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A SURVEY OF DIGITAL MUSIC TECHNOLOGY IMPLEMENTATION BY GRADUATE AND UNDERGRADUATE PIANO PEDAGOGY FACULTY IN AMERICAN COLLEGES AND UNIVERSITIES

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

Doctor of Philosophy

By

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A DISSERTATION APPROVED FOR THE
SCHOOL OF MUSIC

BY

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Finally, to my Creator: Soli Deo Gloria!

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Abstract

A Survey of Digital Music Technology Implementation by Graduate and Undergraduate Piano Pedagogy Faculty in American Colleges and Universities

By: Leonard Thomas Stampfli, Jr.

Major Professor: Dr. Nancy Barry

The purpose of this study was to assess the current level of adoption and diffusion of specific digitally based instructional and music technologies by pedagogues in American graduate and undergraduate pedagogy programs. Data were collected from faculty members who listed piano pedagogy as an area of teaching interest in the *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2005-2006*. The questionnaire sought information about faculty pedagogues, their attitudes toward and usage of generic and digital music instructional technology, and their categorization as Innovators, Early Adopters, Early Majority, Late Majority, and Laggards according to Rogers' (2003) model of technology adoption and diffusion.

Based on 238 valid responses (34%), data results showed that the sample was 60.1% female. The majority (68.4%) belonged to 1 or more professional organizations, attended conferences annually (54.9%), with 42.2% attending at least 1 digital music workshop per conference. Respondents reported frequent usage of generic digital technologies but even greater use of digital music technologies. No significant gender effects were observed, but one-way ANOVA tests revealed that younger faculty members were significantly more likely to use digital music technologies ($F = 2.9$, $p = .023$). Significant correlations were observed between the usage of digital music technology and organizational memberships (r = .164), conference attendance (r = .157), and digital music workshop attendance (r = .492). Using correlation and regression tests, respondent attitudes were shown to be positively and significantly related to the use of generic digital technology and digital music instructional technology (r = .369, r = .664, respectively; p = .000).

Distributions of 4 new summative scales revealed high usage of both generic and digital music technologies, with generally positive faculty attitudes toward digital music technologies. Respondents were placed into Rogerian adoption categories. Similarities were observed between these 5 types of technology adopters and Rogers' (2003) bell-curve model, but a more linear adoption-diffusion pattern was observed than was predicted by Rogers' S-curve model.

A Survey of Digital Music Technology Implementation by Graduate and Undergraduate Piano Pedagogy Faculty in American Colleges and Universities

Chapter 1

The Problem

Introduction

During the latter half of the 20th century, a substantial proliferation of new computer-based technologies emerged that significantly reshaped the American culture. These digital electronic innovations influenced every facet of life, affecting workplace productivity, recreational habits, and educational strategies at all levels (Andrew, 1997). Many of these new technologies are embodied in the rapid development of the micro-computer or personal computer. The evolution of the personal computer, or PC, enabled individuals to manipulate, store, and retrieve vast amounts of information in radical new ways. Institutional networking and widespread Internet access opened powerful new means of communication (Phillips, 1992).

The music profession did not escape the impact of this technological revolution. Adaptations of these new technologies to the creation, performance, and instruction of music offered notable new options by which musicians could pursue their art (Dodge & Jerse, 1985, 1997; Williams & Webster, 1999). During the last three decades, digital technology resulted in the creation of entirely new electronic instruments, recording media, musical notation systems, and computer-based instructional formats. Williams and Webster emphasized the magnitude of these changes in the opening statement of the introduction to their textbook, *Experiencing Music Technology*, second edition, stating

> Computers and technology have quietly crept into the daily affairs of music making. Typewriters have given way to word processors. Musicians can achieve publication quality calligraphy through

> computer desktop notation. Music teachers have the aid of increasingly sophisticated surrogates through computer-based music instruction. Diverse electronic keyboards, drum machines, wind controllers, guitars, and the like easily communicate through the Music Instrument Digital Interface (MIDI). Desktop composing offers the palettes of musical elements and form to anyone from child to professional through computer sequencers and improvisers. . . . And words and acronyms like digital, DAT, DSP, MIDI, memory, and gigabytes are joining the musician's common lexicon, along with sampling and over-sampling audio, SMPTE, sequencing and quantizing, and the laser optical family of terms including CD-ROM, compact disc, and DVD. (p. xxv)

With continued growth and ever-increasing sophistication, both generic digital technologies (computers, presentation software, and various network technologies) and digital innovations directly adapted for musical activities (hereafter referred to as *music technology*) continue to impact many aspects of the music profession, including the instruction of music. The unprecedented long-term growth of digital computer technology enabled music technology's continual improvement in the areas of instrumental performance capability, computer program sophistication, and ease of use by the operator.

Regarding aspects of performance, composition, and education within the music field, these digital music technology advancements consistently influenced (some would say impinged upon) the profession’s paradigm throughout the last three decades (Bowman, 1996; Chappell, 1996). As the viability of music technology improved in terms of effectiveness, ease of use, and economic affordability, its informal dissemination became widespread (Lymenstull, 1991; Williams & Webster, 1999, 2005). Areas of continued interest include MIDI keyboard technology, computer technology, and MIDI recording technology. As new technological innovations such as CD-ROM, laserdisc (now replaced by DVD), and direct digital video recording were integrated with these previously mentioned technologies, the digital multimedia phenomenon came into existence. Digital multimedia workstations and digital music workstations opened new vistas for research and performance in the area of music (Chronister & Timmons, 1991). With improved networking capabilities and the growth in popularity and use of the World Wide Web as an information superhighway, the combinations possible for music technology continue to grow exponentially. The academic potential for this evolving technology continues to challenge the status quo in the field of music education.

