed in chapter 2, the LoTi instrument was selected because of its ability to create three distinctly different scales for study participants: (1) "Level of Technology Implementation" (LoTi) profile (Appendix A); (2) "Current Instructional Practice" (CIP) profile (Appendix B); and (3) "*Personal Computer Use*" (PCU) profile (Appendix C). These profiles provide a basis for investigating the research questions guiding this study.

The *Technology Use Survey* (TUS) instrument consisted of 17 questions with Likert-type responses. Questions examined the frequency of use of various digital technologies. This instrument was created specifically for this study by the researcher (Appendix F).

Instrument Reliability

Technology Use Instrument

The original items for the Technology Use Instrument were developed/adapted after reviewing other survey instruments including the Teacher's Survey: Combined Versions 1-4 (Becker & Anderson, 1998), the "USEiT" Study instrument (Bebell et al., 2004), and the Classroom Information Technology Usage Survey instrument (Weitkamp, 2005). A panel of four experts in the graphic communication education field reviewed and validated 19 Technology Use Instrument items (Appendix F).

LoTi Instrument

Schechter (2000) utilized Cronbach's Alpha to test the internal consistency reliabilities of the LoTi instrument. When examined as three separate components, the LoTi, the PCU, and the CIP, the reliability coefficient estimates were +.7427, +.8148, and + .7353, respectively(Schechter, 2000).

In 2005, the LoTi in-service teacher instrument (used in this study) went through an extensive validation study. The study found each of the three domains (LoTi levels, CIP, and PCU) embedded in the survey achieved content validity and that the domains PCU and CIP emerged as empirically valid (Stoltzfus, 2005).

Data Analysis

Data collected were analyzed with statistical methods to answer each research question as follows:

Research Question #1 - How frequently do students use each of a wide variety of digital technologies in conjunction with graphic communication instruction?

Educators’ response to the TUS instrument (Appendix F) answered research question #1. The data collected for this was descriptive and was evaluated based upon the individual responses of each educator. Data for this question were placed into frequency tables, which were then converted to bar charts (figures) to illustrate how frequently graphic communication educators used each of the digital technologies.

Research Question #2 - At what level of the LoTi Scale do graphic communication educators implement digital technologies?

Educators’ levels on the LoTi scale were used to answer research question #2. Based upon their responses to the LoTi instrument (Appendix D) a level on the scale was established in regard to implementation of digital technologies in the classroom. The level was calculated automatically by the LoTi survey mechanism (http://www.loticonnection.com/) and provided to the researcher. This calculated value for each respondent was then used to determine the level on the LoTi scale.

Research Question #3 - Which selected demographic factors predict graphic communication educators’ implementation of digital technologies as part of their instruction?

After establishing each educator’s level on the LoTi scale, trends were established using demographic responses and the educators’ level on the PCU scale. In this case, the dependent variable was the LoTi level, and the independent variables were selected demographic characteristics and the educator’s PCU level. Data were analyzed utilizing multiple regressions to determine if there was a relationship between the demographic characteristic (independent variable) and the educator’s PCU, in comparison to the educator’s LoTi level.

Research Question #4 - Where along the Teacher-Centered/Learner-Centered continuum do graphic communication educators’ instructional practices fall?

Educators’ levels on the CIP scale were used to answer research question #4. The CIP level for each respondent was provided by the LoTi connection website for use with data analysis. The CIP level was based upon responses to the LoTi instrument (Appendix D). The level was calculated by LoTiconnection.com and provided to the researcher. This calculated value for each respondent was then used to determine the level on the CIP scale.

Research Question #5 - Which selected demographic factors predict where graphic communication educators’ instructional practices fall along the Teacher-Centered/Learner-Centered continuum?

After establishing each educator’s level on the CIP scale, trends were established using demographic responses and the educators’ level on the PCU scale. In this case, the dependent variable was the CIP level, and the independent variables were the demographic questions and the educator’s PCU level. Data were analyzed utilizing multiple regressions to determine if there were a relationship between responses to the demographic instrument and the educator’s PCU in comparison to the educator’s CIP level.

CHAPTER FOUR

Analysis of Data

This study was designed to investigate a threefold problem: 1) to identify the extent to which each of a wide variety of digital technologies were utilized in conjunction with graphic communication education instruction; 2) to identify how selected factors affected the extent to which graphic communication educators implement digital technologies as part of their classroom instruction; and 3) to examine how selected factors affected the point at which graphic communication educators' instructional practices intersect the Teacher-Centered/Learner-Centered (TCLC) continuum. The methods and procedures of investigating this problem were outlined in Chapter Three. The study findings are presented in this chapter, and the conclusions, limitations, and recommendations are presented in Chapter Five.

Sample and Procedure

An initial pre-notice e-mail was sent to 1,241 e-mail addresses compiled from the 5 lists of possible graphic communication educators (Appendix G). Of this original 1,241 e-mail list, 371 e-mail addresses were removed because of incorrect information or direct responses from recipients stating their non-teacher status. A second e-mail containing a letter of consent and instructions for accessing the survey was sent to the remaining 870 recipients (Appendix H). Due to confusion resulting from logging in instructions, two clarification e-mails were sent. A first reminder (Appendix I) was sent out to thank those who had already responded while asking those who had not responded to complete the survey. Following a second reminder (Appendix J), a final e-mail contact (Appendix K) was sent to thank all the recipients who had responded and to ask one last time for recipients to respond to the survey. One hundred and ninety-one surveys were collected for analysis, representing a 22% response rate. Data were analyzed using SPSS software (SPSS, 2008) and then transferred to Excel (Microsoft, 2007) for use in this study.

The procedure for sending out contacts attempted to follow the Dillman's Tailored Design Method (TDM) as outlined in chapter three (Dillman, 2000), unfortunately the confusion over connecting to the survey site, and the low response rate forced the researcher to send out more than the four contacts as outlined in the TDM.

Demographic Analysis

The demographic variables (Appendix E) of the participants' gender, Internet connection in the classroom, location of school, primary grade level, years of teaching experience, age, highest level of education, number of instructional computers, and number of hours of digital technology-related training were analyzed, and frequency distribution data were created. Additionally, an intensity level on the *Personal Computer Use* scale (Appendix C) was calculated for reach respondent.

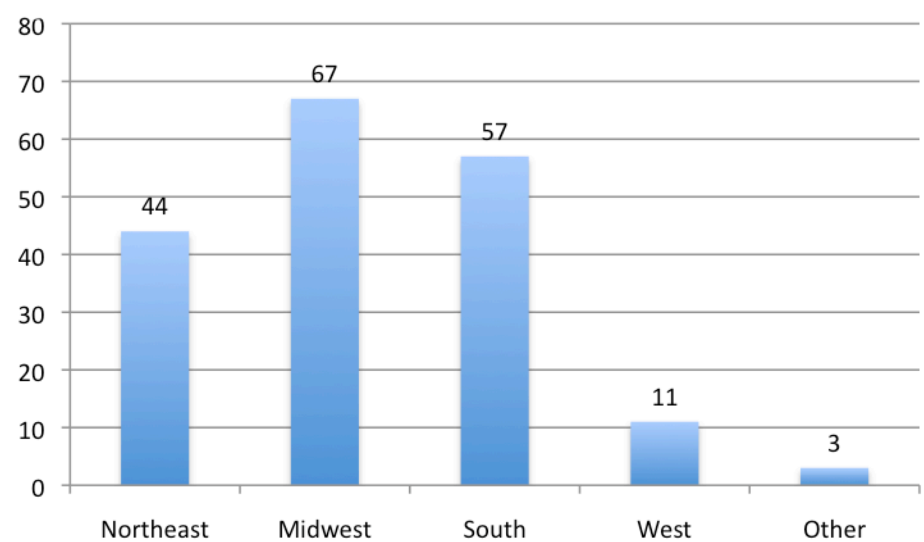
Demographic question #3 was not included in the final analysis because of faulty (invalid) responses/data. When the question was created for the online instrument two of the responses were combined and it was impossible for the researcher to determine the differences between the two responses.

Analysis revealed 66% of the respondents were male, 30.9 % of the respondents were female (*n* = 185), while 6 respondents did not indicate their gender. 98.4% of respondents indicated having an Internet connection in their classroom, while .5% indicated they did not (*n* = 189). Respondent's primary grade level was divided with 49% (*n* = 94) secondary (grades 9-12) and 50% (*n* = 96) Post-Secondary (Community College, University, Etc.). Sixty respondents indicated having only a Bachelor's Degree (31%), 90 indicated having a Master's Degree (47%), and 29 indicated having a Doctorate Degree (15%).

Respondents represented 37 American states and three non-American locations (Appendix L). Respondents' locations were grouped into five categories for analysis. The first four groups represented the four regions created by the United States Census (United States Census Bureau, 2009); the fifth group represented any non-American locations. Results are presented in Figure 1.

Figure 1

In which U.S. state is your school, college, or university located in? (e.g., Indiana and New York) - Divided into Regions per the U.S. Census



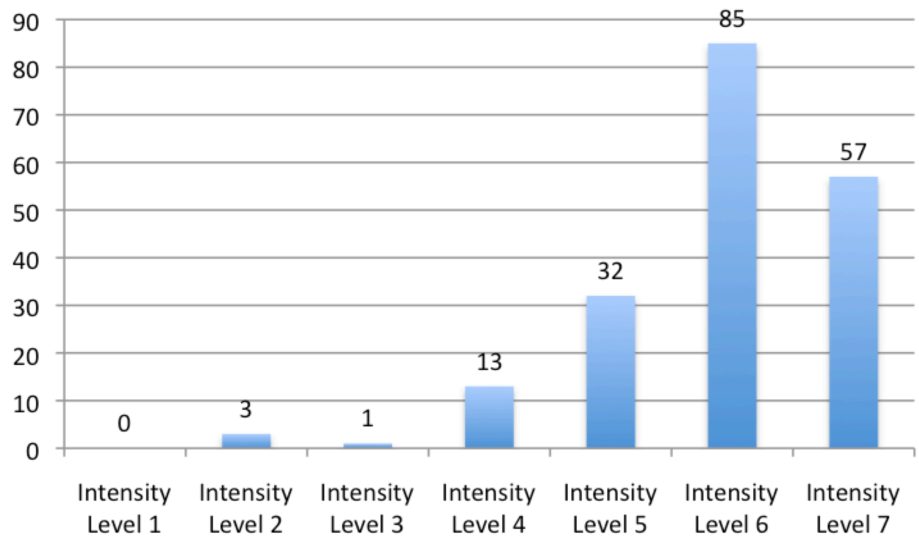
Note. *n* = 182.

In response to the number of years teaching graphic communication, the range was 2 to 43 years, with a mean of 17 years (*n*=190) (Appendix M). Age of respondents ranged from 27 to 68 years, with a mean of 50 years (*n*=186) (Appendix N). Computers available for instructional use by students ranged from 0 to 120 with a mean of 27 (*n*=189) (Appendix O). The number of hours of digital-technology related training received by the respondents over the past 2 years ranged from 0 to 2400 with a mean of 47 hours (*n*=190) (Appendix P).

Analysis regarding respondent's *PCU* level indicated a median of 6, (Figure 2).

Figure 2

Personal Computer Use (PCU)



Note. *n = 191. Mdn = 6.*

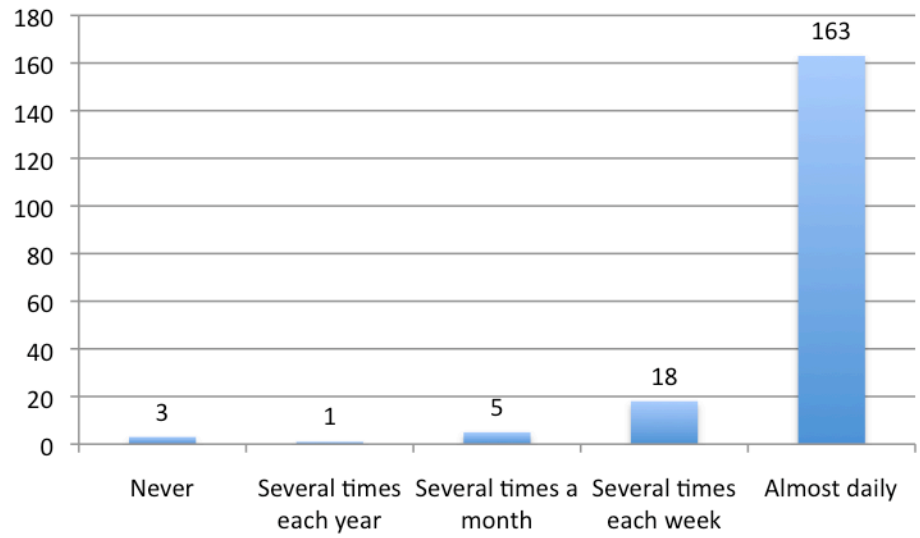
Research Question #1

How frequently do students use each of a wide variety of digital technologies in conjunction with graphic communication instruction?

Educators' responses to the 17 questions on the TUS instrument (Appendix F) answered research question #1. Data for this question were placed into frequency tables, which were then converted to bar charts (figures) to determine use. The following figures illustrate frequency response rate for each question. The total number of responses for each response is included at the bottom of each figure.

Figure 3

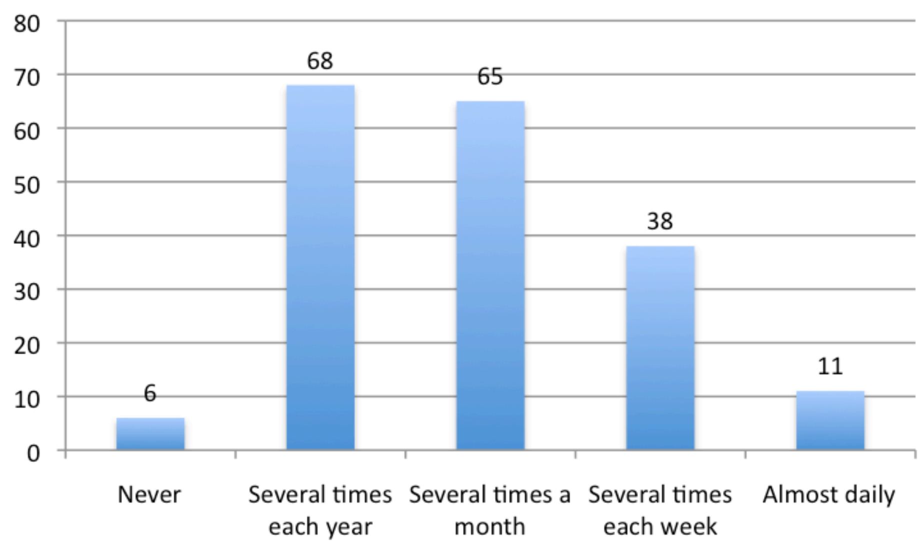
Students use desktop or laptop computers



Note. *n* = 190.

Figure 4

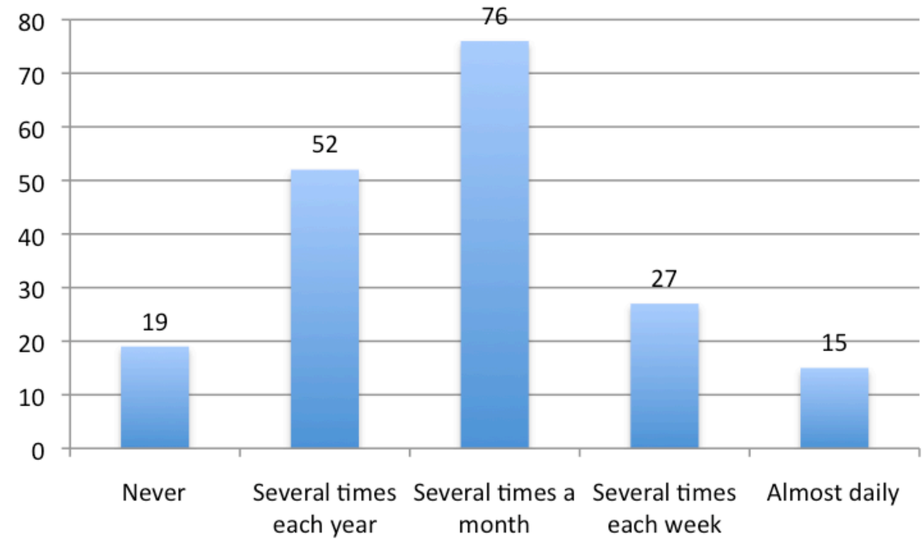
Students use digital scanners



Note. *n* = 188.

Figure 5

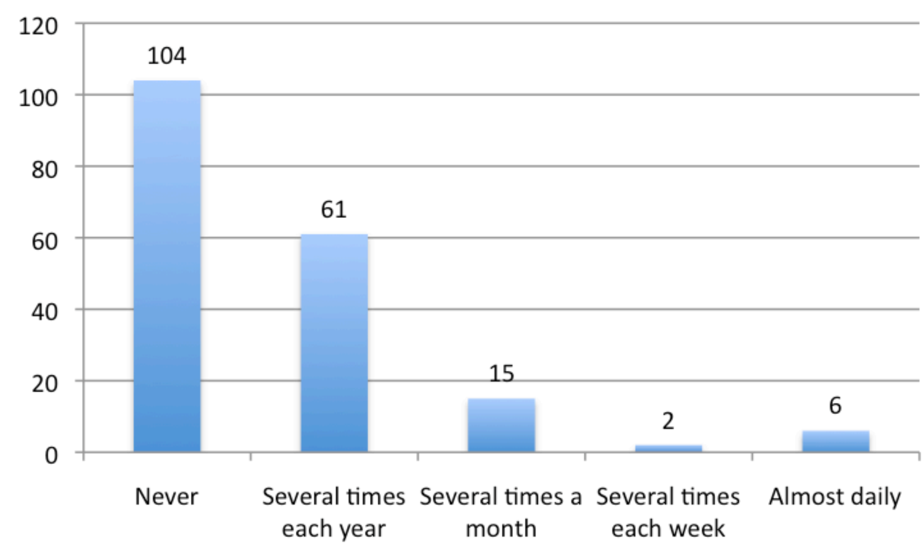
Students use digital still cameras



Note. n = 189.

Figure 6

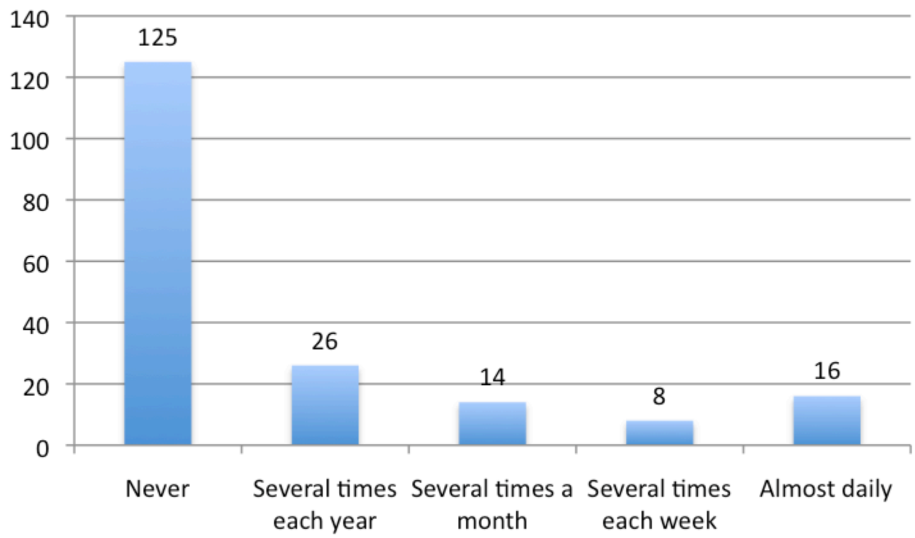
Students use digital video cameras



Note. n = 188.

Figure 7

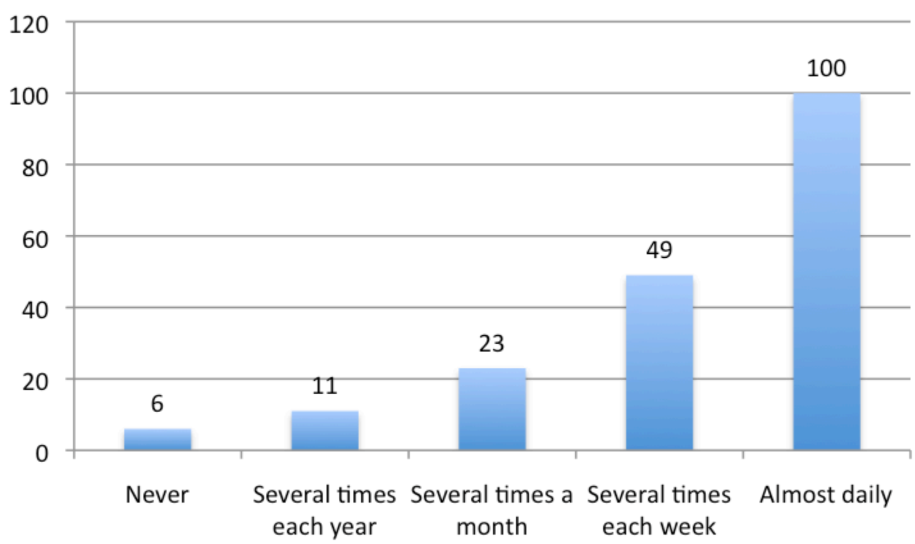
Students use digital drawing tablets



Note. *n* = 189.

Figure 8

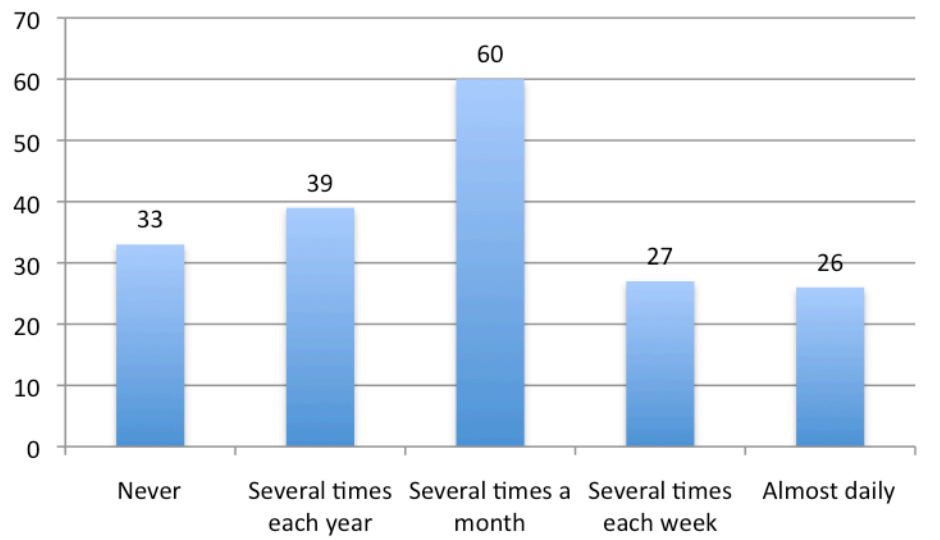
Students use the Internet to access digital content (e.g., locating graphics for use in a project)



Note. *n* = 189.

Figure 9

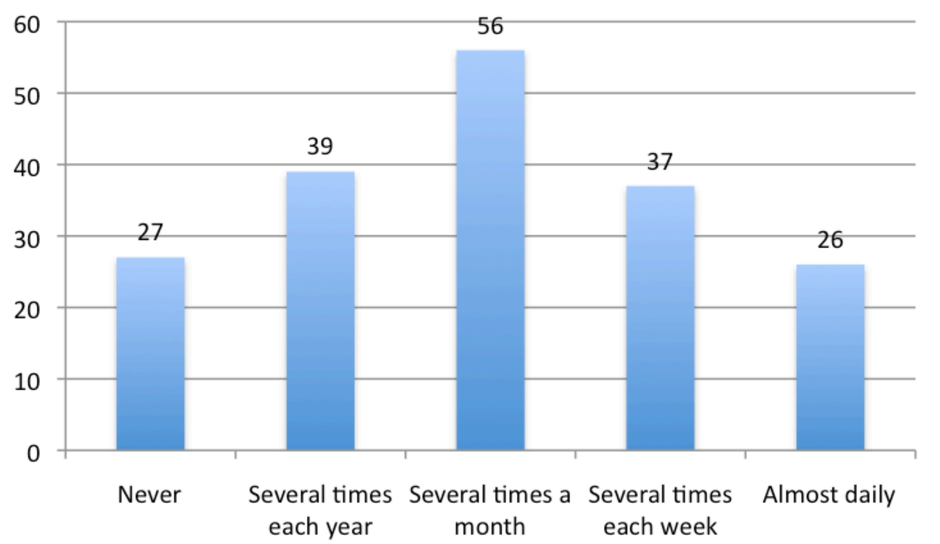
Students use the Internet to solve a technical problem (e.g., using online Help to fix a problem with a computer application they are running)



Note. *n* = 185.

Figure 10

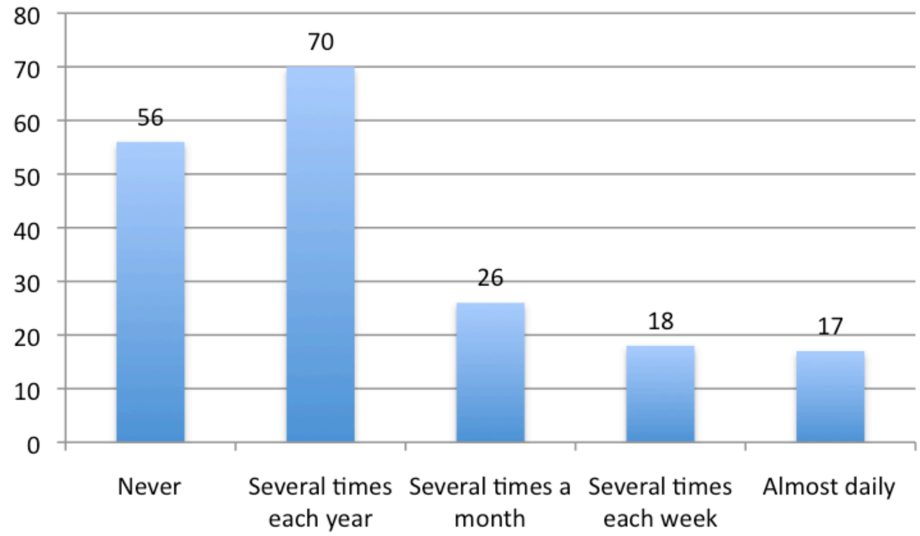
Students complete digital instructional tutorials



Note. *n* = 185.

Figure 11

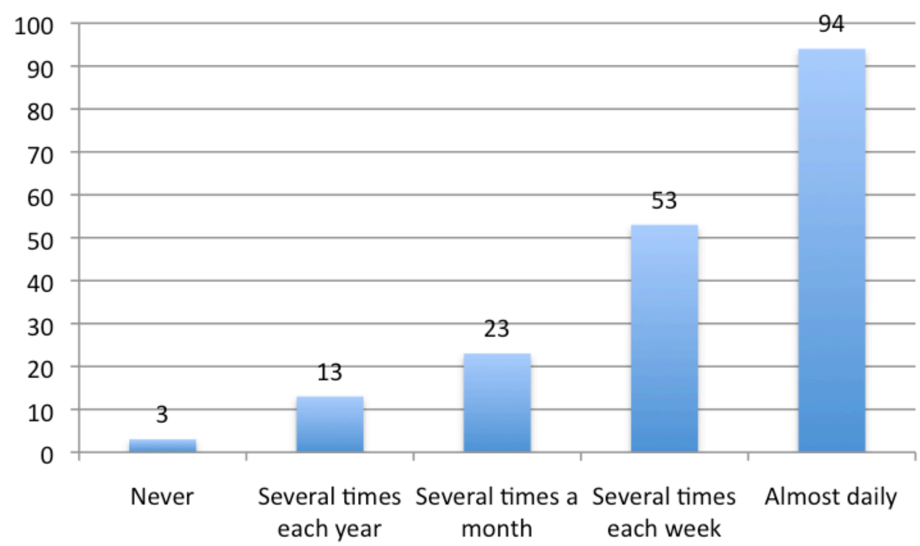
Students create digital multimedia projects using two or more of the following elements: audio, video, animation, or still images



Note. *n* = 187.

Figure 12

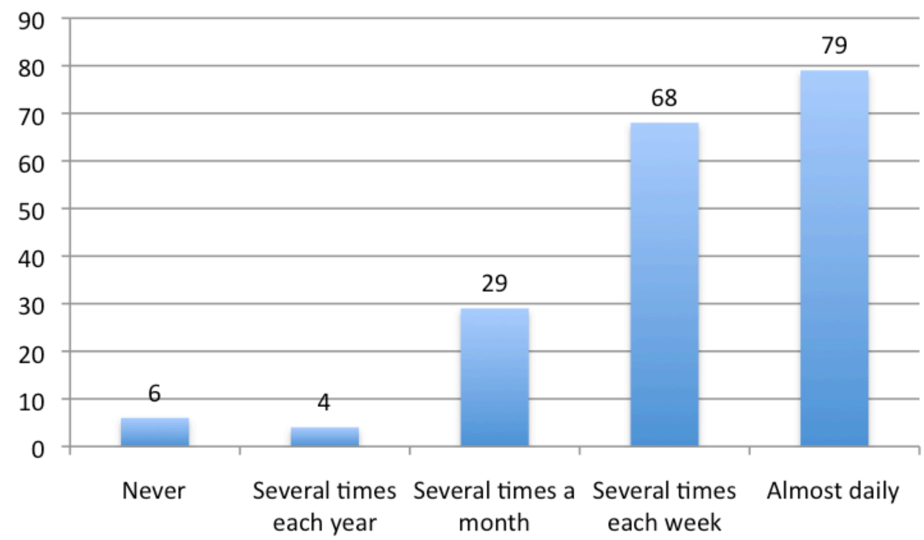
Students create and/or edit page layout projects with page layout software (e.g., Adobe InDesign, QuarkXPress, or similar)



Note. *n* = 186.

Figure 13

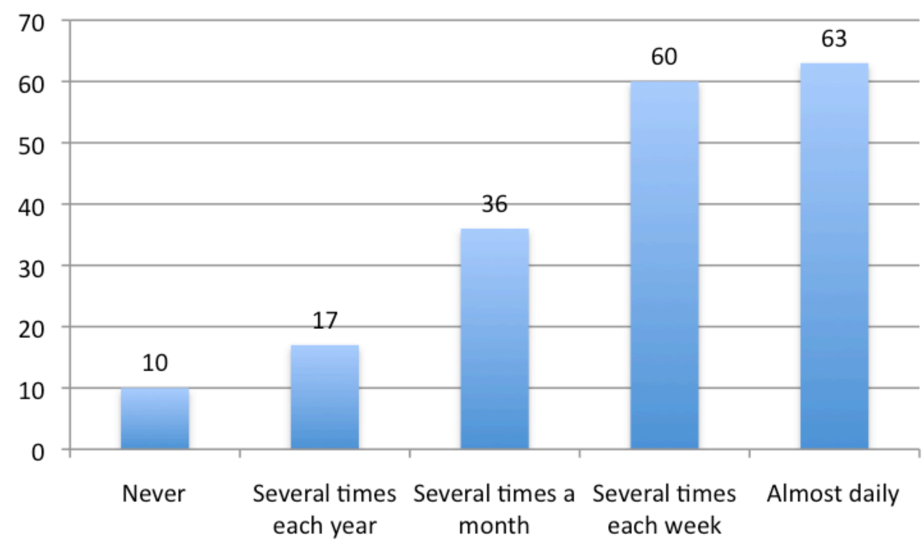
Students create and/or edit digital raster images with image editing software (e.g., Adobe Photoshop or similar)



Note. n = 186.

Figure 14

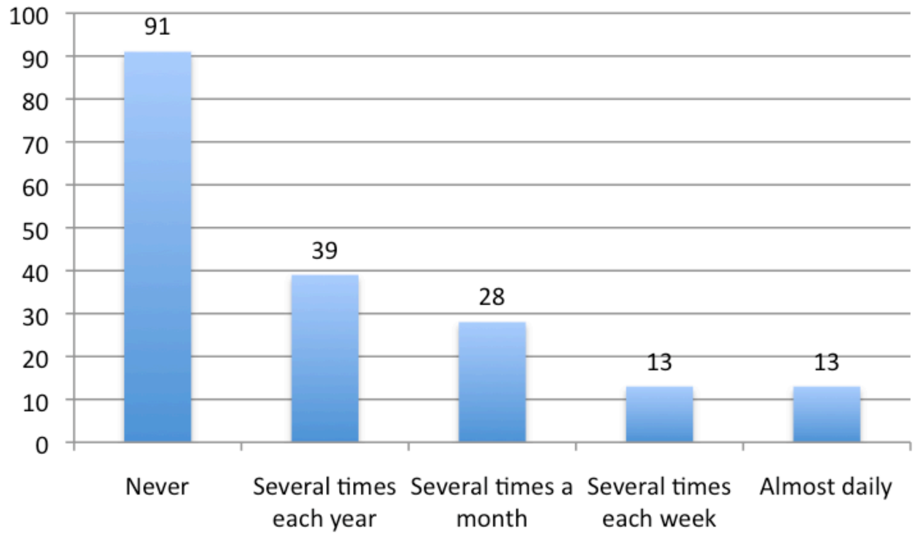
Students create and/or edit vector digital illustrations or designs (e.g., Adobe Illustrator, Corel Draw, or similar)



Note. n = 186.

Figure 15

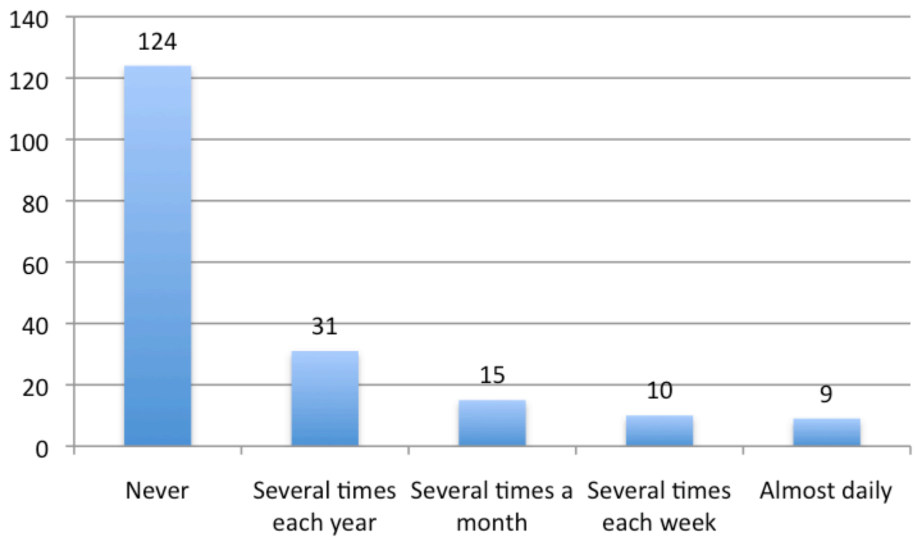
Students create and/or edit Web pages using a visual or WYSIWYG editor (e.g., Adobe Dreamweaver, Adobe GoLive, Microsoft FrontPage, or similar)



Note. *n* = 184.