During this same period of time, college and university music departments also experienced an increase in the establishment and growth of piano pedagogy programs (Kowalchyk, 1989; Renfrow, 1991b). This expansion of piano pedagogy as an academic discipline was not uniform in either its scope or curriculum. Developed according to the unique parameters of individual institutions and their instructors, college and university piano pedagogy programs ranged from single course offerings to complete degree tracks (*Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 1997-1998*; *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 1998-1999*; *Directory of Music Faculties, in Colleges and Universities, U.S. and Canada, 1999-2000*; *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2000-2001*; *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2001-2002*; *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2002-2003*; *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2003-2004*; *Directory of Music Faculties, in Colleges and Universities, U.S. and Canada, 2004-2005*; *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2005-2006*). Pedagogy curricula often were based upon the instructors' educational backgrounds and personal teaching experiences, rather than a compendium of standardized curricular guidelines (Kowalchyk, 1989). Guidelines of this type are usually researched and disseminated by appropriate professional organizations such as the *Music Educators National Conference* (MENC) and administered by accrediting bodies such as the *National Association of Schools of Music* (NASM, 1995, 1996, 2003). Prior to the mid-1970s, piano pedagogy appeared to lack the professional unity needed to achieve widespread acceptance as a viable profession, worthy of specific degree tracks at the undergraduate or graduate level (Kowalchyk, 1989).

During the last 30 years, individual piano pedagogy leaders and professional education organizations made notable attempts to remedy this problem. With the establishment of the *National Conference on Piano Pedagogy* in 1979, leaders within the profession started to examine and disseminate information systematically concerning the trends and curricular developments regarding piano teaching and teacher qualifications (Chronister & Timmons, 1993). The efforts of this newly established professional organization were validated in 1985 when the *National Association of Schools of Music* added pedagogy to its list of accredited degree offerings, including a list of competencies, standards, guidelines, and recommendations for undergraduate and graduate degree plans (NASM, 1986). Other evidence of piano pedagogy's professional validity included the establishment of the *World Piano Pedagogy Conference* in 1996 and the *Music Teachers National Association, Pedagogy Saturday* in 1997.

Need for the Study

Significant improvement in computer-based hardware occurred during the last 30 years. No longer depending entirely upon the internal resources of the individual computer platform, the IBM PC and Apple Macintosh computers of the late 1980s and the 1990s offered greater multimedia possibilities, working in combination with enhanced hardware peripherals (Bowen, 1999; Kunitz, 1988; Uszler, Gordon, & Smith, 2000). With the substantial enhancement of PC computing power and reliability, the music industry gradually replaced older hardware sequencers with computer analogs, software-based sequencing and digital audio recording applications that were more powerful, efficient, and easier to use (Abeles, Hoffer, & Klotman, 1994; Rudolph, 2004). The computer and music technology markets also offered new software for multimedia presentation, music notation, MIDI recording, digital-audio recording, and interactive multimedia applications for individualized music instruction (Berr, 2000; Brandom & Purcell-Engler, 1992; Uszler, Gordon, & Smith, 1991, 2000; Williams & Webster, 1999, 2005).

In 1983, the major keyboard manufacturers collectively introduced a standardized control interface for keyboards known as MIDI 1. By the mid 1990s, the MIDI 1 protocol was universally accepted by computer and electronic keyboard manufacturers as the standard keyboard communications interface. Manufacturers developed a variety of MIDI piano keyboards, workstations, and their peripherals, capable of producing an amazing selection of electronic and traditional instrumental sounds (International Association of Electronic Keyboard Manufacturers, 2002). Throughout the 1980s and 1990s, market indicators confirmed that the American consumer continued to be quite willing to invest in computers and various types of music technology (Abeles et al., 1994; Dodge & Jerse, 1997; Rona, 1994, Williams & Webster, 2005).

As 21st century consumers continually purchase digital music technology for personal use, its influence on current and potential students, whether positive or negative, cannot be ignored (Williams & Webster, 2005). Guiding students in the use of music technology presents a continuing challenge to keyboard teachers at most levels of the discipline (LeBaron, 2001; Renfrow, 1991a). Recognition of the importance of this challenge is evidenced by the increased interest shown by various prestigious and established professional music education organizations: National Association of Schools of Music (NASM), National Conference on Piano Pedagogy (NCPP), Music Educator's National Conference (MENC), the World Piano Pedagogy Conference (WPPC), and the National Conference on Keyboard Pedagogy (NCKP). The leading periodicals and professional journals representing piano teachers at all levels (*American Music Teacher*, *Clavier*, *Keyboard Companion*, *Piano Pedagogy Forum*, etc.) have presented many articles discussing the existence, impact, and challenges of technology on the profession.

What is still not evident is the actual diffusion (level of use) regarding music technology by current college and university piano pedagogues. This includes the degree of personal use employed by pedagogues in their professional activities and class preparation, as well as the level of attention these technologies receive in their programs' respective curricula. Some researchers gauge the success of future technology use by how contemporary educators view and utilize these digital tools in their current classes (Andrew, 1997). Andrew's study indicates that classroom educators who demonstrate distaste or timidity when exposing students to these digital innovations negatively affect the teaching outcomes and the students' attitudes towards specific digital technologies.

In her 1989 study profiling piano pedagogy instructors at American colleges and universities, Kowalchyk noted

> Current piano pedagogy instructors are not concerned with computer technology, electronic keyboards or synthesizers. By ranking Keyboard/Synthesizers/Computer Technology ninth out of the eleven recommended courses for future instructors, they seem to be paying little attention to technological advances in keyboard instruments. Electronic keyboard instrument sales currently outnumber acoustic piano sales. Undoubtedly, there will be a growing market of youngsters who want to play electronic keyboards. (p. 106)

Kowalchyk went on to point to the current and future impact of these instruments upon the piano teaching profession. She suggested that future teachers need training in the increasingly sophisticated area of digital keyboard and computer technology, implying that this was the responsibility of piano pedagogues.

During the 17 years since Kowalchyk's (1989) study, the capabilities and potential benefits of digital music technology grew with the frequent appearance of new digital innovations. Similar growth in digital instructional technology also took place during this same time period. Unlike their counterparts in music technology, researchers generated a number of adoption and diffusion studies related to emerging generic instructional technologies. These studies sought to determine the actual level of use in a variety of workplace and educational scenarios, as opposed to simply assuming that the possession of a technology was equivalent to its adoption or use by individuals (Beynon & MacKay, 1993; Holloway, 1977, 1996; Rogers, 1995, 2003). A review of the pertinent literature by this author revealed no similar diffusion and adoption studies related to the use of digital music technology within American institutions of higher learning. This is particularly true of relevant studies pertaining to American undergraduate and graduate piano pedagogy programs. After almost two decades of change, it now seems appropriate to revisit this facet of piano pedagogy assessment.

College and university pedagogy instructors already teach a generation of music students familiar with at least some of this digital technology. Many of these students harbor personal expectations regarding the incorporation of digital technology within their education (Uszler, Gordon, & Smith, 2000). Since the profession's future piano and keyboard teachers will likely come from the current population of university and college pedagogy students, it seems prudent to ascertain the current value piano pedagogues place on various digital technologies (LeBaron, 2001). This can best be achieved by investigating the actual use or implementation of these innovations rather than the potential use of music technology by current collegiate piano pedagogues. An assessment of the status of personal use of digital technology by pedagogues and its curricular integration within their degree programs should provide a better understanding of the actual diffusion of music technology within the undergraduate and graduate piano pedagogy community.

Purpose of the Study

The purpose of this study is to assess the current level of diffusion and adoption of specific digitally based instructional and music technologies by piano pedagogues in American graduate and undergraduate pedagogy programs. Based upon reported use, the objectives of this study are to

1. Identify profiles of piano pedagogy faculty who use, and do not use, certain *generic digital instructional* technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject;
2. Identify profiles of piano pedagogy faculty who use, and do not use, specific *digital music* technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject;
3. Identify the specific attitudes of the overall sample, and of demographic and

pedagogical subgroups of respondents, related to implementation or non-implementation of generic digital instructional or digital music technologies;

4. Examine the relationship between faculty instructional technology adoption and usage and digital music technology adoption and usage; and
5. Compare the patterns of generic digital instructional and digital music technology usage with the five-part adopter categories of the Rogerian typology concerning the adoption of innovations.

Limitations

This study followed a standard model for the diffusion and adoption of innovations. This author examined the diffusion of specific educational and musical innovations, hereafter referred to as digital music technology and generic digital instructional technology (IT) that have been established within the last 10 to 15 years. Many of these innovations should be available within the average music department of American colleges and universities. While this study may contribute to a better assessment of the current state of adoption and diffusion of digital technology within the piano pedagogy community, it only touched on a fraction of the factors concerned with the change process. Regarding the proposed adoption and diffusion model for this study, a number of factors in the change process that leads to innovation use were not pursued or statistically controlled. Among these was the means by which information concerning an innovation is spread throughout the target population (Holloway, 1977).

With the exception of demographic information, the objective survey instrument was predominantly composed of (a) closed-ended questions, (b) open-ended questions, and (c) Likert-type scale items. While the survey questions offered participants the opportunity to comment on various areas of interest, the information gained through this survey revealed some unanticipated factors of causality in the change process, but probably missed information available through alternative question formats.

Some of the technological objectives presented in the Renfrow (1991a) dissertation were not considered in this study. Since the publication of Renfrow's (1991a) study, newer IT innovations replaced some of the technologies that were in use during his study (Carter, 1998; Rogers, 2003). Some of these older technologies are no longer commercially available. In their place, manufacturers now market similar technologies, claiming that these innovations provide better efficiency and reliability than their predecessors (Cuban, 2001; Williams & Webster, 2005).

Renfrow (1991a) derived his study population from the second edition of the *Directory of Piano Pedagogy Offerings in American Colleges and Universities* (National Conference on Piano Pedagogy, 1991), published and maintained by the now defunct National Conference on Piano Pedagogy. As this list is no longer accurate and no other dedicated piano pedagogy directory is available, the current study population was derived from those faculty members who listed piano pedagogy as an area of teaching interest in the *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2005-2006*.

Definition of Terms

The following list of definitions aids in the understanding of specific terms generally used in adoption and diffusion studies. This section also defines potentially unfamiliar terms related to generic instructional technology and music-related technology.

<u>Adopter:</u> piano pedagogy faculty member who has implemented or who is in the process of implementing one or more of the innovations listed in the survey instrument.

Computer-Assisted Music Instruction Software (CAI): also referred to as *computer-based instruction* (CBI). These applications can be divided into three categories of use: drill-and-practice, flexible practice, and simulation (offering multiple approaches and choices of study). These categories are listed in an ascending order of hardware requirements and programming sophistication. Each category represents a different level of flexibility for the student (user) and instructor (facilitator), with simulation providing the most user-based options (Williams & Webster, 1999).