Figure 16

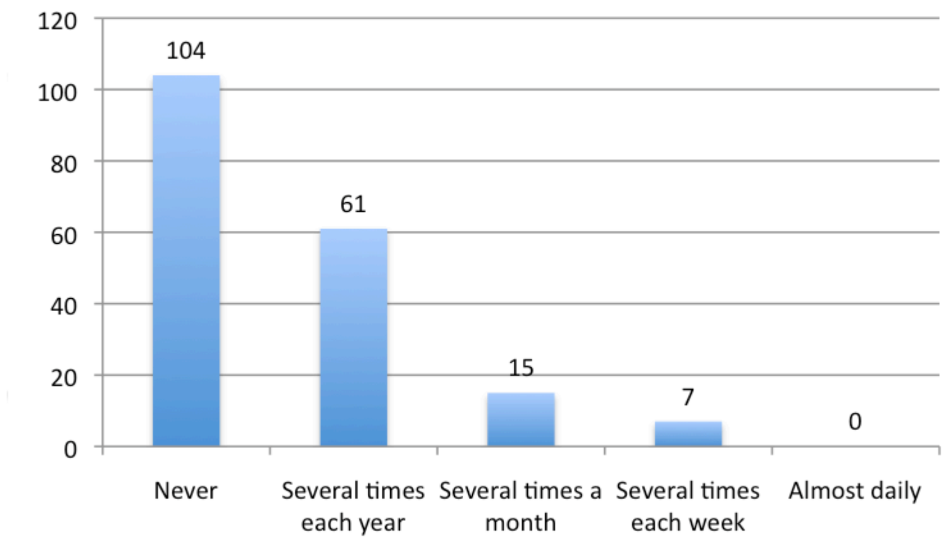
Students create and/or edit Web pages by typing HTML code



Note. *n* = 189.

Figure 17

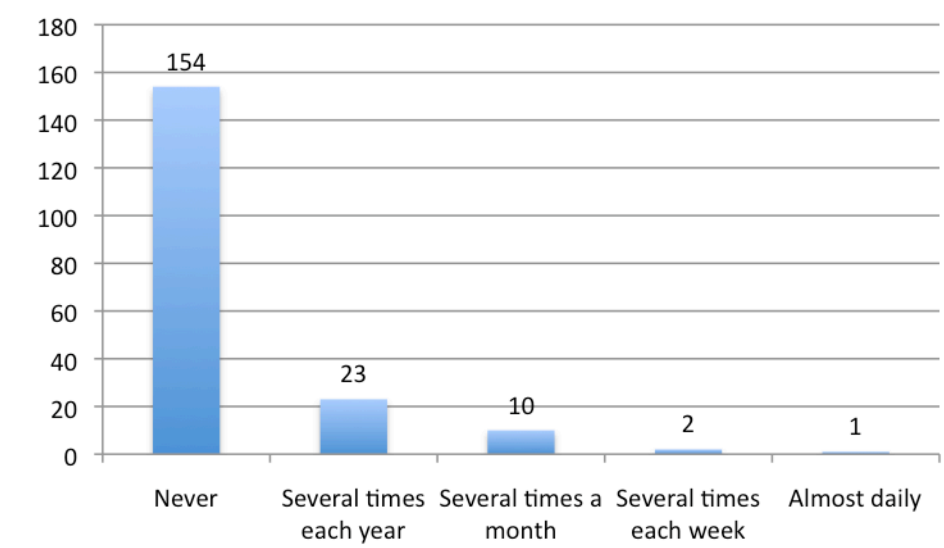
Students create and/or edit digital spreadsheets (e.g., Microsoft Excel, Apple Numbers, or similar)



Note. n = 187.

Figure 18

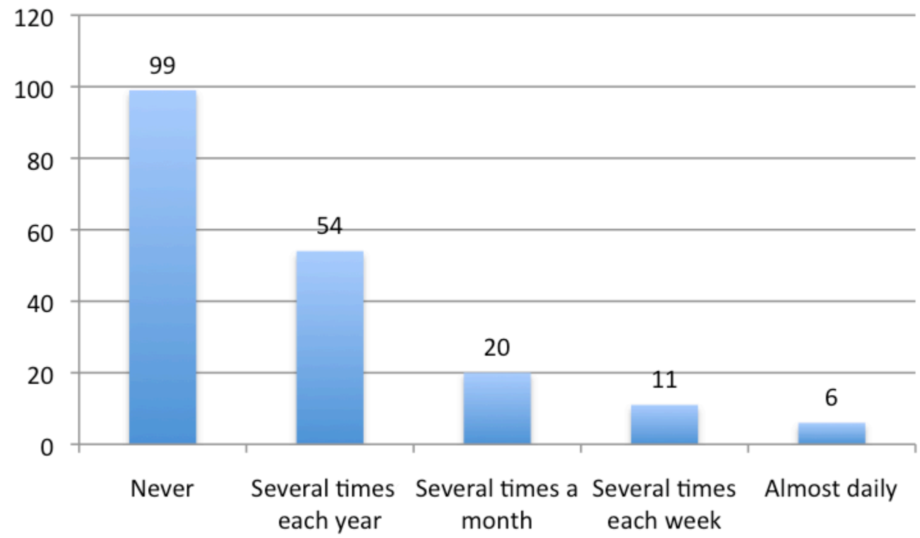
Students create and/or edit digital databases (e.g., Microsoft Access, Filemaker, or similar)



Note. n = 190.

Figure 19

Students create and/or edit digital animations (e.g., Adobe Flash, or similar)

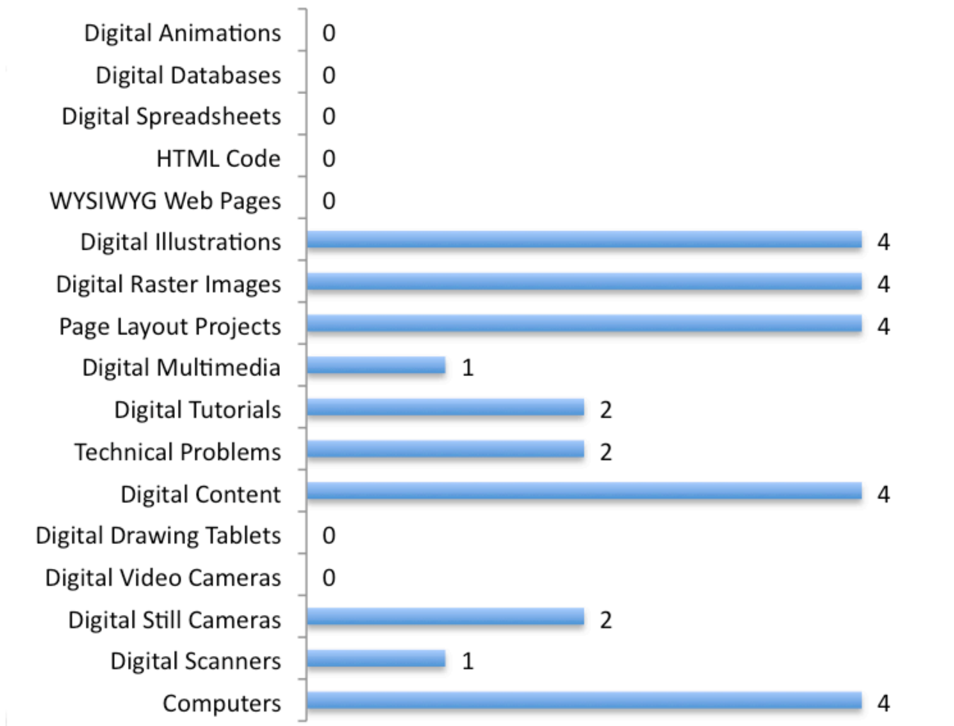


Note. n = 190.

Figure 20 illustrates the most frequent scores for each of the 17 questions on the *Technology Use Survey*.

Figure 20

Overall Most Frequent Responses to the Technology Use Survey Instrument



Note. 0 = Never; 1 = Several times each year; 2 = Several times a month; 3 = Several times each week; 4 = Almost daily

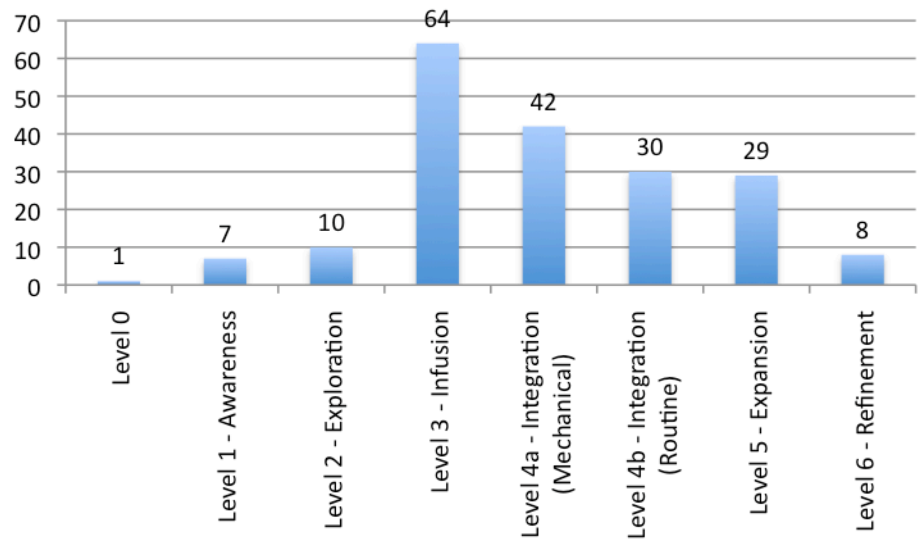
Research Question #2

At what level of the Levels of Technology Implementation (LoTi) Scale do graphic communication educators implement digital technologies?

Based upon responses to the LoTi instrument (Appendix D), a level on the *Levels of Technology Implementation* (Appendix A) scale was computed for each respondent. A high level on this scale aligns with technology being incorporated completely and beneficially as part of instruction, while a low level corresponds with technology not being incorporated as a valuable or important aspect of instruction. The calculated value (level) was then used to determine frequencies among respondents. The median level of all respondents corresponded with a Level 4a – Integration (Mechanical), Figure 21.

Figure 21

Level of Technology Implementation (LoTi)



Note. *n = 191. Mdn = 4a.*

Research Question #3

Which selected demographic factors predict graphic communication educators' implementation of digital technologies as part of their instruction?

After establishing each educator's level of technology implementation on the LoTi scale (RQ2) as the dependent variable, trends were established using 10 independent variables. The independent variables were: (1) Gender; (2) Classroom Internet Connection; (3) Respondent's Region; (4) Age; (5) Number of Hours of Technology-Related Training; (6) Total Years of Teaching Graphic Communication; (7) Primary Grade Level; (8) Highest Level of Education; (9) Number of Computers Available in Classroom; and (10) Respondent's PCU intensity level.

Multiple regression analysis was used to determine if significant relationships existed between the independent variables and the dependent variable.

A correlation matrix table was created and is shown in Appendix Q. *Personal Computer Use* (PCU) had a moderately strong correlation (r = .419) with educators' level of technology implementation. Gender (r = .002), and educators' regions (r = -.013) each had very weak correlations. Classroom Internet connection (r = -.223), and the number of computer's in the classroom (r = .214) both had slight correlations. The age of educator (r = -.154), number of hours of digital-technology related training (r = .175), educator's total years of teaching (r = -1.55), educator's primary grade level (r = .117), and educators highest level of education (r = .181) all had weak correlations.

Using the enter method in SPSS, a significant model emerged ($F_{10, 151} = 7.797$, $p <$ .0005). Adjusted R Square = .297. *Personal Computer Use*, classroom Internet connection, and the number of computers all emerged as significant variables and are shown in Table 2.

Table 2

Multiple Regression Coefficients[a] - Research Question #3

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	*t*	Sig.
1	(Constant)	5.005	1.631		3.069	.003
	Gender of Educator	.009	.222	.003	.039	.969
	Classroom Internet Connection	-5.506	1.276	-.299	-4.314	.000
	Educator's Region	.005	.105	.003	.051	.960
	Age of Educator	.002	.015	.011	.115	.909
	Number of Hours of Digital Technology-Related Training	.003	.002	.097	1.358	.176
	Educator's Total Years of Graphic Communication Teaching Experience	-.026	.014	-.180	-1.904	.059
	Educator's Primary Grade Level	.056	.215	.020	.262	.794
	Educator's Highest Level of Education	.253	.164	.122	1.542	.125
	Number of Computers in Educator's Graphic Communication Classroom	.018	.006	.207	2.782	.006
	Personal Computer Use (PCU)	.644	.114	.387	5.661	.000

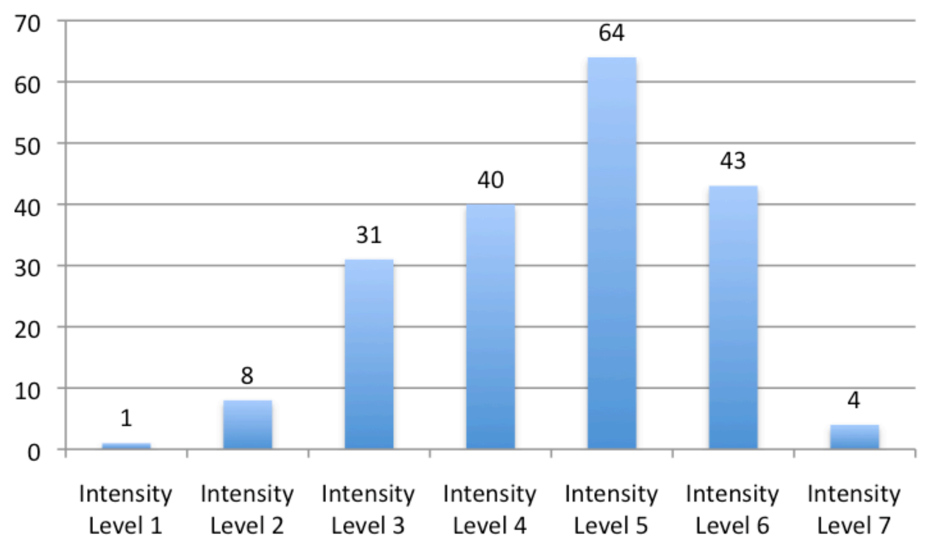
a. Dependent Variable: Level of Technology Implementation (LoTi)

Research Question #4
Where along the Teacher-Centered/Learner-Centered continuum do graphic communication educators' instructional practices fall?

Based upon responses to the LoTi instrument (Appendix D), a level on the *Current Instructional Practices* (Appendix B) scale was established for each respondent. A high intensity level on this scale aligns with a focus on a learner-based approach to teaching and learning, while a low intensity level corresponds with a subject-based approach to teaching and learning. The calculated value for each respondent was then used to determine frequencies. The median level of all respondents corresponded with a CIP Intensity Level 5, Figure 22.

Figure 22

Current Instructional Practices (CIP)



Note. *n = 191. Mdn = 5.*

Research Question #5
Which selected demographic factors predict where graphic communication educators' instructional practices fall along the Teacher-Centered/Learner-Centered continuum?

After establishing each educator's intensity level on the *Current Instructional Practices* scale (RQ4) as the dependent variable, trends were established using 10 independent variables. The independent variables were: (1) Gender; (2) Classroom Internet Connection; (3) Respondent's Region; (4) Age; (5) Number of Hours of Technology-Related Training; (6) Total Years of Teaching Graphic Communication; (7) Primary Grade Level; (8) Highest Level of Education; (9) Number of Computers Available in Classroom; and (10) Respondent's PCU intensity level.

Multiple regression analysis was used to determine if significant relationships existed between the independent variables and the dependent variable.

A correlation matrix table was created and is shown in Appendix R. PCU had a moderately strong correlation ($r = .382$), while gender ($r = .040$), classroom Internet connection ($r = .025$), educator's region ($r = -.076$) and educator's total years of teaching ($r = -.079$) had very low correlations. The number of hours of digital-technology related training ($r = .143$), educator's primary grade level ($r = .111$), educator's highest level of education ($r = .146$) and number of computers in the classroom ($r = .202$) all had slight correlations.

Using the enter method in SPSS a significant model emerged ($F_{10, 151} = 3.677$, $p < .0005$). Adjusted R Square = .143. *Personal Computer Use* emerged as the only significant variable and is shown in Table 3.