Computer-Based Music Notation Software: application that allows the user to create music notation through the computer keyboard or a combination of the computer keyboard and a MIDI piano keyboard, connected by a MIDI interface.

Diffusion: process that allows an innovation to be communicated through specific channels over time among the members of the social system or group (Rogers, 1995).

Digital Keyboards: portable keyboards without a built-in stand. These instruments vary in size, price, and onboard features. Some models offer weighted keys that produce louder or softer tones depending upon the velocity with which the key is struck. While less expensive keyboards in this category contain internal sound systems, portable keyboards produced as professional equipment (or “pro gear”) rely upon external sound amplification equipment. Many of these keyboards provide a large number of instrumental timbres or sounds.

Digital Piano: stand-alone units that simulate the look, sound, and tactile key action of a typical upright piano. These units often have a varying number of other instrumental timbres, depending upon the design (and price) of the instrument. These units possess an internal sound system, requiring no external sound reinforcement equipment.

Digital Synthesizer: keyboard units capable of generating new timbres or sounds. Some synthesizers enable the user to import third-party sound samples or record analog sounds for further manipulation. Most synthesizers are portable and rely upon external sound systems (Williams & Webster, 1999, 2005).

Digital Keyboard Workstation: keyboard units that incorporate many of the functions or applications normally associated with a combination of personal computers, sequencers, and MIDI keyboards. These workstations usually include onboard digital sequencers and digital effects processors.

Digital MIDI Sequencer: computer-based or dedicated hardware that functions as a digital music recorder when connected to an input device such as a MIDI keyboard. MIDI-based sequencers depend on an external MIDI sound source for both recording and playback. These digital units record individual or multiple musical parts (tracks) using a variety of instrumental sounds. Some models allow the user to input the music one note at a time (step-time recording). MIDI units provide the ability to edit music elements such as pitch, rhythm, and volume for each note on each track, allowing the user to achieve greater input accuracy. Unlike analog machines such as tape recorders or record players, digital sequencers usually allow users to play back a recording at different tempos without affecting the pitch level of the music.

Direct Digital Sequencers: sequencers that record digital or analog sounds produced by digital instruments, traditional instruments, voices, and other acoustical phenomena. Digital recording units (like tape recorders) do not need music instrumentation for audio playback as do MIDI-based sequencers. Both software and hardware models utilize an analog-to-digital (ADAT) conversion system that interfaces between the microphone and the computer, which acts as the digital storage and manipulation engine for the sequencer. The editing capabilities of direct digital recordings of analog sounds are more limited than those of MIDI instruments.

Group Lesson Controller: communication system between the instructor and students within a digital keyboard lab or older analog keyboard lab. This device enables the user to interact with individual students, designated subgroups, or the entire class through their headphones. Depending upon the chosen configuration, students and teacher can interact vocally and pianistically, since both parties can hear each other play their respective instruments.

Implementation: process that occurs when an individual actually puts an innovation into use.

Innovation: idea, practice, or object that is perceived as new by an individual or other unit of adoption (Rogers, 1995).

MIDI Technology: a user communication protocol that acts as an interface or communication conduit between similarly equipped digital instruments, computers, and other peripheral equipment. MIDI is an acronym for Music Instrument Digital Interface. MIDI technology has become standardized throughout the keyboard and computer industry on a worldwide basis.

Overview of Dissertation

As previously stated, the purpose of this study was to survey the current level of diffusion and adoption of specific digitally based instructional and music technologies used by piano pedagogues in American undergraduate and graduate piano pedagogy programs. Chapter 2 presents a study of the related literature. This chapter includes a review of books, conference proceedings, journal articles, doctoral dissertations, and online articles from related professional web sites. Subjects of investigation include the diffusion and adoption of innovations, the impact of change and reform on American education, strategies for overcoming obstacles to technology implementation, the impact of technology on music education, and the impact of technology on piano pedagogy. Chapter 3 outlines the research methodology. Chapter 4 presents the research data and analysis results. Chapter 5 presents a summary consisting of conclusions from the data and recommendations to the piano pedagogy profession.

Chapter 2

Review of the Literature

Introduction

The following literature review presents similar studies, supporting the need and validity of this current study regarding the adoption and diffusion of specific digital music technologies in current graduate and undergraduate piano pedagogy programs. The understanding of how these existing studies relate to general educational reform is particularly important. This research information comes from a variety of books, online journal articles, graduate dissertations, and professional journals dealing with related subject matter.

Other topics of importance to this study include the history of educational change and reform, including the impact of educational or IT technology on schools. Additional research includes studies concerning music technology as it affects specific public school programs, independent piano studios, and piano pedagogy programs at the college and university level. This review also investigates studies related to technology-based curriculum issues in other educational disciplines.

An Introduction to the Adoption and Diffusion of an Innovation

Since before the 1940s, researchers have pursued the status of relatively new technologies. Many of these early studies appeared to be without a comprehensive or unifying model that could provide an overall framework to facilitate better integration of similar research topics and their results regarding the status of these new technologies in various environments (Katz, 1963; Ruttan, 1996). However, in the mid-20th century, a new research model emerged, usually referred to as the *adoption and diffusion of innovations*. This model gave researchers a standardized tool by which they could develop a more systematic means of pursuing and evaluating information on the dissemination and integration of new technologies within specific organizations, subcultures, and professions (Mahajan & Peterson, 1985; Rogers, 1962).

According to Rogers and like-minded researchers, studies on the adoption and diffusion of an innovation help explain the what, where, and why of new technology acceptance or rejection in areas such as education (Holloway, 1996; Mahajan & Peterson, 1985). Rogers (2003) refers to diffusion as "a process by which an individual or other decision-making unit moves from initial knowledge of an innovation to the decision confirmation of the innovation as the *innovation-decision process*" (p. 21). In this five-step process of (a) knowledge, (b) persuasion, (c) decision, (d) implementation, and (e) confirmation, adoption is the decision to make use of an innovation as the optimal course of action available. The corollary to this decision is rejection, whereby an individual avoids the innovation under consideration. While other variations of adoption and diffusion theory exist, the most comprehensive and widely accepted model (approaching the level of a diffusion paradigm) was compiled and formulated by E. M. Rogers. Acknowledged as a leader in this field of study, Rogers refined and updated his theory throughout the last five decades (Dalton, 1989; Holloway, 1977, 1996; Mahajan & Peterson, 1985; Rogers, 1962, 1983, 1995, 2003; Rogers & Shoemaker, 1971).

Mahajan and Peterson (1985) categorized three distinct uses for this research type in their handbook of various statistical models for innovation adoption and diffusion. The initial use *described* behavioral events such as the spread of rumors or the diffusion of certain agricultural innovations (Rogers, 1962). Mahajan and Peterson (1985) referred to the second use as *normative*, a context through which marketing agents used diffusion models as a basis for determining product dissemination. They noted that practically all of the other uses are a subset of the normative use. Describing the third use, they postulated, “The third and perhaps most common use is *forecasting*. Used most often in business activities, forecasting attempts to predict the success or failure of new products” (p.71). They considered this particularly true of technological forecasting.

Most of the studies discussed in this chapter are based upon some variation of this model and proved useful in the attempt to determine accurately the change process regarding an innovation’s status within a given market, group or subculture on a specific timeline (Rogers, 1962, 2003). In essence, these studies provide a “snapshot” regarding the status of a technology at any point along its introduction, dissemination, and eventual adoption. More importantly, it provides researchers with a means to evaluate more objectively the reasons behind the success or failure of a technology in a given social structure (Mahajan & Peterson, 1985; Rogers, 2003; Todd, 1992). The diffusion process is now one of the most widely researched and best documented social phenomena, penetrating more than two dozen distinct academic disciplines (Mahajan & Peterson, 1985; Rogers, 1983, 2003).

Models and Definitions of the Adoption and Diffusion of an Innovation

Within this research field, the terms “adoption” and “diffusion” are so closely linked as to appear interchangeable. Many studies do tend to use these terms indiscriminately, using either or both to describe the entire adoption and diffusion process regarding both individuals and the social groups in which they function (Holloway, 1996; Mahajan & Peterson, 1985; Rogers, 1995). However, some researchers are more circumspect in distinguishing between these two concepts.

A number of variations in the basic concept or definition of adoption and diffusion appears in the literature. Chari and Hopenhayn (1991) described diffusion from the perspective of economic or market forces, suggesting, "Under general conditions, there is a lag between the appearance of a technology and its peak usage, a phenomenon known as diffusion" (p. 1142). Mahatoo's (1985) *The Dynamics of Consumer Behavior* offers an example of adoption and diffusion from a consumer product-marketing perspective. Mahatoo saw the definition of *adoption* as an activity relating to individual consumers who choose to purchase and use a new product or innovation. He differentiated this concept from *diffusion* by describing diffusion as the adoption of a new product or innovation within a specific market or social group over a period of time. The research literature revealed that the majority of these studies either utilized some form of Rogers' diffusion model or modified it for their own goals (Anderson, R., Hansen, Johnson, & Klassen, 1979; Brancheau & Wetherbe, 1990; Carter, 1998; Dalton, 1989; Damanpour, 1988; Hall & Loucks, 1977; Mahajan & Peterson, 1985; Zhang, 1999). Expanding significantly on Mahatoo's (1985) market model to include research fields with similar interests, Rogers (2003) defined diffusion as "the process in which an innovation is communicated through certain channels over time among the members of the social system" (p. 5). This definition helps clarify why sponsorship of early diffusion and adoption studies originated primarily with government and corporate entities (Dutton, Sweet, & Rogers, 1989; Hall & Loucks, 1977; Rogers, 1983). These early studies attempted to monitor and understand various marketing strategies regarding the dissemination of agricultural methods and products (Katz, 1963; Rogers, 1962). Over the next decade, researchers applied this model to other areas, particularly medical and educational research (Rogers & Shoemaker, 1971). Thereafter, marketing groups, governmental agencies, and educational researchers increasingly utilized diffusion studies to probe the dissemination of new digital technologies as they impacted the nation's educational systems (Fullan & Stiegelbauer, 1991).

As with governmental agencies and corporate marketing specialists, academic researchers tracked product loyalty, frequency of product use, and product infiltration pertaining both to individuals and the aggregate whole of a subsociety or organization within specified social systems (Mahatoo, 1985; Rogers, 1995). In turn, adoption and diffusion studies strongly influenced members within various professional, public, and political sectors of our society. Therefore, a number of researchers suggest that many commercial entities, professional organizations, and even governmental sponsors use these studies primarily to foster an agenda that results in an adoption of a favored innovation (Mahatoo, 1985; Peck, Cuban, & Kirkpatrick, 2002; Rogers, 2003). However, educational researchers focus more on institutional change relating to curricular or administrative problem solving than to market-driven concerns (Curry, 1992; Fullan, 1982; Fullan & Stiegelbauer, 1991).