Table 3

Multiple Regression Coefficients[a] - Research Question #5

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	*t*	Sig.
1	(Constant)	1.964	1.492		1.316	.190
	Gender of Educator	.067	.203	.026	.331	.741
	Classroom Internet Connection	-.637	1.168	-.042	-.545	.586
	Educator's Region	-.066	.096	-.052	-.687	.493
	Age of Educator	.001	.013	.010	.094	.925
	Number of Hours of Digital Technology-Related Training	.002	.002	.073	.921	.359
	Educator's Total Years of Graphic Communication Teaching Experience	-.012	.013	-.097	-.927	.355
	Educator's Primary Grade Level	.065	.197	.027	.330	.742
	Educator's Highest Level of Education	.150	.150	.087	.998	.320
	Number of Computers in Educator's Graphic Communication Classroom	.011	.006	.150	1.828	.069
	Personal Computer Use (PCU)	.466	.104	.338	4.472	.000

a. Dependent Variable: *Current Instructional Practices* (CIP)

CHAPTER FIVE

Overview

This chapter begins with a summary and discussion of findings from Chapter Four and continues with possible implications of the findings, general limitations of the study, and suggestions for continued research.

Summary of Findings

Demographic Data

Nearly two-thirds (66%) of the total respondents were male (n = 185): 64.5% of the secondary education respondents were male, 35.5% were females (n = 93); 71.7% of the post-secondary education respondents were male, and 28.3% were female (n = 92). The high percentage of male respondents was expected, but was considerably lower than found in a similar educational field. Specifically, in a study of Technology Education teachers' beliefs and practices only 17% of the respondents were female (Sanders, Sherman, Kwon, & Pembridge, 2009) The higher percentage of female teachers in Graphic Communication could be the result of the changing curriculum in Graphic Communication. Today, numerous graphic communication classrooms are filled with computers and scanners, rather than printing presses and film as they once were. This shift to a "clean" environment, based more upon design than production is a likely explanation for the increased number of female Graphic Communication educators.

Just over 98% of the respondents indicated having an active Internet connection in their classroom, which corresponds to data from the National Center for Education Statistics (National Center for Education Statistics, 2006). Only one respondent indicated the absence of an Internet connection, while three respondents did not respond to this question. Grade level was evenly distributed between secondary (*n* = 93) and post-secondary education levels (*n* = 92).

Nearly half of all respondents indicated having a master's degree (*n* = 90), followed by 31% having a bachelor's degree (*n* = 60). Respondents having a doctoral degree (*n* = 29) only accounted for 15% of the respondents, and twelve respondents did not answer this question. The majority of respondents with a doctorate were post-secondary (*n* = 25) educators, and the majority or respondents holding a bachelor's degree were secondary (*n* =44) educators. Respondents with a master's degree were secondary (*n* = 40) educators and post-secondary (*n* = 50) educators. Among American secondary educators across all disciplines (Snyder, Dillow, & Hoffman, 2009), 50.8% had a bachelor's degree, 40.9% had a master's degree, and 1.2% had a doctoral degree. In comparison to this national data across all disciplines, more graphic communication teachers at the secondary level had master's degrees (42.6%) and doctoral degrees (4.3%). The percentages in this study for master's and doctoral degrees are slightly higher than the national average indicating graphic communication educators tend to have earned a higher degree than other subject-matter educators at the secondary level.

Respondents represented 37 American states and 3 non-American locations, including Canada, Kenya, and Greece. The largest percentage (35.1%) of respondents came from the Midwest region, which included responses from Indiana, Illinois, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, and Nebraska. Illinois had the largest number of respondents (n = 18) from a single state. This result was expected because the Graphic Arts Technical Association of Illinois listserv was one of the sources for prospective participants in this study. The second largest number of respondents came from Pennsylvania (n = 15). Delaware, Louisiana, Mississippi, Nebraska, Utah, Washington, West Virginia, and Wyoming each had only a single respondent.

The number of years of teaching experience ranged from 2 to 43, with a mean of 17 years. The range of the number of years teaching experience for secondary educators was 2 to 43 and for post-secondary educators the range was 2 to 42. The average number of years teaching experience for secondary educators was 16.84, and 17.88 for post-secondary educators. Age of respondents provided a range of 27 to 68, with a mean of 50 for secondary and post-secondary combined. The range of ages for secondary educators was 27 to 68, and the range of ages for post-secondary educators was 29 to 66. The average age for secondary educators was 49.49 and 49.61 for post-secondary educators. The median age of 50 for secondary graphic communication educators is slightly higher than the median age of 46 as reported by national statistics (Snyder et al., 2009) for secondary educators in the United States.

Responses to the number of computers in the classroom and the number of hours of technology-related training were quite varied. Respondents indicated a range from 0 to 120 computers available for instruction and 0 to 2,400 hours of digital-technology related training. It is difficult to imagine 120 computers in a single graphic communication classroom, unless the respondent was referring to a large computer lab rather than an individual classroom. Similarly, it is difficult to imagine one of the respondents had a total of 2,400 total hours of digital technology-related training over the past 2-years. The average number of computers (27) and the average number of training hours (47) show a reasonable outcome to this question, but the extremely high outlier for both questions clearly elevate these averages.

Personal Computer Use (PCU) was considered a demographic variable and was utilized in the multiple regression analysis of research questions 3 and 5. The PCU scale (Appendix C) creates intensity levels from 0 to 7 based upon responses to the LoTi instrument (Appendix D). A level of 0 indicates the participant is not at all comfortable with computers and relies more on traditional paper/pencil activities for conveying instruction. A level of 7 indicates the participant demonstrates an extremely high skill level with computers and is involved with training others in the use of computers and technology (Rakes et al., 2006). Respondents' median level on the PCU was equal to a 6. This level indicated that the majority of respondents had a high to extremely high skill level when using computers for personal use. This level also indicates respondents have the capacity to serve as troubleshooters when it comes to technical assistance (Rakes et al., 2006). When respondents were divided into secondary and post-secondary educators, the median level of 6 on the PCU stayed the same for both groups. Post-secondary educators had a slightly higher average on the PCU than secondary educators.

Graphic communication educators had a higher median PCU level than other groups of educators. The national PCU median level for the period of July 1st to June 30th, 2008 was 5 (n = 44,001) (LoTi Connection, 2009).

Research Question #1

How frequently do students use each of a wide variety of digital technologies in conjunction with graphic communication instruction?

Graphic communication educators use a variety of digital technologies in the classroom. The most frequently used technology was the computer with over 85% of the respondents stating they used the computer almost daily. Only three of the total respondents indicated never using a computer. This high rate of computer use corresponds with the changing role of the computer in graphic communication. Digital image processing (on computers) computer has virtually replaced the process camera and darkroom, and is now the centerpiece of the classroom.

A 2006 survey of 1,000 American secondary teachers from various subjects, showed digital technology use at only 37% daily (CDW-Government, 2006), much lower than the 85% rate identified in this study. Clearly graphic communication classrooms are much more actively engaging students in digital computing activities than were other secondary classrooms three years ago.

Two other highly used digital technologies were “using the Internet to access digital content” and “creating or editing with a page layout program”. Both of these had a very high daily usage (52%, 49% respectively) and helped to enforce the notion that students are creating items such as brochures and posters, and using the Internet to find content for their projects.

Students create and/or edit digital raster images” and “students create and/or edit vector digital illustrations” were also most frequently used “almost daily.” These findings indicate students are frequently creating and/or editing digital images as part of their instruction, but do not tell us the percentage of these digital images that are intended for use on printed pages versus Web pages. However other data indicate that students are creating Web pages and digital animations very infrequently. This provides another indicator that perhaps graphic communication instruction is continuing to follow outdated curriculum based substantially on print, while there is growing evidence that consumers are increasingly turning to non-print information sources (e.g., to the Web, for news, e-books, e-journals, etc.).

Multiple digital technologies fell into the most frequently used “several times a month” category. These included “digital still cameras”, “use of the Internet to solve a technical problem”, and “completing digital instructional tutorials”. Digital camera use was expected to be relatively low, but using the Internet to solve a technical problem and using digital tutorials was expected to be higher. Using the Internet to solve a technical problem was expected to be higher because of the built in help features of various computer programs that use the Internet to find answers. The results of this study suggest graphic communication educators generally use resources other than the Internet to solve technical problems, possibly their own storehouse of knowledge, or books available in the classroom for students to use. The use of digital tutorials is seen as a lower order technology use (Maddox et al., 2001), and it was expected graphic communication educators would be utilizing this more often, as digital tutorials have been a part of graphic communication education for many years, and many textbooks use this format of digital tutorials to teach subject matter. Adobe's "Classroom in a Book for Photoshop CS3" (von Alten & Faulkner, 2007) and Against The Clock's "Adobe InDesign CS3" (Kendra & Poyssick, 2007) are both examples of textbooks intended for classrooms that rely heavily on digital tutorials. The limited use of digital tutorials suggests graphic communication educators are able to teach the various technologies without the help of digital tutorials, and that the class projects being created do not fall into a standardized format such as the digital tutorial class projects being created directly from textbooks.

The high rate of page layout program use suggests educators in this study may be overemphasizing a stagnant area of the field, while under-emphasizing the trend toward non-print media. According to the United States Bureau of Labor Statistics, employment in the publishing industry is expected to decline as newspapers continue to struggle, and the book, periodical, and directory publishing industry's remains flat (Bureau of Labor Statistics & U.S. Department of Labor, 2009b). Demand in the prepress and technicians sectors of the industry is expected to decline rapidly (Bureau of Labor Statistics & U.S. Department of Labor, 2009d), and the demand for desktop publishers is expected to have little or no change (Bureau of Labor Statistics & U.S. Department of Labor, 2009a). The only related industry expected to increase in demand is graphic designers, with Web site design and animation skills especially in high demand as companies move away from print (Bureau of Labor Statistics & U.S. Department of Labor, 2009c).

Responses to "students use digital scanners" and "students create multimedia projects utilizing at least two of the following elements; audio, video, animation, or still images" indicated these were most frequently used only "several times each year." Using a digital scanner was expected to be much higher, though this may be related to the frequent creation of raster and vector images instead of scanning images. Creating multimedia projects several times a year was an unexpected response as it was expected students would be creating more digital media that included sound, motion, and images.

Students' "use of digital video cameras", "use digital drawing tablets", "creation and/or editing of Web pages using a visual or WYSIWYG editor", "creation and/or editing of Web pages by typing HTML code", "creation and/or editing digital spreadsheets", "creation and/or editing digital databases", and "creation and/or editing digital animations" all had the majority of responses as "never." The "never" response with regard to the use of these technologies might be explained by a lack of funds for purchasing graphic communication hardware/software, but could also be a result of graphic communication teachers continuing to teach a predominantly print based curriculum.

Digital drawing tablets have become more accessible and more affordable in recent years, but the extent of their actual use in the graphic communication industry is unknown. Digital video cameras use was expected to be higher with the advent of free and inexpensive movie editing programs such as *iMovie* (which has been shipped free with every Macintosh since 2000), and the popularity of Web sites like *YouTube.* Creating Web pages using HTML code appears to have been replaced in the classroom by teaching students how to create Web pages with a WYSIWYG editor, although responses to students creating Web pages with a visual or WYSIWYG was also lower than expected. Spreadsheet and database creation/editing was expected to be higher as the printing industry relies heavily on spreadsheets for estimating prices, and for database technology to create variable data printing. In both cases certain computer programs now do all of the print estimating and provide database editing and formatting, although it is unclear if the graphic communication educators in this study utilized this software.

Research Question #2
At what level of the *Levels of Technology Implementation* scale do graphic communication educators implement digital technologies?

The median level of *4a – Mechanical Integration* on the LoTi scale (Appendix A) indicated respondents' classroom practices engaged students in exploring real-world issues, as well as solving problems with digital tools and resources. Level 4a is also the level at which instruction begins to shift from a teacher-centered learning environment to a student-centered learning environment where emphasis is placed on applied learning (Moersch, 2002a).

In comparison, the national median LoTi level was 2 (LoTi Connection, 2009). At a level of 2, the instructional focus emphasizes content understanding and direct instruction, as well as a focus on lower levels of student cognitive understanding. Traditional classroom practices are utilized, and the student is not the center of learning. Technology is used sparingly for extension or enrichment activities, and reinforces lower cognitive skills (Moersch, 2002a). The difference in levels between the national data and the respondents of this study clearly indicates graphic communication educators are implementing the use of technology in the classroom as a tool to help identify and solve actual problems rather than just using technology as enrichment or extension tools. Additionally, their 4a position on the LoTi scale suggests graphic communication educators are emphasizing higher levels of cognitive understanding as part of their instruction.

When data were divided into secondary and post-secondary respondents, both groups reported a median LoTi level of 4a, though the average LoTi level for post-secondary educators was slightly higher than the secondary educators.

Research Question #3
Which selected demographic factors predict graphic communication educators' implementation of digital technologies as part of their instruction?

Personal Computer Use (PCU) was the most significant predictor of the *Levels of Technology Implementation* and had the highest correlation to the LoTi level. This indicates respondents with a high intensity level of *Personal Computer Use* would implement technology use in the classroom higher than those respondents with a lower intensity level on the PCU.

The fact that the classroom had an Internet connection is statistically significant, but it is not a clear indicator of the Level of Technology Implementation level. All but one of the 189 respondents indicated having an Internet connection. The range of classroom computers numbered from 0 to 120. While statistically significant, the fact that 4 respondents indicated having more than 100 computers in their classroom suggests some respondents may have reported the number of computers in their *program* rather than their individual classrooms, particularly since the average number of instructional computers *per secondary school* in the U.S. is 253 (Snyder et al., 2009).

Research Question #4

Where along the Teacher-Centered/Learner-Centered continuum do graphic communication educators' instructional practices fall?

The median intensity level of 5 on the *Current Instructional Practices* scale (Appendix B) indicates: 1) respondents' instructional practices tended to lean more toward a learner-based approach; 2) student input helps to guide the instruction, but educators may still utilize teacher-directed activities, such as lectures based upon the content being addressed; and 3) types of learning activities are diversified, and provide critical thinking and problem-solving skills (Moersch, 2009). Data from Figure 22 also illustrates the majority (58.1%) of graphic communication educators level on the *CIP* was 5 or higher, clearly indicating a learner-based approach to instruction.

In comparison, the median national CIP level was 4 indicating a subject-matter approach with learning activities being presented sequentially and the use of lectures and teacher-directed presentation commonplace (LoTi Connection, 2009).

Traditionally, the graphic communication curriculum is project driven and allows students to design products, such as a poster for musical group or a brochure for a school club. Teachers may teach a graphic communication process through a demonstration or lecture, but the student often drives the content. This CIP intensity level of 5 corresponds with the learner-centered approach which Weimer (2002) concluded had five hallmarks: (1) a shift in the balance of power from student to teacher; (2) a refocus on the content of projects; (3) the teacher becomes a facilitator and an active learner in the process; (4) responsibility for learning shifts to the students; and (5) assessments are created to help the learning process (Weimer, 2002).

When respondents were divided into secondary and post-secondary educators the median level remained at 5, and there was very little difference in the mean between the two groups (4.49, 4.68 respectively) suggesting graphic communication educators at the secondary and post-secondary level use similar instructional practices.

Research Question #5

Which selected demographic factors predict where graphic communication educators' instructional practices fall along the Teacher-Centered/Learner-Centered continuum?

The only significant predictor of *Current Instructional Practices* was the respondent's level on the *Personal Computer Use* scale. The fact that only one independent variable was significant is an interesting finding because it suggests that respondent's education, grade level, gender, age, number of training hours, classroom Internet connection, respondent's location, number of computers, or total years of teaching were not significant predictors in the results.

Implications & Conclusions

In a 1984 nationwide study, there were only 5.8 computers in every school that reported using them (Hood, 1985). In 2009, the numbers have increased dramatically to an average number of 253 instructional computers per school (Snyder et al., 2009). Computers and the available classroom digital technologies have changed over time and so has the focus on using digital technologies as an essential tool in the classroom.

The majority of study participants (85%) utilize computers almost daily, yet it seems these same educators may not be teaching the most relevant software when it comes to their students getting a job in the printing or graphic communication industry. When examining the frequency responses from the *Technology Use Survey* it is unclear how current graphic communication educators are keeping their curriculum in direct relation to the ever-changing printing and graphic arts industry.

As previously mentioned, the publishing and desktop publishing industries are both experiencing economic stagnation, prepress technicians are expected to experience a steady employment decline, and the only area of graphic communication expected to experience steady growth is graphic design and Web site development (Bureau of Labor Statistics & U.S. Department of Labor, 2009a, 2009b, 2009c, 2009d). One example of this economic downturn is the newspaper industry. According to the March 12, 2009 issue of the *New York Times*, the future of large newspapers is very much in jeopardy after the *Rocky Mountain Times*, the *Seattle Post-Intelligencer*, and the *Tucson Citizen* all discontinued their printed newspapers (Perez-Pena, 2009). While the decline of newspaper publishing may not have an immediate and direct effect upon students, it is one indicator of the graphic communication industry employment shift away from focusing upon print toward the Web and digital media.

As the number of computers has increased and the types of available digital technologies have changed, findings from this study indicate graphic communication educators may not be adjusting their classroom instruction to meet the needs of the changing printing and graphic communication industry. The findings of this study indicate many of the advanced digital technologies the current workforce demands are not being instructed on a frequent basis. In fact, 47.6 % of participants never require their students to create Web pages with a visual or WYSIWYG editor. Even fewer (64.9%) require their students to create Web pages using HTML code. Even though Web site development is clearly in demand in the workplace.

While graphic communication educators use a variety of digital technologies, the frequency and variety of the technologies used varies greatly. Graphic communication teachers use computers for instruction virtually every day, but for what purpose? Vector and raster graphics are created and/or edited frequently in the classroom, but relatively little time is spent creating Web pages, digital animations, spreadsheets and databases.

Page layout programs are used often, but multimedia projects are rarely part of instruction. While most of the digital technologies investigated in this study are utilized in the graphic communication industry, graphic communication classrooms seem geared toward print communication, with less emphasis on non-print media. Page layout programs for instance are directly linked to desktop publishing and are used almost daily by 49.2% of the study participants. But the demand for jobs utilizing page layout skills is stagnant. It appears graphic communication educators are still teaching curriculum based upon old industry needs and are not in touch with the current industry. Over the past 10 years, the printing industry has experienced dramatic change, and when the average number of years teaching is examined (17), it is clear many of the teacher participants in this study have experienced the dramatic change in digital technology, though it is not clear that they have updated their curriculum and instruction in accordance with this rapid technological change.

The perceived lack of advanced use of digital technologies in the classroom does not correspond to the higher level of personal computer use by the participants. The median response to the *PCU* scale of the *LoTi* instrument was 6, indicating a very high personal computer and technology knowledge. In contrast, the data collected from the *Technology Use* instrument indicate educators are using standard digital tools (e.g., page layout software, raster image editing/creation, and vector image editing/creation) quite often in instruction, but more advanced digital technologies (e.g., Web page design, digital animations, and digital multimedia) are used infrequently. Reasons for this disparity could be lack of software or equipment, but could also be related to the idea of time and incentive to update the current classroom instructional practices.

Another implication of the findings is that while students are frequently using the Internet to access digital content, they are infrequently using the Internet to solve technical problems. It appears teachers are encouraging students to use the Internet to access images and files for use in their projects, but are not encouraging students to access the Internet to solve problems. The Internet provides a virtual library of assistance to any computer with an Internet connection, but it appears graphic communication students may not be using it to its full potential. Web sites like Adobe.com provide a plethora of information and digital tutorials directly linked to software being instructed in the classroom, but it seems graphic communication educators are not using content such as this to help with instruction, despite immediate access to a wide range of more than 150 graphic communication related tutorials from the *Graphic Comm Central* portal (http://teched.vt.edu/GCC).

An interesting finding is that students are completing digital tutorials less frequently (most frequent response was “several times a month”) in the classroom than expected, though it is not clear how they are teaching software applications if digital tutorials are being used infrequently. Many text books companies like *Against the Clock* and *Adobe Classroom in a Book* utilize software experts to create extensive electronic tutorials but it seems more than half of participants (63.8%) in this study report that their students are using them “several times a month” or less.

Data from the *Levels of Technology Implementation, Current Instructional Practice*, and *Personal Computer Use* components of the LoTi instrument suggest graphic communication educators are well versed in using digital technologies, incorporating learner-centered practices, and providing a learning environment valuing student input, but it is not clear that the current curriculum being instructed provides students with the diverse range of knowledge and skills currently and used in the graphic communication industry.

In comparison to national LoTi data for secondary educators across all disciplines, graphic communication educators score higher on all three scales and score substantially higher on the LoTi scale (LoTi Connection, 2009). National educational standards such as those mandated by the NCLB Act have shifted from teaching students to use technology to using technology to learn content (Northeast & the Islands Regional Technology in Education Consortium, 2002) and it appears graphic communication educators are doing just that.

Limitations to Findings

The LoTi instrument (LoTi, CIP, and PCU scales) was intended to assess general secondary educators. It was not created specifically for use with graphic communication educators, nor was it created for use with post-secondary educators. Several of the questions on the LoTi instrument are clearly directed toward secondary educators. For instance, question #42 (Appendix D) states "The curriculum demands at our school such as implementing standards and increasing student test scores have diverted my attention away from using computers in my classroom." Post-secondary educators do not deal with standards such as NCLB or have to worry about test scores on a school wide basis. In an effort to examine the potential issues, data was analyzed for both groups and the results were presented in the Summary of Findings above. This reexamination of the data helps to validate the results for secondary and post-secondary educators although it does not change the basic premise of the LoTi instrument to be used for general secondary school educators and not necessarily for a specific group of educators, or for educators at the post-secondary level.

Another limitation was the group of graphic communication educators in this study. As the prospective participant list was compiled from five independent sources of graphic communication educators, the pool of prospective participants was beyond the researcher's control.

Another limitation was the fact that prospective participants for this study were persons appearing on lists of graphic communication educators obtained by the researcher from five different organizations. This was a "convenience sample" rather than a true representation of all graphic communication educators in the United States. There were, for example, a disproportionate number of Midwestern graphic communication teachers on the composite list, and only 37 states were represented. Moreover, the criteria used by the five organizations for identifying "graphic communication educators" who appeared on these lists were unknown to the researcher.

Another concern from the compiled list of educators was the inability of the researcher to ensure all possible participants on the list were current graphic communication educators. In some schools the graphic communication teacher might be a science teacher who teaches a class on graphic design, while in other schools the graphic communication teacher might be considered an art teacher. The lists were assumed to contain only graphic communication educators, but the reality was unknown.

Delivery of the invitation to participate in this study also created complications. Because a proprietary Web survey instrument was used for this survey, the researcher could not provide a simple link for participants to follow; each participant had to log into the Loticonnection.com Web site and create a unique username and password for entry. The log-in procedure generated many questions from respondents, resulting in two clarification e-mails to all respondents. Various log-in difficulties could have caused some respondents to become frustrated and not complete the survey.

Future Study

While this study provides a snapshot into the use of digital technologies in graphic communication classrooms, this researcher suggests the following areas for further investigation:

1. Because of the aforementioned limitations of the LoTi instrument, it would be beneficial for future researchers to develop a valid and reliable instrument to examine technology implementation, personal computers use, and learner-centered teaching practices specifically in graphic communication classrooms.

2. Because of the log-in problems associated with the proprietary LoTi procedures, it is suggested future researchers might create and administer original instrumentation and administer it through a more “user-friendly” Web service such as SurveyMonkey. This would also provide researchers more control of their instrument design and data handling.

3. The *Technology Use Survey* could be revised to examine the purposes and specific duration for which individual digital technologies are being used in graphic communication classrooms. Revision of this instrument could also facilitate the gathering of more detailed information about the software and hardware used by graphic communication classrooms.

4. Because the results of the *Technology Use Survey* raises questions regarding the extent to which graphic communication education is “in step” with the graphic communication industry, researchers might investigate this issue. Many graphic communication students are expecting to find employment in the graphic communication industry, but it is unclear how well prepared these students are in that regard.

5. The differences between secondary and post-secondary educators should be investigated more thoroughly.

REFERENCES

Ali, A., & Franklin, T. (2001). Internet use in the classroom: Potential and pitfalls for student learning and teacher-student relationships. *Educational Technology 41*(4), 57-59.

American Psychological Association. (2008). Learner-centered psychological principles. Retrieved 9/9, 2008, from http://www.apa.org/ed/lcp2/lcp14.html

Apple Computer. (1995). Changing the conversation about teaching learning & technology: A report on 10 years of Apple classroom of tomorrow research. Cupertinoa, California.

Barron, A. E., Kemker, K., Harmes, C., & Kalaydjian, K. (2003). Large scale research study on technology in k-12 schools: Technology integration as it relates to the national technology standards. *Journal of Research on Technology in Education, 35*(4), 489-507.

Bauer, J., & Kenton, J. (2005). Toward technology integration in the schools: Why it isn't happening. *Journal of Technology and Teacher Education, 13*(4), 519-546.

Bebell, D., Russell, M., & O'Dwyer, L. (2004). Measuring teachers' technology uses: Why multiple measures are more revealing. *Journal of Research on Technology in Education, 37*(1), 45-63.

Becker, H. J., & Anderson, R. E. (1998). Teaching, learning, and computing: 1998. A national survey of schools and teachers describing their best practices, teaching philosophies, and uses of technology.

Best, S. J., & Krueger, B. S. (2004). *Internet data collection*. Thousand Oaks, Calif.: Sage Publications.

Bitter, G., & Person, M. (2002). *Using technology in the classroom* (Fifth ed.). Boston: Allyn & Bacon.

Blue, C. N. (2007, Spring). Does access to communication technologies outside the classroom have significance in student learning. *Visual Communications Journal* 23-28.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

Bull, G., & Bull, G. (2003-2004). The digital disconnect: A recent pew study. *Learning & Leading With Technology, 31*(4), 28-31.

Bureau of Labor Statistics, & U.S. Department of Labor. (2009a). Career guides to industries, 2008-09 edition, desktop publishers. from http://www.bls.gov/oco/ocos276.htm

Bureau of Labor Statistics, & U.S. Department of Labor. (2009b). Career guides to industries, 2008-09 edition, publishing, except software. from http://www.bls.gov/oco/cg/cgs013.htm

Bureau of Labor Statistics, & U.S. Department of Labor. (2009c). Occupational outlook handbook, 2008-09 edition, graphic designers. from http://www.bls.gov/oco/ocos090.htm

Bureau of Labor Statistics, & U.S. Department of Labor. (2009d). Occupational outlook handbook, 2008-09 edition, prepress technicians and workers. from http://www.bls.gov/oco/ocos230.htm

Burton, D. (2001). How do we teach? Results of a national survey of instruction in secondary art education. *Studies in Art Education, 42*(2), 131-145.

Butler, D. L., & Sellbom, M. (2002). Barriers to adopting technology for teaching and learning. *Educause Quarterly, 2*, 24-28.

California Technology Assistance Project. (2002). Summary of statewide results from the 2002 California technology survey. In California Department of Education (Ed.).

CDW-Government. (2006). Teachers Talk Tech 2006. Retrieved 5/2, 2008, from http://newsroom.cdwg.com/features/feature-06-26-06.html

Consortium for School Networking. (2004). Digital leadership divide: Without visionary leadership, disparities in school technology budgets increase. Retrieved 4/12, 2008, from http://www.cosn.org

Corbin, J. F. (2003). *The integration of technology into the middle and high school science curriculum.* Dissertation. University of Central Florida.

Daley, B. J., Watkins, K., Williams, S. W., Courtenay, B., Davis, M., & Dymock, D. (2001). Exploring learning in a technology-enhanced environment. *Educational Technology & Society, 4*(3), 126-138.

Daniels, D. H., & Perrry, K. E. (2003). "Learner-centered according to children. *Theory Into Practice, 42*(2), 102-108.

Deacon, C. R. (1999). *The effect of computer access and subject area on the level of teacher Implementation of technology (technology Implementation)* Dissertation. Seton Hall University.

DeRoma, V., & Nida, S. (2004). A focus on "Hands-on," Learner-centered technology at the Citadel. *TechTrends, 48*(5), 37-41.

Dharavath, H. N. (2002). *Current status of graphic communications technology education in the mountain states and its impact on the graphic communications industry.* University of Wyoming, Laramie, Wyoming.

Dillman, D. A. (2000). *Mail and Internet surveys: The tailored design method* (2nd ed.). New York: Wiley.

Dwyer, D. (1994). Apple classrooms of tomorrow: What we've learned. *Educational Leadership* (April), 4-10.

Feeney, D. R. (2001). *Rates of adoption in a university course management system.* Dissertation. West Virginia University.

Franklin, C. (2007). Factors that influence elementary teachers use of computers. *Journal of Technology and Teacher Education, 15*(2), 267-293.

Griffin, D. A. (2003). *Educators' technology level of use and methods for learning technology integration.* Dissertation. University of North Texas.

Guhlin, M. (2008). Loti in k-12 schools. Retrieved 9/21, 2008, from http://www.necc2008.org/group/lotimotion/forum/topic/show?id=1997968%3ATopic%3A18825

Gulek, J. C., & Demirtas, H. (2005). Learning with technology: The impact of laptop use on student achievement. *The Journal of Technology, Learning, and Assessment, 3*(2), 4-20.

Hao, T.-Y. (2001). *A study of important content for undergraduate graphic communications programs.* Dissertation. University of Northern Iowa, Cedar Falls, IA.

Hood, J. F. (1985). Microcomputers in schools, 1984-85. A comprehensive survey and analysis. *Market Data Retrieval,* (ED265822).
Hooper, S., & Rieber, L. P. (1995). Teaching with technology. In A. C. Ornstein (Ed.), *Teaching: Theory into practice*. Needham Heights, MA: Allyn & Bacon.
International Society for Technology in Education. (2002). Creating a foundation for technology use, *NETS for Teachers - Preparing Teachers to use Technology*.
Jonassen, D. H., Howland, J., Moore, J., & Marra, R. M. (2003). *Learning to solve problems with technology: A constructivist perspective*. Upper Saddle River, New Jersey: Merrill Prentice Hall.
Judson, E. (2006). How teachers integrate technology and their beliefs about learning: Is there a connection? *Journal of Technology and Teacher Education, 14*(3), 581-597.
Kendra, E., & Poyssick, G. (2007). *Adobe InDesign CS3: The professional portfolio*. Tampa, Fl: Against The Clock.
Kim, S. H., & Bagaka, J. (2005). The digital divide in students' usage of technology tools: A multilevel analysis of the role of teacher practices and classroom characteristics. *Contemporary Issues in Technology and Teacher Education, 5*(3/4), 318-329.
Lambert, N. M., & McCombs, B. L. (Eds.). (1998). *How students learn: Reforming schools through learner-centered education*. Washington, D.C.: American Psychological Association.
Larson, L. L. (2003). *A descriptive study of technology integration and faculty professional development in one higher education institution* Dissertation. Pepperdine University.
Lengel, J. G., & Lengel, K. M. (2006). *Integrating technology: A practical guide*. Boston: Allyn & Bacon.
Levenson, H. R. (2007, Spring). A cube model for planning technological change in the printing industry – influences from within the industry and external environment. *Visual Communications Journal* 15-21.
Lewin, L. (2001). *Using the Internet to strengthen curriculum*. Alexandria, Va.: Association for Supervision and Curriculum Development.
Li, Q. (2007). Student and teacher views about technology: A tale of two cities. *Journal of Research on Technology in Education, 39*(4), 377-398.
Lockard, J., & Abrams, P. D. (2004). *Computers for twenty-first century educators* (Sixth ed.). Boston: Allyn & Bacon.
LoTi Connection. (2009). National LoTi technology use profile. Carlsbad, Ca.
Maddox, C. D., Johnson, D. L., & Willis, J. W. (2001). *Educational computing: Learning with tomorrow's technologies* (Third ed.). Needham Heights, Ma: Allyn & Bacon.
Mandell, S., Sorge, D. H., & Russell, J. D. (2002). Tips for technology integration. *TechTrends, 46*(5), 39-43.
Marcinkiewicz, H. R. (1993). Computers and teachers: Factors influencing computer use in the classroom. *Journal of Research on Computing in Education, 26*(2), 220-237.
McCombs, B. L., & Miller, L. (2007). *Learner-centered classroom practices and assessments: Maximizing student motivation, learning, and achievement*. Thousand Okas, Ca.: Corwin Press.

McCombs, B. L., & Whisler, J. S. (1997). *The learner-centered classroom and school*. San Francisco: Jossey-Bass Publishers.
Mehta, D. D. P. (2007, Spring). A comparison of waterless litho with conventional litho on productivity, eco-friendliness, and technical skills needed. *Visual Communications Journal* 5-14.
Microsoft. (2007). Microsoft Excel 2008 for Mac. Santa Rosa, Ca.: Microsoft Corporation.
Middleton, B. M., & Murray, R. K. (1999). The impact of instructional technology on student academic achievement in reading and mathematics. *International Journal of Instructional Media, 26*(1), 109-116.
Moersch, C. (1995). Levels of technology Implementation (LoTi): A framework for measuring classroom technology use. *Learning and Leading with Technology, 23*(3), 40-42.
Moersch, C. (2001). Next steps: Using LoTi as a research tool. *Learning & Leading with Technology, 29*(3), 22-27.
Moersch, C. (2002a). *Beyond hardware - using existing technology to promote higher-level thinking*: International Society for Technology in Education.
Moersch, C. (2002b). Measures of success: Six instruments to assess teachers' use of technology. *Learning & Leading With Technology, 30*(3), 10-13, 24-28.
Moersch, C. (2009). Current instructional practices framework. Retrieved April 29, 2009, from http://www.loticonnection.com/cipframework.html
Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: A review of the literature. *Journal of Information Technology for Teacher Education, 9*(3), 319-341.
National Center for Education Statistics. (2002). Internet access in United States public schools and classrooms: 1994-2001. Washington, D. C.: U.S. Department of Education.
National Center for Education Statistics. (2006). Internet access in United States public schools and classrooms: 1994-2005. Washington, D. C.: U.S. Department of Education.
Norris, C., Sullivan, T., Poirot, J., & Soloway, E. (2003). No access, no use, no impact: Snapshot surveys of educational technology in k-12. *Journal of Research on Technology in Education, 36*(1), 15-27.
Northeast & the Islands Regional Technology in Education Consortium. (2002). Technology briefs for no child left behind planners. Retrieved 10/15, 2007, from http://www.neirtec.org/products/techbriefs/index_html.asp
O'Neil, J., Harold F., & Perez, R. S. (Eds.). (2003). *Technology applications in education: A learning view*. Mahwah, New Jersey: Lawrence Erlbaum Associates.
Oliver, G. R. (2007). *Apparent quality of alternative halftone screening when compared to conventional screening in commercial offset lithography.* Clemson University, Clemson, S.C.
Osmond, P. K. (2002). *Graphic communication industry training: A critical comparison of knowledge gained and satisfaction of learners between on-site delivery and web-based delivery.* Dissertation. University of Idaho, Moscow, Idaho.
Perez-Pena, R. (2009). As cities go from two papers to one, Talk of zero. *New York Times*, from http://www.nytimes.com/2009/03/12/business/media/12papers.html