Based on Rogers' (2003) definition of diffusion, there are four main elements: (a) innovation, (b) communication channels, (c) time, and (d) the social system. Rogers' model suggested these four elements are present within any diffusion research study, regardless of topic. As previously defined, the five step innovation decision process is a time-related sequence by which an individual or group moves from the initial knowledge of an innovation to the final confirmation of its implementation (Carter, 1998; Rogers, 1983, 2003; Rogers & Shoemaker, 1971). In chapter 4 of *The New Meaning of*

Educational Change, Fullan and Stiegelbauer (1991) developed a similar set of innovation decision parameters, referred to as *change processes*, paralleling Rogers' innovative decision time sequence (Anderson, M., 1992).

Definition of an Innovation

Within the research literature, many individualized definitions exist for the term *innovation*. Tilton (1971) suggested three categories or contexts in which this term might be defined. Tilton saw an innovation as an object, an idea, or a practice. Steiner (1965) regarded an innovation as a combination of both ideas and practice synonymous with *invention*, referring to the manner in which two or more existing concepts or entities are combined to produce a novel configuration, previously unknown by those involved in the creative process. Myers and Marquis (1969) emphasized the process of technical development, stating, "a technical innovation is a complex activity which proceeds from the conceptualization of a new idea to a solution of the problem and into the actual utilization of a new term of economic or social value" (p. 1). Mohr (1969) simply defined innovation as "the successful introduction into an applied situation of means or ends that are new to that situation" (p. 112).

Knight (1967) described an innovation as the development of a slightly different process, whereby an existing innovation becomes part of an adopter's cognitive state and behavioral repertoire. Supporting this position, Knight postulated "an innovation is the adoption of a change, which is new to an organization and to the relevant environment" (p.78). Supporters of this definition see an innovation as both the process and the final product. From this perspective, the process of the adoption of the innovation appears to be implied (Mohr, 1969). Innovation can also refer specifically to any idea, procedure, or mechanism that has been invented or reinvented in a novel manner, independent from the final decision of adoption or nonadoption. This description emphasizes the reasons something is new or novel, as opposed to the more inclusive processes of invention and adoption previously suggested (Damanpour, 1988; Holloway, 1996; Zaltman, Duncan, & Holbek, 1973).

Some researchers approached the concept of innovation in far greater detail, further subdividing the definition of innovation into a number of categories (Zaltman et al., 1973). Rogers and Shoemaker (1971) defined innovation in the following manner:

> An innovation is an idea, practice, or object perceived as new by the individual. It matters little, as far as human behavior is concerned, whether or not an idea is 'objectively' new as measured by the lapse of time since its first use or discovery. The perceived newness of the idea for the individual determines his or her reaction to it. If the idea seems new and different to the individual, it is an innovation. (p. 19)

Zaltman et al. (1973) amended the Rogers and Shoemaker (1971) definition by anticipating the possibility that the unit of adoption can be larger than a single individual. They went on to point out that in an organization, not all of the members may consider a specific item to be an innovation. In his later research, Rogers (2003) acknowledged this important delineation in the preface to his fifth edition of *Diffusion of Innovations* and appended the original Rogers and Shoemaker definition by adding "or other unit of adoption" (p.12).

While disparities exist between some authors concerning the most accurate list of innovation attributes (Becker & Whisler, 1967), most diffusion and adoption studies surveyed for this project favored the third use of the term, innovation, indicating an idea, practice, or artifact (Zaltman et al., 1973). For these researchers, the distinguishing characteristic of innovation is the user's perception of its newness, rather than the actual chronological appearance of the object in society. In this context, a practice, object, or idea may be an innovation to one group, but not to another (Rogers, 1983, 2003). For the purposes of this study, an innovation is understood to possess the characteristics of Rogers and Shoemaker's (1971) definition, in conjunction with the third concept of the Zaltman et al. definition. Hereafter, an innovation refers to an idea, practice, or material artifact that has been invented, independent of the decision to accept or reject its use through adoption or nonadoption (Crain, 1966; Holloway, 1977, 1996; Rogers, 1962, 1983, 2003; Zaltman et al., 1973).

Attributes of Innovations: Their Effect on the Rate of Adoption of an Innovation

In the first edition of *Diffusion of Innovations*, Rogers (1962) established five categories describing the attributes or characteristics of innovations. He continued to reiterate these same broadly defined categories in his subsequent collaboration with Shoemaker, his many journal articles, and the later editions of his book (Rogers, 1983, 1995, 2003; Rogers & Shoemaker, 1971). From his perspective, these characteristics directly influence the innovation's rate of adoption within a given organization or social group. Favoring the Rogerian model, Carter (1998) stated, "Rate of adoption is the relative speed with which members of a social system adopt an innovation" (p.8). Rogers' (2003) five characteristics of innovations are

1. *Relative advantage* is the degree to which an innovation is perceived as better than the idea it supersedes.
2. *Compatibility* is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.
3. *Complexity* is the degree to which an innovation is perceived as difficult to understand and use.
4. *Trialability* is the degree to which an innovation may be experimented with on a limited basis.
5. *Observability* is the degree to which the results of an innovation

are visible to others. (pp. 15-16; Rogers & Shoemaker, 1971)

The degree to which small businesses or corporate entities evaluate these characteristics is usually defined in economic terms, inevitably centered upon direct financial profit. However, within educational structures, production efficiency and bureaucratic self-interest often become an alternative criterion of profit (Carter, 1998; Cook & Emerson, 1987; Holloway, 1977). A number of diffusion researchers are less satisfied with those categories, subdividing Rogers' (2003) concept of innovations into more specific categories. Holloway (1977) cited an educational diffusion study involving the following 16 characteristics to describe 18 educational technology innovations used in his diffusion study: clarity of results, initial cost, repercussion, divisibility, novelty, association with teaching, complexity, pervasiveness, efficiency, advantage, continuing cost, pleasure, colleague approval, administrative approval, administrative penalty, and compatibility.