Powers, R., & Blubaugh, W. (2005). Technology in mathematics education: Preparing teachers for the future. *Contemporary Issues in Technology and Teacher Education, 5*(3/4), 254-270.
Project Tomorrow 3. (2006). Our voices, our future: Student and teacher views on science, technology & education, *National Report on NetDay's Speak Up Event*.
Prust, Z. A. (2003). *Graphic communications: The printed image*. Tinley Park, Il: Goodheart-Wilcox Company, Inc.
Rakes, G. C., Fields, V. S., & Cox, K. E. (2006). The influence of teachers' technology use on instructional practices. *Journal of Research on Technology in Education, 38*(4), 409-424.
Rogers, P. L. (2000). Barriers to adopting emerging technologies in education. *Journal of Educational Computing Research, 22*(4), 455-472.
Russell, M., O'Dwyer, L., Bebell, D., & Miranda, H. (2004). Technical report for the USEiT study. Boston, Ma.: Boston College, Technology and Assessment Study Collaborative.
Sanders, M., Sherman, T., Kwon, H., & Pembridge, J. (2009). *Technology education in the United States: Teacher's beliefs and practices.* Paper presented at the Proceedings of the American Society for Engineering Education.
Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1997). *Teaching with technology: Creating student-centered classrooms*. New York: Teachers College Press.
Schechter, E. L. (2000). *Factors relating to classroom Implementation of computer technology in elementary schools.* Dissertation. St. John's University, Jamaica, N.Y.
Sherry, L., Lawyer-Brook, D., & Black, L. (1997). Evaluation of the Boulder Valley Internet project: A theory-based approach to evaluation design. *Journal of Interactive Learning Research, 8*(2), 199-233.
Shiveley, J. M. (2005). Toward assessing Internet use in the social studies classroom: Developing an inventory based on a review of relevant literature. *Contemporary Issues in Technology and Teacher Education, October*(Online Submission), 39.
Snyder, T. A., Dillow, S. A., & Hoffman, C. M. (2009). Digest of education statistics 2008, *NCES 2009-020*. Washington, D.C.: National Center for Education Statistics.
SPSS. (2008). SPSS statistics for Macintosh, version 17.0.0,. Chicago: SPSS INC.
State Educational Technology Directors Association. (2007). *Setda's national trends report 2007: A report from all 50 states and DC regarding NCLB's title ii, part d enhancing education through technology (EETT) program*. Retrieved. from http://www.setda.org.
Stoltzfus, J. (2005). Determining educational technology and instructional learning skill sets (details): A new approach to the LoTi framework for the 21st century.
Strickland, J., & Nazzal, A. (2005). Using Webquests to teach content: Comparing instructional strategies. *Contemporary Issues in Technology and Teacher Education, 5*(2).
Sue, V. M., & Ritter, L. A. (2007). *Conducting online surveys*. Los Angeles: Sage Publications.
Sund, R. B., & Trowbridge, L. W. (1974). *Student-centered teaching in the secondary school*. Columbus, OH: Charles E. Merrill Publishing Co.

United States Census Bureau. (2009). United States geographic regions.   Retrieved March 28, 2009, 2009, from http://www.census.gov/geo/www/geo_defn.html#CensusRegion
United States Department of Education. (2004). *Toward a new golden age in American education: How the Internet, the law and today's students are revolutionizing expectations*. Retrieved. from http://www.ed.gov/about/offices/list/os/technology/plan/2004/index.html.
United States Department of Education. (2005). *Enhancing education through technology*. Retrieved 9/9/07. from http://www.whitehouse.gov/omb/expectmore/summary/10003305.2005.html.
von Alten, J. W., & Faulkner, A. (2007). *Adobe Photoshop CS3 classroom in a book for windows and Mac os*. Berkeley, Ca.: Peachpit.
Waite, J. J., & Hutcheson, D. (2007, Spring). Printing industry guidelines for print students part two: Printing process control and color separation. *Visual Communications Journal* 29-43.
Weimer, M. (2002). *Learner-centered teaching: Five key changes to practice*. San Francisco: Jossey-Bass.
Weitkamp, E. W. (2005). *Teaching style and technology: The role of educational values in the adoption of information technology Innovations in the classroom.* University of Northern Colorado, Greeley, Colorado.
Wentworth, N., & Earle, R. (2003). Trends in computer uses as reported in *computers in the schools*. *Computers in the Schools, 20*(1/2), 77-90.
Wozney, L., Venkatesh, V., & Abrami, P. C. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education, 14*(1), 36.
Wright, V. H., & Wilson, E. K. (2005-2006). From preservice to inservice teaching: A study of technology integration. *Journal of Computing in Teacher Education, 22*(2), 49-55.
Yun, G. W., & Trumbo, C. W. (2000). Comparative response to a survey executed by post, e-mail, & web form. *Journal of Computer-Mediated Communication (Online), 6*(1).

APPENDICES

Appendix A

Levels of Technology Implementation Framework (Scale)

Level 0

Category: Nonuse

Description: A perceived lack of access to technology-based tools (e.g., computers) or a lack of time to pursue electronic technology implementation. Existing technology is predominately text-based (e.g., ditto sheets, chalkboard, overhead projector).

Level 1

Category: Awareness

Description: The use of technology-based tools is either (1) one step removed from the classroom teacher (e.g., integrated learning system labs, special computer-based pull-out programs, computer literacy classes, central word processing labs), (2) used almost exclusively by the classroom teacher for classroom and/or curriculum management tasks (e.g., taking attendance, using grade book programs, accessing email, retrieving lesson plans from a curriculum management system or the Internet) and/or (3) used to embellish or enhance teacher-directed lessons or lectures (e.g., multimedia presentations).

Level 2

Category: Exploration

Description: Technology-based tools supplement the existing instructional program (e.g., tutorials, educational games, basic skill applications) or complement selected multimedia and/or web-based projects (e.g., Internet-based research papers, informational multimedia presentations) at the knowledge/comprehension level. The electronic technology is employed either as extension activities, enrichment exercises, or technology-based tools and generally reinforces lower cognitive skill development relating to the content under investigation.

Level 3

Category: Infusion

Description: Technology-based tools including databases, spreadsheet and graphing packages, multimedia and desktop publishing applications, and Internet use complement selected instructional events (e.g., field investigation using spreadsheets/graphs to analyze results from local water quality samples) or multimedia/web-based projects at the analysis, synthesis, and evaluation levels. Though the learning activity may or may not be perceived as authentic by the student, emphasis is, nonetheless, placed on higher levels of cognitive processing and in-depth treatment of the content using a variety of thinking skill strategies (e.g., problem-solving, decision-making, reflective thinking, experimentation, scientific inquiry).

Level 4A

Category: Integration (Mechanical)

Description: Technology-based tools are integrated in a mechanical manner that provides rich context for students' understanding of the pertinent concepts, themes, and processes. Heavy reliance is placed on prepackaged materials and/or outside resources (e.g., assistance from other colleagues), and/or interventions (e.g., professional development workshops) that aid the teacher in the daily management of their operational curriculum. Technology (e.g., multimedia, telecommunications, databases, spreadsheets, word processing) is perceived as a tool to identify and solve authentic problems as perceived by the students relating to an overall theme/concept. Emphasis is placed on student action and on issues resolution that require higher levels of student cognitive processing and in-depth examination of the content.

Level 4B

Category: Integration (Routine)

Description: Technology-based tools are integrated in a routine manner that provides rich context for students' understanding of the pertinent concepts, themes, and processes. At this level, teachers can readily design and implement learning experiences (e.g., units of instruction) that empower students to identify and solve authentic problems relating to an overall theme/concept using the available technology (e.g., multimedia applications, Internet, databases, spreadsheets, word processing) with little or no outside assistance. Emphasis is again placed on student action and on issues resolution that require higher levels of student cognitive processing and in-depth examination of the content.

Level 5

Category: Expansion

Description: Technology access is extended beyond the classroom. Classroom teachers actively elicit technology applications and networking from other schools, business enterprises, governmental agencies (e.g., contacting NASA to establish a link to an orbiting space shuttle via Internet), research institutions, and universities to expand student experiences directed at problem-solving, issues resolution, and student activism surrounding a major theme/concept. The complexity and sophistication of the technology-based tools used in the learning environment are now commensurate with (1) the diversity, inventiveness, and spontaneity of the teacher's experiential-based approach to teaching and learning and (2) the students' level of complex thinking (e.g., analysis, synthesis, evaluation) and in-depth understanding of the content experienced in the classroom.

Level 6

Category: Refinement

Description: Technology is perceived as a process, product (e.g., invention, patent, new software design), and/or tool for students to find solutions related to an identified "real-world" problem or issue of significance to them. At this level, there is no longer a division between instruction and technology use in the classroom. Technology provides a seamless medium for information queries, problem-solving, and/or product development. Students have ready access to and a complete understanding of a vast array of technology-based tools to accomplish any particular task at school. The instructional curriculum is entirely learner-based. The content emerges based on the needs of the learner according to his/her interests, needs, and/or aspirations and is supported by unlimited access to the most current computer applications and infrastructure available.

Note. Adapted from "Beyond Hardware – Using Existing Technology To Promote Higher-Level Thinking" by Christopher Moersch, 2002, p. 47-49.

Appendix B

Current Instructional Practices (CIP) Scale of the LoTi Instrument

Level 0

Description: A CIP Intensity Level 0 indicates that one or more questionnaire statements were not applicable to the participant's current instructional practices.

Level 1

Description: At a CIP Intensity Level 1, the participant's current instructional practices align exclusively with a subject-matter based approach to teaching and learning. Teaching strategies tend to lean toward lectures and/or teacher-led presentations. The use of curriculum materials aligned to specific content standards serves as the focus for student learning. Learning activities tend to be sequential and uniform for all students. Evaluation techniques focus on traditional measures such as essays, quizzes, short-answers, or true-false questions. Student projects tend to be teacher-directed in terms of identifying project outcomes as well as requirements for project completion.

Level 2

Description: Similar to a CIP Intensity Level 1, the participant at a CIP Intensity Level 2 supports instructional practices consistent with a subject-matter based approach to teaching and learning, but not at the same level of intensity or commitment. Teaching strategies tend to lean toward lectures and/or teacher-led presentations. The use of curriculum materials aligned to specific content standards serves as the focus for student learning. Learning activities tend to be sequential and uniform for all students. Evaluation techniques focus on traditional measures such as essays, quizzes, short-answers, or true-false questions. Student projects tend to be teacher-directed in terms of identifying project outcomes as well as requirements for project completion.

Level 3

Description: At a CIP Intensity Level 3, the participant supports instructional practices aligned somewhat with a subject-matter based approach to teaching and learning‹an approach characterized by sequential and uniform learning activities for all students, teacher-directed presentations, and/or the use of traditional evaluation techniques. However, the participant may also support the use of student-directed projects that provide opportunities for students to determine the "look and feel" of a final product based on specific content standards.

Level 4

Description: At a CIP Intensity Level 4, the participant may feel comfortable supporting or implementing either a subject-matter or learning-based approach to instruction based on the content being addressed. In a subject-matter based approach, learning activities tend to be sequential, student projects tend to be uniform for all students, the use of lectures and/or teacher-directed presentations are the norm as well as traditional evaluation strategies. In a learner-based approach, learning activities are diversified and based mostly on student questions, the teacher serves more as a co-learner or facilitator in the classroom, student projects are primarily student-directed, and the use of alternative assessment strategies including performance-based assessments, peer reviews, and student reflections are the norm.

Level 5

Description: At a CIP Intensity Level 5, the participant's instructional practices tend to lean more toward a learner-based approach. The essential content embedded in the standards emerges based on students "need to know" as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Both students and teachers are involved in devising appropriate assessment instruments (e.g., performance-based, journals, peer reviews, self-reflections) by which student performance will be assessed. However, the use of teacher-directed activities (e.g., lectures, presentations, teacher-directed projects) may surface based on the nature of the content being addressed and at the desired level of student cognition.

Level 6

Description: Similar to a CIP Intensity Level 7, the participant at a CIP Intensity Level 6 supports instructional practices consistent with a learner-based approach, but not at the same level of intensity or commitment. The essential content embedded in the standards emerges based on students "need to know" as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Students, teacher/facilitators, and occasionally parents are all involved in devising appropriate assessment instruments (e.g., performance-based, journals, peer reviews, self-reflections) by which student performance will be assessed.

Level *7*

At a CIP Intensity Level 7, the participant's current instructional practices align exclusively with a learner-based approach to teaching and learning. The essential content embedded in the standards emerges based on students "need to know" as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Students, teacher/facilitators, and occasionally parents are all involved in devising appropriate assessment instruments (e.g., performance-based, journals, peer reviews, self-reflections) by which student performance will be assessed.

Note. Adapted from http://www.loticonnection.com/cipframework.html, 2009.

Appendix C

The Personal Computer Use (PCU) Scale of the LoTi Instrument

Level 0

Description: A PCU Intensity Level 0 indicates that the participant does not feel comfortable or have the skill level to use computers for personal use. Participants at Intensity Level 0 rely more on the use of overhead projectors, chalkboards, and/or traditional paper/pencil activities than using computers for conveying information or classroom management tasks.

Level 1

Description: A PCU Intensity Level 1 indicates that the participant demonstrates little skill level with using computers for personal use. Participants at Intensity Level 1 may have a general awareness of various technology-related tools such as word processors, spreadsheets, or the Internet, but generally are not using them.

Level 2

Description: A PCU Intensity Level 2 indicates that the participant demonstrates little to moderate skill level with using computers for personal use. Participants at Intensity Level 2 may occasionally browse the Internet, use email, or use a word processor program; yet, may not have the confidence or feel comfortable troubleshooting simple "technology" problems or glitches as they arise. At school, their use of computers may be limited to a grade book or attendance program.

Level 3

Description: A PCU Intensity Level 3 indicates that the participant demonstrates moderate skill level with using computers for personal use. Participants at Intensity Level 3 may begin to become "regular" users of selected applications such as the Internet, email, or a word processor program. They may also feel comfortable troubleshooting simple "technology" problems such as rebooting a machine or hitting the "Back" button on an Internet browser, but rely on mostly technology support staff or others to assist them with any troubleshooting issues.

Level 4

Description: A PCU Intensity Level 4 indicates that the participant demonstrates moderate to high skill level with using computers for personal use. Participants at Intensity Level 4 commonly use a broader range of software applications including multimedia (e.g., Microsoft Powerpoint, HyperStudio), spreadsheets, and simple database applications. They typically have the confidence and are able to troubleshoot simple hardware, software, and/or peripheral problems without assistance from technology support staff.

Level 5

Description: A PCU Intensity Level 5 indicates that the participant demonstrates high skill level with using computers for personal use. Participants at Intensity Level 5 are commonly able to use the computer to create their own web pages, produce sophisticated multimedia products, and/or effortlessly use common productivity applications (e.g., Microsoft Excel, FileMaker Pro), desktop publishing software, and web-based tools. They are also able to confidently troubleshoot most hardware, software, and/or peripheral problems without assistance from technology support staff.

Level 6

Description: A PCU Intensity Level 6 indicates that the participant demonstrates high to extremely high skill level with using computers for personal use. Participants at Intensity Level 6 are sophisticated in the use of most, if not all, multimedia, productivity, desktop publishing, and web-based applications. They typically serve as "troubleshooters" for others in need of assistance and sometimes seek certification for achieving selected technology-related skills.

Level 7

Description: A PCU Intensity Level 7 indicates that the participant demonstrates extremely high skill level with using computers for personal use. Participants at Intensity Level 7 are expert computer users, troubleshooters, and/or technology mentors. They typically are involved in training others on any technology-related task and are usually involved in selected support groups from around the world that allow them access to answers for all technology-based inquiries they may have.

Note. Adapted from http://www.loticonnection.com/pcuframework.html, 2009.

Appendix D

Levels of Technology Implementation (LoTi) Instrument Questions

1- I design projects that require students to analyze information, think creatively, make predictions, and/or draw conclusions using electronic resources such as multi-purpose calculators, hand-held computers, the classroom computer(s), or computer peripherals (e.g., digital video cameras, probes, MIDI devices).

2 - I use our classroom computer(s) primarily to present information to students using presentation software (e.g., PowerPoint) or interactive white boards because it helps students better understand the content that I teach.

3 - I currently use instructional units acquired from colleagues, curriculum resource catalogs, or the Internet that integrate the use of computers with higher order thinking skills and student-directed learning (e.g., students generate questions, define tasks, set goals, self-assess learning).

4 - Students in my classroom design either web-based or multimedia presentations to showcase their research (e.g., information gathering) on topics that I assign in class.

5 - I have experienced past success with designing and implementing web-based projects that emphasize complex thinking skill strategies such as problem-solving, creative problem solving, investigation, scientific inquiry, or decision-making.

6 - My students collaborate with me in setting both group and individual academic goals that provide opportunities for them to direct their own learning within my classroom curriculum.

7 - I have stretched the limits of instructional computing in my classroom using the most current and complete technology infrastructure (e.g., small student/computer ratio, high-speed Internet access, updated computer software, teleconferencing capability).

8 - Students in my classroom use the available technology resources (e.g., websites, multimedia applications, spread- sheets, MIDI devices) to complete projects that focus on critical content and higher order thinking skills (e.g., analysis, synthesis, evaluation).

9 - I use computers primarily to support my classroom management tasks such as taking attendance, posting assignments to a web page, using a gradebook program, and/or communicating with parents via email.

10 - In my classroom, students use multiple software applications/hardware peripherals (e.g., Internet browsers, productivity tools, multimedia applications, digital video cameras, MIDI devices) as well as resources beyond the school building (e.g., partnerships with business professionals, other schools) to solve problems of interest to them.

11 - In my classroom, students use computers primarily to improve their basic skills or understand better what I am teaching them with the aid of supplemental instructional resources (e.g., CD's, Internet, integrated learning systems-ILS, tutorial programs).

12 - Technical problems prevent me and/or my students from using the classroom computers during the instructional day.

13 - I access the computer daily to browse the Internet, send/ receive email, and/or use different productivity and multi- media tools (e.g., word processor, spreadsheet, database, presentation software).

14 - I empower my students to discover innovative ways to use our school's vast technology infrastructure to make a real difference in their lives, in their school, or in their community.

15 - I am proficient with and knowledgeable about the technology resources (e.g., hardware, software programs, peripherals) appropriate for my grade level or content area.

16 - Locating good software programs, websites, or CD's to supplement my curriculum and reinforce specific content is a priority of mine at this time.

17 - Getting more comfortable with using computers during my instructional day is my goal for this school year.

18 - I have the background to assist others in the use of a variety of software applications (e.g., Excel, Inspiration, PowerPoint), the Internet (Web browsers, Web page construction and design), and peripherals (e.g., digital video cameras, probes, MIDI devices).

19 - The current student-to-computer ratio in my classroom(s) is not sufficient for me to use computer(s) during my instructional day.

20 - I consistently provide alternative assessment opportunities (e.g., performance-based assessment, peer reviews, self- reflection) that encourage students to "showcase" their content understanding in nontraditional ways.

21 - In my classroom, students use the Internet for (1) collaboration with others, (2) publishing, (3) communication, and (4) research to solve issues and problems of personal interest to them that address specific content areas.

22 - Students in my classroom participate in online collaborative projects (not including email exchanges) with other entities (e.g., schools, businesses, organizations) to find solutions, make decisions, or seek a resolution to an issue of importance to them.

23 - Given my current curriculum demands and class size, it is much easier and more practical for students to learn about and use computers and related technologies outside of my classroom (e.g., computer lab).

24 - I use my classroom computer(s) primarily to locate and print out lesson plans appropriate to my grade level or content area.

25 - Using the classroom computers is not a priority for me this school year.

26 - I do not have to call someone (e.g., computer technician, network manager) to figure out a problem with my computer or a software application; I have the confidence and expertise to "fix" it myself.

27 - I prefer using previously-developed curriculum materials (e.g., instructional kits, existing Web-based projects) that (1) emphasize complex thinking skill strategies (e.g., creative problem-solving, decision-making, investigation), (2) promote the use of computers, and (3) provide opportunities for students to direct their own learning.

28 - My students' creative thinking and problem-solving opportunities are supported by our school's extensive technology infrastructure (e.g., high-speed Internet access, unlimited access to computers, updated computer software, multimedia and video production stations).

29 - My personal professional development involves investigating and implementing the newest innovations in instructional design and computer technology that takes full advantage of my school's extensive technology infrastructure (e.g., immediate access to the newest software applications, multimedia and video production stations, teleconferencing equipment).

30 - I favor previously developed curriculum materials (e.g., instructional kits, existing Web-based projects) that emphasize students using technology to solve "real" problems or issues of importance to them rather than building my own instructional units from scratch.

31 - I have an immediate need and interest in contacting other teachers, "qualified" consultants, and/or related professionals who can assist me in my ongoing effort to design and manage student-directed learning experiences using the available computers.

32 - Students' use of information and inquiry skills to solve problems of personal relevance guides the types of instructional materials used in and out of my classroom.

33 - I take into consideration my students' background, prior experiences, and desire to solve relevant problems of interest to them when planning instructional activities that utilize our available technology.

34 - I am able to design my own student-centered instructional materials that take advantage of our existing computers to engage students in their own learning (e.g., students generate questions, define tasks, set goals, self-assess learning).

35 - I alter my instructional use of the classroom computer(s) based upon (1) the newest software and Web-based innovations and (2) the most current research on teaching and learning (e.g., differentiated instruction, problem-based learning, multiple intelligences).

36 - Students applying what they have learned in the classroom to a real world situation (e.g., student-generated recycling program, student-generated business, student-generated play/musical) is a vital part of my instructional approach to using the classroom computer(s).

37 - I need more training on using technology with relevant and challenging learning experiences for my students rather than how to use specific software applications to support my current lesson plans.

38 - An ongoing goal of mine is for students to learn how to create their own Web page

or multimedia presentation that shows what they have been learning in class.

39 - The types of professional development offered through our school, district, and/or professional organizations does not satisfy my need for bigger, more engaging experiences for my students that take advantage of both my "technology" expertise and personal interest in developing student-centered curriculum materials.

40 - My students use the classroom computer(s) for research purposes that require them to investigate an issue/problem, think creatively, take a position, make decisions, and/or seek out a solution.

41 - Having students apply what they have learned in my classroom to the world they live in is a cornerstone to my approach to instruction and assessment.

42 - The curriculum demands at our school such as implementing standards and increasing student test scores have diverted my attention away from using the computers in my classroom.

43 - I have the background and confidence to show others how to merge technology with relevant and challenging learning experiences that emphasize higher order thinking skills and provide problem-solving opportunities for students.

44 - Though I currently use a student-centered approach when creating instructional units, it is still difficult for me to design these units on my own to take full advantage of our classroom computers.

45 - My immediate professional development need is to learn how my students can use my classroom computer(s) to achieve specific outcomes aligned to district or state standards.

46 - It is easy for me to identify software applications, peripherals, and Web-based resources that support and expand student's critical and creative thinking skills, and promote self-directed problem solving.

47 - My students have immediate access to all forms of the most current technology infrastructure available (e.g., easy access to newest computers, latest software applications, small student/computer ratio, video or teleconferencing kiosks) that they use to pursue problem-solving opportunities surrounding issues of personal and/or social importance.

48 - I need access to more resources and/or training to start using computers as part of my instructional day.

49 - I frequently explore new types of software applications, Web-based tools, and peripherals as they become available.

50 - Students' questions and previous experiences heavily influence the content that I teach as well as how I design learning activities for my students.

Appendix E

Demographic Questions

1) What is your gender?
   a) Female
   b) Male
2) Do you have an Internet connection in your classroom?
   a) Yes
   b) No
3) Which statement best describes the content of your technology-related training?
   a) No Training
   b) Mostly technology skills training (e.g., training on software applications, the Internet, troubleshoot hardware)
   c) Mostly curriculum integration training (e.g., how technology can be effectively integrated in the classroom)
   d) A combination of technology skills and curriculum integration training
4) Which category best describes your primary grade level?
   a) Secondary (grades 9-12)
   b) Post-Secondary (Community College, University, etc.)
5) How many years of teaching experience do you have in education? (Please enter actual number, i.e. 12)
6) What is your age? (Please enter actual number, i.e. 41)
7) In what state is your school located? (Enter only state, not city or town, i.e. Michigan)
8) What is your highest level of education?
   a) Bachelor's Degree
   b) Master's Degree
   c) Doctoral Degree
9) How many computers do you have for instructional use in your graphic communication classroom? (Please enter actual number, i.e. 8)
10) How many hours of digital technology-related training have you received over the past two years? (Please estimate and enter an actual number, i.e. 20)

Appendix F

Technology Use Survey

INSTRUCTIONS: How often are your students using the following digital technologies as part of classroom projects or assignments?

1) Students utilize desktop or laptop computers
   a. Never
   b. A few times each year
   c. Several times a month
   d. A few times each week
   e. Almost daily

2) Students utilize digital scanners
   a. Never
   b. A few times each year
   c. Several times a month
   d. A few times each week
   e. Almost daily

3) Students utilize digital cameras
   a) Never
   b) A few times each year
   c) Several times a month
   d) A few times each week
   e) Almost daily

4) Students utilize digital camcorders
   a) Never
   b) A few times each year
   c) Several times a month
   d) A few times each week
   e) Almost daily

5) Students utilize digital drawing tablets
    a) Never
    b) A few times each year
    c) Several times a month
    d) A few times each week
    e) Almost daily

6) Students use the Internet to access digital content, (e.g., finding copyright free graphics for use in a project)
    a) Never
    b) A few times each year
    c) Several times a month
    d) A few times each week
    e) Almost daily

7) Students use the Internet to solve a technical problem (e.g., using online Help in a computer software program)
    a) Never
    b) A few times each year
    c) Several times a month
    d) A few times each week
    e) Almost daily

8) Students complete digital instructional tutorials
    a) Never
    b) A few times each year
    c) Several times a month
    d) A few times each week
    e) Almost daily

9) Students create multimedia projects utilizing at least two of the following elements; audio, video, animation, or still images
   a) Never
   b) A few times each year
   c) Several times a month
   d) A few times each week
   e) Almost daily

10) Students complete page layout projects with page layout software (e.g., Adobe InDesign, Quark Xpress, or similar)
   a) Never
   b) A few times each year
   c) Several times a month
   d) A few times each week
   e) Almost daily

11) Students manipulate digital bitmap images with image editing software (e.g., Adobe Photoshop or similar)
   a) Never
   b) A few times each year
   c) Several times a month
   d) A few times each week
   e) Almost daily

12) Students create object oriented/vector digital illustrations or designs (e.g., Adobe Illustrator, Freehand, Corel Draw, or similar)
   a) Never
   b) A few times each year
   c) Several times a month
   d) A few times each week
   e) Almost daily

13) Students create or edit Web pages using a visual or WYSIWYG editor (e.g., Adobe Dreamweaver, Adobe GoLive, Microsoft FrontPage, or similar

a) Never
b) A few times each year
c) Several times a month
d) A few times each week
e) Almost daily

14) Students create or edit Web pages by typing HTML code

a) Never
b) A few times each year
c) Several times a month
d) A few times each week
e) Almost daily

15) Students create or edit digital spreadsheets (e.g., Microsoft Excel, Apple Numbers, or similar)

a) Never
b) A few times each year
c) Several times a month
d) A few times each week
e) Almost daily

16) Students create or edit digital databases (e.g., Microsoft Access, Filemaker, or similar)

a) Never
b) A few times each year
c) Several times a month
d) A few times each week
e) Almost daily

17) Students create or edit digital animations (e.g., Adobe Flash, or similar)

a) Never
b) A few times each year
c) Several times a month
d) A few times each week
e) Almost daily

Appendix G

Pre-Notice E-mail Letter

Sent on March 7th, 2009

Dear graphic communication educator,

A few days from now you will receive an email with a request to participate in a research study of “Digital Technologies in Graphic Communication Education,” which I’m conducting as part of my doctoral program at Virginia Tech.

The online survey should take approximately 20 minutes, and your participation will directly benefit the field of graphic communication by providing an educator's viewpoint.

I am sending out this initial e-mail so that you can be on the lookout for the e-mail containing the survey link.

Your involvement in this study is greatly appreciated!

Sincerely,

Charles T. Weiss

Appendix H

Letter of Consent – Invitation to Participate E-mail

Sent on March 11th, 2009

Dear Graphic Communication Educator,

This email is an invitation to participate in a research study of "Digital Technologies in Graphic Communication Education," which I'm conducting as part of my doctoral program at Virginia Tech. Your involvement in this study is greatly appreciated!

The purpose of this study is to investigate: 1) the use of digital technologies in graphic communication classrooms; and, 2) the instructional practices of graphic communication educators.

You are one of 900 selected participants. Your name is included because of your involvement with graphic communication education, and your affilitation with one of the following sources: (1) the International Graphic Arts Education Association; (2) the Graphic Arts Technical Foundation; (3) the Graphic Arts Technical Association of Illinois; (4) the Print and Graphics Scholarship Foundation; and, (5) the Graphic Comm Central Project/ListServ.

After reading this consent letter, you may choose to participate in this study by clicking on the LoTi Lounge "link" at the bottom of this page. This online survey will take up to 20 minutes to complete. Completing the survey poses *no* risk to you, because your responses will be kept anonymous and no individual data (only aggregated data) will be reported. While this study will not result in any direct benefit or compensation to you, your responses WILL benefit the field of graphic communication by providing an educator's viewpoint.

Your participation in this study is completely voluntary. You are free to withdraw from the study at any time without penalty and may choose not to answer any questions you prefer not to answer.

By agreeing to participate in this study, you have the responsibility of honestly answering the survey questions to the best of your ability.

THANKS for taking the time to help me with my doctoral dissertation research!
~ Charles Weiss

By completing and submitting this online questionnaire, I indicate my willingness to participate in this study.

LoTi Lounge Instructions for New Users

1. Access the LoTi Lounge a http://www.lotilounge.com/

2. Click on the link that says 'Sign Me Up!' (in the 'I'm a New User' section of the LoTi Lounge login block) to complete a ONE TIME registration sequence that will identify you as part of the Weiss Dissertation Study.

3. Follow the registration instructions on the screen. You will first be prompted to enter your Group ID and Password.
Group ID: weiss
Password: weiss

4. Next, you will be prompted to enter your User Information including a User ID and Password of your choosing (NOT the Group ID and Password given above). This User ID and password should be something you will remember as it is what you will use to login to LoTi Lounge in the future.

5. Next, you will be prompted to enter your Email address. Entering a valid email address is necessary to have full access to LoTi Lounge. By doing this you will be able to save and complete your survey at another time. Your e-mail address will NOT be directly linked to your response, and your responses WILL be kept anonymous.

6. Finally, you will be prompted to select "Weiss Dissertation Study" from a structural list that has already been entered into the computer based on the Group ID you were given. Choose "Weiss Dissertation Study" and click 'Continue' to complete the registration process.

If you have any additional questions about this study please contact Charles Weiss, telephone: (309) 298-1488; or e-mail CT-Weiss@wiu.edu.

If you should have any questions about the protection of human research participants regarding this study, you may contact Dr. David Moore, Chair Virginia Tech Institutional Review Board for the Protection of Human Subjects, telephone: (540) 231-4991; email: moored@vt.edu; address: Office of Research Compliance, 2000 Kraft Drive, Suite 2000 (0497), Blacksburg, VA 24060.

Appendix I

Reminder E-mail #1

Sent on March 16th, 2009

Graphic Communication Educators,

If you have already filled out your survey, THANKS!

If you have not had a chance to fill out your survey, or had problems logging into the LoTi Lounge, please take a few minutes and do so now. Your input will help create a research basis from the edcuator's viewpoint.

As an added benefit of filling out the survey, you will also be given a snapshot of your current teaching practices through three different scales: (1) *Personal Computer Use*, (2) *Current Instructional Practices*, and (3) Level of Technology Implementation. Your ratings on each scale along with an explanation of each will be given to you upon your completion of the survey.

If you had problems logging into the survey, follow the steps below and simply use a new login and password. Your login is part of the LoT Lounge and is not part of my research. Please make sure you follow step 4 (below) to correctly complete your registration.

Thanks for your input and time...

~ charles

LoTi Lounge Instructions for New Users

1. Access the LoTi Lounge a http://www.lotilounge.com/

2. Click on the link that says 'Sign Me Up!' (in the 'I'm a New User' section of the LoTi Lounge login block) to complete a ONE TIME registration sequence that will identify you as part of the Weiss Dissertation Study.

3. Follow the registration instructions on the screen. You will first be prompted to enter your Group ID and Password.
Group ID: weiss
Password: weiss

4. Next, you will be prompted to enter your User Information including a User ID and Password of your choosing (NOT the Group ID and Password given above). This User ID and password should be something you will remember as it is what you will use to login to LoTi Lounge in the future. In order to continue your registration you need to answer something for both pull-downs. **Please select "Multiple Grade Levels Apply" from the**

Grade Level and "Technology" from the Subject Area Drop-Downs. There are no pull-downs for post-secondary educators, so please use the suggested pull-downs to register. These are a requirement of the LoTi Lounge registration, and not part of this study's research.

5. Next, you will be prompted to enter your Email address. Entering a valid email address is necessary to have full access to LoTi Lounge. By doing this you will be able to save and complete your survey at another time. Your e-mail address will NOT be directly linked to your response, and your responses WILL be kept anonymous.

6. Finally, you will be prompted to select "Weiss Dissertation Study" from a structural list that has already been entered into the computer based on the Group ID you were given. Choose "Weiss Dissertation Study" and click 'Continue' to complete the registration process.

If you have any additional questions about this study please contact Charles Weiss, telephone: (309) 298-1488; or e-mail CT-Weiss@wiu.edu.

If you should have any questions about the protection of human research participants regarding this study, you may contact Dr. David Moore, Chair Virginia Tech Institutional Review Board for the Protection of Human Subjects, telephone: (540) 231-4991; email: moored@vt.edu; address: Office of Research Compliance, 2000 Kraft Drive, Suite 2000 (0497), Blacksburg, VA 24060.

Appendix J

Reminder E-mail #2

Sent on March 20th, 2009

What's the dpi of a typical Web image? 72

What's the dpi of a good quality print image? 300 or more

Just like the quality of an image increases with higher dpi, so does my research. The more responses I receive, the better my research is going to be!

So, if you have not had a chance, please login and complete your survey...

thanks ~ charles

Instructions to Access the Graphic Communication Education Research Survey

1. Access the LoTi Lounge a http://www.lotilounge.com/

2. Click on the link that says 'Sign Me Up!' (in the 'I'm a New User' section of the LoTi Lounge login block) to complete a ONE TIME registration sequence that will identify you as part of the Weiss Dissertation Study.