While some models further subdivide these categories, most adoption and diffusion studies found by this author generally follow Rogers' (2003) five general characterizations of an innovation (Anderson, M., 1992; Anderson, R., et al., 1979; Carter, 1998; Crain, 1966; Damanpour, 1988; Damanpour & Evan, 1984; Holloway, 1977, 1996; Leonard-Barton, 1984; Rogers & Shoemaker, 1971). Additional studies offer more detailed explanations and examples of these attributes (Buttolph, 1992; Cook & Emerson, 1987; Fullan & Stiegelbauer, 1991; Kershaw, 1996; Mahatoo, 1985; Rogers, 2003; Taylor, 1970; Zaltman et al., 1973).

Rate of Adoption and Diffusion Curves

In the preface of the *Diffusion of Innovations*, fifth edition, Rogers (2003) reflected on the expanded refinement and use of this research model, stating that each of the previous four editions of his book was published approximately a decade apart, coinciding with turning points in the growth of diffusion research. He observed

> Today I estimate this number to be more than 5,200, and the field of diffusion continues to grow (at about the same rate of 120 diffusion publications per year . . .). No other field of behavior science research represents more effort by more scholars in more disciplines in more nations. (p. xviii)

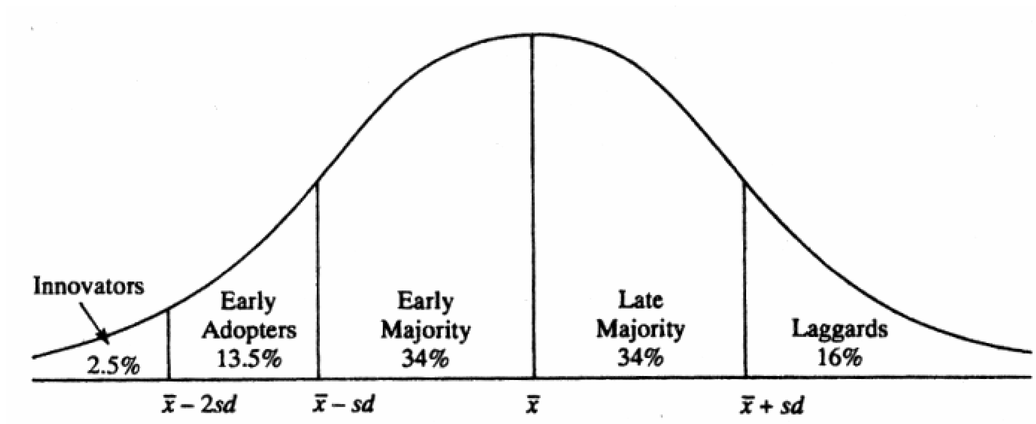


Figure 1. Frequency of new adoptions.

Note. From "The Adoption of Spreadsheet Software: Testing Innovation Diffusion in the Context of End-User Computing," by J. Brancheau and J. Wetherbe, 1990, *Information Systems Research, A Journal of the Institute of Management Sciences,1*(2), p.118. Copyright, 1990 by J. Brancheau and J. Wetherbe.

In spite of the sheer magnitude and variety of diffusion studies, the statistical representation for rates of adoption in all diffusion studies proved to be remarkably similar. Using line graphs as a medium of representation, rates of adoption or diffusion can appear as either a bell-shaped curve or S-shaped curve (Rogers, 2003). The bell-shaped curve, as shown above in Figure 1, represents the frequency of adoption, indicating the number of individuals in the social group who have adopted the innovation at each designated time interval on the grid. The S-shaped curve illustrates the typical diffusion rate as extrapolated in most studies. The S-shaped curve in Figure 2 graphically represents the total accumulation of innovation adopters over a designated period of time, taken from an early adoption and diffusion study tracking farmers who adopted hybrid corn seed in two Iowa communities (Rogers, 2003; Ryan & Gross, 1943).