3. Follow the registration instructions on the screen. You will first be prompted to enter your Group ID and Password.
Group ID: weiss
Password: weiss

4. Next, you will be prompted to enter your User Information including a User ID and Password of your choosing *(NOT the Group ID and Password given above)*. This User ID and password should be something you will remember as it is what you will use to login to LoTi Lounge in the future. In order to continue your registration you need to answer something for both pull-downs. **Please select "Multiple Grade Levels Apply" from the Grade Level and "Technology" from the Subject Area Drop-Downs**. There are no pull-downs for post-secondary educators, so please use the suggested pull-downs to register. These are a requirement of the LoTi Lounge registration, and not part of this study's research.

5. Next, you will be prompted to enter your Email address. Entering a valid email address is necessary to have full access to LoTi Lounge. By doing this you will be able to save and complete your survey at another time. Your e-mail address will NOT be directly linked to your response, and your responses WILL be kept anonymous.

6. Finally, you will be prompted to select “Weiss Dissertation Study” from a structural list that has already been entered into the computer based on the Group ID you were given. Choose “Weiss Dissertation Study” and click 'Continue' to complete the registration process.

If you have any additional questions about this study please contact Charles Weiss, telephone: (309) 298-1488; or e-mail CT-Weiss@wiu.edu.

If you should have any questions about the protection of human research participants regarding this study, you may contact Dr. David Moore, Chair Virginia Tech Institutional Review Board for the Protection of Human Subjects, telephone: (540) 231-4991; email: moored@vt.edu; address: Office of Research Compliance, 2000 Kraft Drive, Suite 2000 (0497), Blacksburg, VA 24060.

Appendix K

Final Thank You E-mail

Sent on March 25th, 2009

First of all, thanks to everyone who has completed a survey! Your input will not only help me with my research, it will also give graphic communication educators a chance to show off what they are doing. I hope to publish an article related to this early next fall. Be on the lookout!

If you have been waiting for the right time to complete the survey, how about doing it right now?

The survey will be available through the end of this weekend (March 29th) so you still have time to complete it.

One final note that will probably make all of you happy... This will be the last time you hear from me :-)

I really appreciate your input, and hope the best for all the graphic communication programs out there...

Best Regards ~ charles

Instructions to Access the Graphic Communication Education Research Survey

1. Access the LoTi Lounge a http://www.lotilounge.com/

2. Click on the link that says 'Sign Me Up!' (in the 'I'm a New User' section of the LoTi Lounge login block) to complete a ONE TIME registration sequence that will identify you as part of the Weiss Dissertation Study.

3. Follow the registration instructions on the screen. You will first be prompted to enter your Group ID and Password.
Group ID: weiss
Password: weiss

4. Next, you will be prompted to enter your User Information including a User ID and Password of your choosing *(NOT the Group ID and Password given above)*. This User ID and password should be something you will remember as it is what you will use to login to LoTi Lounge in the future. In order to continue your registration you need to answer something for both pull-downs. **Please select "Multiple Grade Levels Apply" from the Grade Level and "Technology" from the Subject Area Drop-Downs**. There are no pull-downs for post-secondary educators, so please use the suggested pull-downs

to register. These are a requirement of the LoTi Lounge registration, and not part of this study's research.

5. Next, you will be prompted to enter your Email address. Entering a valid email address is necessary to have full access to LoTi Lounge. By doing this you will be able to save and complete your survey at another time. Your e-mail address will NOT be directly linked to your response, and your responses WILL be kept anonymous.

6. Finally, you will be prompted to select "Weiss Dissertation Study" from a structural list that has already been entered into the computer based on the Group ID you were given. Choose "Weiss Dissertation Study" and click 'Continue' to complete the registration process.

If you have any additional questions about this study please contact Charles Weiss, telephone: (309) 298-1488; or e-mail CT-Weiss@wiu.edu.

If you should have any questions about the protection of human research participants regarding this study, you may contact Dr. David Moore, Chair Virginia Tech Institutional Review Board for the Protection of Human Subjects, telephone: (540) 231-4991; email: moored@vt.edu; address: Office of Research Compliance, 2000 Kraft Drive, Suite 2000 (0497), Blacksburg, VA 24060.

Appendix L

Location

In which U.S. state is your school, college, or university located in? (e.g., Indiana, New York, etc.)

Response	n	%
Alabama	3	1.6
Arizona	3	1.6
California	4	2.1
Colorado	2	1.0
Delaware	1	.5
Florida	2	1.0
Georgia	7	3.7
Illinois	18	9.4
Indiana	3	1.6
Iowa	4	2.1
Kansas	4	2.1
Kentucky	3	1.6
Louisiana	1	.5
Maine	2	1.0
Maryland	5	2.6
Massachusetts	9	4.7
Michigan	11	5.8
Minnesota	5	2.6
Mississippi	1	.5
Missouri	3	1.6
Nebraska	1	.5
New Hampshire	2	1.0
New Jersey	4	2.1
New York	10	5.2
North Carolina	7	3.7
Ohio	9	4.7
Oklahoma	4	2.1
Pennsylvania	15	7.9
Rhode Island	2	1.0
South Carolina	8	4.2

Texas	9	4.7
Utah	1	.5
Virginia	5	2.6
Washington	1	.5
West Virginia	1	.5
Wisconsin	8	4.2
Wyoming	1	.5
British Columbia, Canada	1	.5
Nairobi, Kenya	1	.5
Athens, Greece	1	.5

Note. *n* = 182.

Appendix M

Years Teaching

How many total years of teaching experience do you have in graphic communication education? (Please enter actual number, i.e. 12)

Response	n	%
2	5	2.6
3	4	2.1
4	2	1.0
5	3	1.6
6	7	3.7
7	7	3.7
8	9	4.7
9	9	4.7
10	12	6.3
11	7	3.7
12	12	6.3
13	5	2.6
14	6	3.1
15	12	6.3
16	5	2.6
17	4	2.1
18	9	4.7
19	2	1.0
20	6	3.1
21	1	.5
22	5	2.6
23	4	2.1
24	2	1.0
25	13	6.8
26	2	1.0
27	2	1.0
28	4	2.1
29	3	1.6
30	6	3.1
31	3	1.6

32	2	1.0
33	1	.5
34	2	1.0
35	3	1.6
36	2	1.0
37	2	1.0
38	1	.5
39	2	1.0
40	1	.5
41	1	.5
42	1	.5
43	1	.5

Note. n = 190.

Appendix N

Age

What is your age? (Please enter actual number, i.e. 41)

Response	n	%
27	2	1.0
29	3	1.6
31	1	.5
32	1	.5
33	2	1.0
34	2	1.0
35	2	1.0
36	2	1.0
37	2	1.0
38	4	2.1
39	4	2.1
40	7	3.7
41	4	2.1
42	4	2.1
43	3	1.6
44	9	4.7
45	8	4.2
46	6	3.1
47	8	4.2
48	10	5.2
49	7	3.7
50	6	3.1
51	3	1.6
52	9	4.7
53	12	6.3
54	6	3.1
55	8	4.2
56	7	3.7
57	9	4.7
58	5	2.6
59	4	2.1

60	5	2.6
61	5	2.6
62	3	1.6
63	4	2.1
64	5	2.6
66	2	1.0
68	2	1.0

Note. n = 186.

Appendix O

Number of Instructional Computers

How many computers do you have for instructional use by your students in your graphic communication classroom? (Please enter actual number, i.e. 8)

Response	n	%
0	1	.5
1	1	.5
6	1	.5
8	2	1.0
9	1	.5
10	2	1.0
12	4	2.1
13	2	1.0
14	7	3.7
15	5	2.6
16	8	4.2
17	4	2.1
18	11	5.8
19	3	1.6
20	25	13.1
21	3	1.6
22	11	5.8
23	2	1.0
24	11	5.8
25	18	9.4
26	6	3.1
27	2	1.0
28	5	2.6
29	1	.5
30	12	6.3
31	2	1.0
32	3	1.6
33	1	.5
34	5	2.6
35	3	1.6

36	1	.5
38	1	.5
40	7	3.7
41	1	.5
47	1	.5
48	2	1.0
50	1	.5
52	1	.5
55	1	.5
60	2	1.0
65	1	.5
72	1	.5
75	3	1.6
102	1	.5
110	1	.5
114	1	.5
120	1	.5

Note. *n* = 189.

Appendix P

Number of Training Hours

How many hours of digital technology-related training have you received over the past two years? (Please estimate and enter an actual number, i.e. 20)

Response	n	%
0	24	12.6
2	6	3.1
3	1	.5
4	6	3.1
5	12	6.3
6	4	2.1
8	6	3.1
9	1	.5
10	11	5.8
12	5	2.6
15	7	3.7
16	1	.5
18	1	.5
20	15	7.9
24	6	3.1
25	4	2.1
28	1	.5
30	7	3.7
32	4	2.1
35	4	2.1
36	2	1.0
40	20	10.5
45	1	.5
48	1	.5
50	9	4.7
54	1	.5
60	4	2.1
64	3	1.6
75	1	.5
80	8	4.2

90	2	1.0
100	2	1.0
120	3	1.6
150	1	.5
160	2	1.0
200	1	.5
300	1	.5
576	1	.5
2400	1	.5

Note. n = 190.

Appendix Q

Research Question #3 LoTi Correlation Matrix

Correlations

		Level of Technology Implementation (LoTi)	Gender of Educator	Classroom Internet Connection	Educator's Region	Age of Educator	Number of Hours of Digital Technology-Related Training	Educator's Total Years of Graphic Communication Teaching Experience	Educator's Primary Grade Level	Educator's Highest Level of Education	Number of Computers in Educator's Graphic Communication Classroom	Personal Computer Use (PCU)
Pearson Correlation	Level of Technology Implementation (LoTi)	1.000	-.002	-.223	-.013	-.154	.175	-.155	.117	.181	.214	.419
	Gender of Educator	-.002	1.000	.115	-.088	-.202	-.116	-.316	-.089	-.102	-.128	.071
	Classroom Internet Connection	-.223	.115	1.000	-.018	-.046	.008	.043	.081	.021	.209	.092
	Educator's Region	-.013	-.088	-.018	1.000	.105	-.109	-.058	.065	.061	.028	-.095
	Age of Educator	-.154	-.202	-.046	.105	1.000	-.158	.613	.010	-.050	.083	-.165
	Number of Hours of Digital Technology-Related Training	.175	-.116	.008	-.109	-.158	1.000	.059	.033	-.008	.227	.119
	Educator's Total Years of Graphic Communication Teaching Experience	-.155	-.316	.043	-.058	.613	.059	1.000	.057	.206	.158	-.083
	Educator's Primary Grade Level	.117	-.089	.081	.065	.010	.033	.057	1.000	.419	.269	.057
	Educator's Highest Level of Education	.181	-.102	.021	.061	-.050	-.008	.206	.419	1.000	.258	.109
	Number of Computers in Educator's Graphic Communication Classroom	.214	-.128	.209	.028	.083	.227	.158	.269	.258	1.000	.100
	Personal Computer Use (PCU)	.419	.071	.092	-.095	-.165	.119	-.083	.057	.109	.100	1.000
Sig. (1-tailed)	Level of Technology Implementation (LoTi)	.	.492	.002	.436	.025	.013	.025	.069	.011	.003	.000
	Gender of Educator	.492	.	.073	.134	.005	.070	.000	.130	.098	.052	.186
	Classroom Internet Connection	.002	.073	.	.410	.280	.459	.296	.153	.396	.004	.122
	Educator's Region	.436	.134	.410	.	.092	.084	.232	.207	.220	.362	.115
	Age of Educator	.025	.005	.280	.092	.	.022	.000	.451	.264	.147	.018
	Number of Hours of Digital Technology-Related Training	.013	.070	.459	.084	.022	.	.226	.341	.459	.002	.065
	Educator's Total Years of Graphic Communication Teaching Experience	.025	.000	.296	.232	.000	.226	.	.234	.004	.022	.145
	Educator's Primary Grade Level	.069	.130	.153	.207	.451	.341	.234	.	.000	.000	.237
	Educator's Highest Level of Education	.011	.098	.396	.220	.264	.459	.004	.000	.	.000	.084
	Number of Computers in Educator's Graphic Communication Classroom	.003	.052	.004	.362	.147	.002	.022	.000	.000	.	.103
	Personal Computer Use (PCU)	.000	.186	.122	.115	.018	.065	.145	.237	.084	.103	.

Note. N = 162.

Appendix R

Research Question #5 CIP Correlation Matrix

Correlations

		Current Instructional Practices (CIP)	Gender of Educator	Classroom Internet Connection	Educator's Region	Age of Educator	Number of Hours of Digital Technology-Related Training	Educator's Total Years of Graphic Communication Teaching Experience	Educator's Primary Grade Level	Educator's Highest Level of Education	Number of Computers in Educator's Graphic Communication Classroom	Personal Computer Use (PCU)
Pearson Correlation	Current Instructional Practices (CIP)	1.000	.040	.025	-.076	-.117	.143	-.079	.111	.146	.202	.382
	Gender of Educator	.040	1.000	.115	-.088	-.202	-.116	-.316	-.089	-.102	-.128	.071
	Classroom Internet Connection	.025	.115	1.000	-.018	-.046	.008	.043	.081	.021	.209	.092
	Educator's Region	-.076	-.088	-.018	1.000	.105	-.109	-.058	.065	.061	.028	-.095
	Age of Educator	-.117	-.202	-.046	.105	1.000	-.158	.613	.010	-.050	.083	-.165
	Number of Hours of Digital Technology-Related Training	.143	-.116	.008	-.109	-.158	1.000	.059	.033	-.008	.227	.119
	Educator's Total Years of Graphic Communication Teaching Experience	-.079	-.316	.043	-.058	.613	.059	1.000	.057	.206	.158	-.083
	Educator's Primary Grade Level	.111	-.089	.081	.065	.010	.033	.057	1.000	.419	.269	.057
	Educator's Highest Level of Education	.146	-.102	.021	.061	-.050	-.008	.206	.419	1.000	.258	.109
	Number of Computers in Educator's Graphic Communication Classroom	.202	-.128	.209	.028	.083	.227	.158	.269	.258	1.000	.100
	Personal Computer Use (PCU)	.382	.071	.092	-.095	-.165	.119	-.083	.057	.109	.100	1.000
Sig. (1-tailed)	Current Instructional Practices (CIP)	.	.309	.377	.169	.068	.035	.160	.080	.032	.005	.000
	Gender of Educator	.309	.	.073	.134	.005	.070	.000	.130	.098	.052	.186
	Classroom Internet Connection	.377	.073	.	.410	.280	.459	.296	.153	.396	.004	.122
	Educator's Region	.169	.134	.410	.	.092	.084	.232	.207	.220	.362	.115
	Age of Educator	.068	.005	.280	.092	.	.022	.000	.451	.264	.147	.018
	Number of Hours of Digital Technology-Related Training	.035	.070	.459	.084	.022	.	.226	.341	.459	.002	.065
	Educator's Total Years of Graphic Communication Teaching Experience	.160	.000	.296	.232	.000	.226	.	.234	.004	.022	.145
	Educator's Primary Grade Level	.080	.130	.153	.207	.451	.341	.234	.	.000	.000	.237
	Educator's Highest Level of Education	.032	.098	.396	.220	.264	.459	.004	.000	.	.000	.084
	Number of Computers in Educator's Graphic Communication Classroom	.005	.052	.004	.362	.147	.002	.022	.000	.000	.	.103
	Personal Computer Use (PCU)	.000	.186	.122	.115	.018	.065	.145	.237	.084	.103	.

Note. N= 162.

Appendix S

Virginia Tech IRB Approval

VirginiaTech

Office of Research Compliance
Carmen T. Green, IRB Administrator
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24061
540/231-4358 Fax 540/231-0959
e-mail ctgreen@vt.edu
www.irb.vt.edu
FWA00000572(expires 1/20/2010)
IRB # is IRB00000667

DATE: February 18, 2009

MEMORANDUM

TO: Mark E. Sanders
Charles Weiss

FROM: Carmen Green

SUBJECT: **IRB Exempt Approval:** "Use of Digital Technologies in Graphic Communication Education" , IRB # 09-109

I have reviewed your request to the IRB for exemption for the above referenced project. The research falls within the exempt status. Approval is granted effective as of February 18, 2009.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in the research protocol. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.

2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

cc: File

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Appendix T

LoTi Connection Approval

LoTi Connection, Inc.
PO Box 130037 Carlsbad, CA 92013-0037
(V) 760-431-2232 (F) 760-946-7605
www.loticonnection.com

Permission for Use of the LoTi Framework

May 12th, 2009

To: Virginia Tech
Dissertation Review Boards

Please accept this letter as notification that Mr. Charles Weiss is hereby granted permission to utilize the LoTi Framework and corresponding LoTi Questionnaire to collect data for his doctoral dissertation study. Mr. Weiss is permitted to use the LoTi Questionnaire and the LoTi Framework for purposes of the study only. In addition, Mr. Weiss has permission to review all available LoTi Questionnaire results on the individuals taking place in his study.

The guidelines for using LoTi Connection copyrighted material as part of this dissertation study are as follows:

1. Permission to reprint the LoTi Framework is granted provided that the content remains unchanged and that attribution is given to LoTi Connection.
2. Permission to reprint selected questions from the LoTi Questionnaire in the Appendices of the study is granted provided that the content remains unchanged and that attribution is given to LoTi Connection.
3. LoTi Connection holds the right to restrict usage of any intellectual property if LoTi Connection finds that the content is being used in an inappropriate manner.

Sincerely,

Dennee Saunders
Assistant Executive Director

Date 05/12/2009