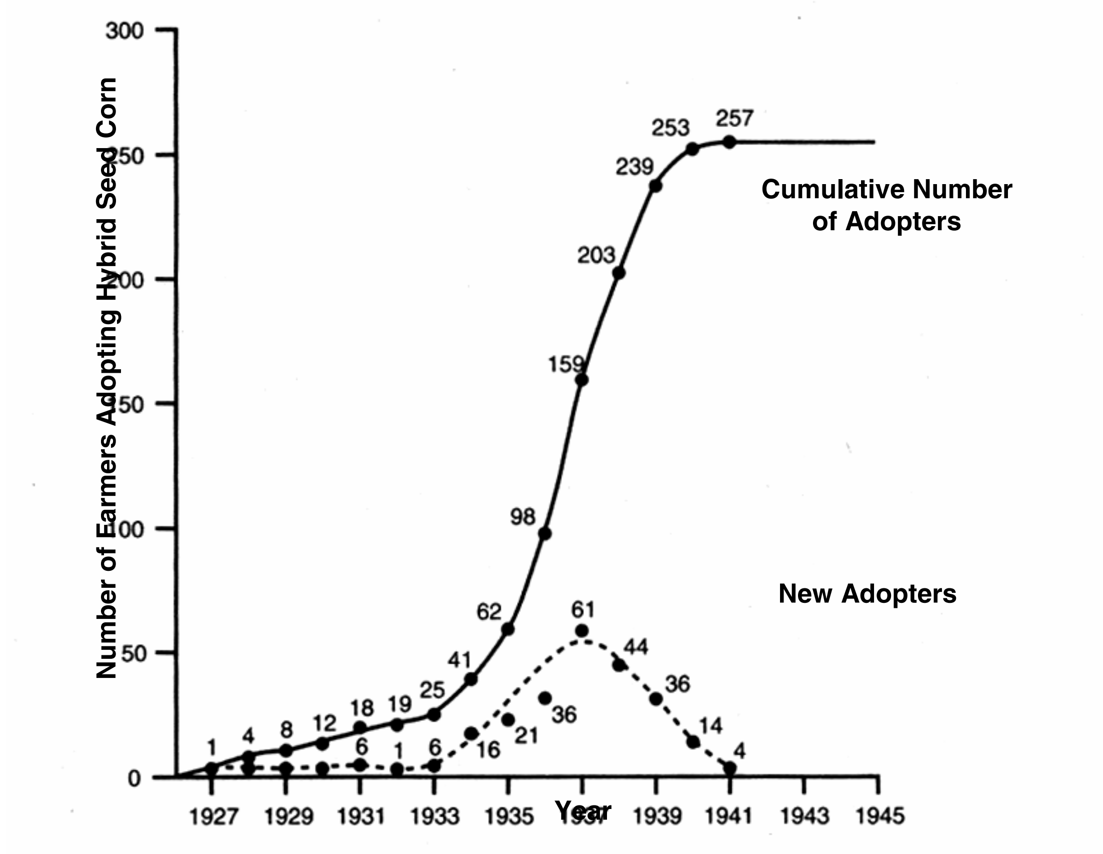


Figure 2. Diffusion table of hybrid corn in Iowa, 1943.

Note. From *Diffusion of Innovation, 5th ed.* (p. 273), by E.M Rogers, 2003, New York: Free Press. Copyright 2003 by E.M. Rogers.

With both graphs, the initial adoption rate begins slowly, as represented by the shallow slope visible early in the diffusion timeline. As the studies proceed, the curve accelerates to a maximum slope or percentage of adopters, reaching a point where approximately half of the system's population accepts the innovation. The subsequent rate of adoption gradually drops off as fewer remaining individuals implement the innovation. The representation in Figure 2 forms the typical S-curve researchers use to track the diffusion process over time (Brancheau & Wetherbe, 1990; Rogers, 1962, 2003). Mahajan and Peterson (1985) discussed this statistical phenomena stating

> Although all wide variety of innovations in diffusion processes have been investigated, one research finding keeps reoccurring: If the cumulative adoption time pass or temporal pattern of the diffusion process is plotted, the resulting distribution can generally be described as taking the form of an S-shaped (sigmoid) curve. (p. 8)

Though S-shaped diffusion curves retain the same general shape throughout the statistical results of their respective studies, the exact form (the slope and the asymptote) varies according to the parameters and results of each unique design (Brancheau & Wetherbe, 1990; Kershaw, 1996; Mahajan & Peterson, 1985).

All social organizations or communities constitute a variety of individuals who exhibit various levels of awareness regarding new ideas, practices, and inventions. They also demonstrate differing degrees of willingness to participate in the adoption process (Brancheau & Wetherbe, 1990; Buttolph, 1992; Carter, 1998; Whiteside & James, 1986). Statistically describing the adopters within a social system in terms of each individual's adoption time proves tedious and impractical (Rogers, 2003). In order to measure the time element (the initial appearance of an innovation and its total diffusion) in a more efficient and organized manner, a number of somewhat arbitrary categories appear necessary (Holloway, 1977; Rogers, 2003; Zaltman et al., 1973). Anyone attempting to standardize a timeline through an adopter categories grid should examine the number of adopter categories, the percentage of group members that fall into each category, and the statistical method of defining these categories (Rogers & Shoemaker, 1971).

Adopter Categories

Early adoption and diffusion studies manifested a number of creative but disparate terms such as Advance Scouts, Lighthouses, Earliest Acceptors, Pioneers, "Non-Parochials," and Spark Plugs (Rogers, 1962). Recognizing the need for a standard set of descriptors regarding adopter categories, Rogers (2003) used his statistical background to develop a set of five idealized categories, based upon the criterion of innovativeness along a specific timeline. The five adopter categories are presented in chronological order, according to the point of acceptance or adoption within the diffusion timeframe for a typical social group.

Innovators: The individuals in this category are not only willing, but eager to try new ideas. The interests of innovators often lead them outside of their own social system, developing relationships with specific groups of innovators. Rogers (1962) identifies this group as "venturesome." They are risk-takers who are willing to accept the occasional failure of newly adopted ideas within their own social system or the marketplace. Because of the level of risk inherent in their decisions, this group must have a strong resource base. Rogers (2003) points out

> While an innovator may not be respected by other members of a local system, the innovator plays an important role in the diffusion process: that of launching the new idea in the system by importing the innovation from outside of the system's boundaries. Thus, the innovator plays a gatekeeping role in the flow of new ideas into a system. (p. 283)

Early Adopters: Individuals within this group are better integrated into the local social system than innovators. This group appears to have a greater degree of opinion leadership regarding new innovations (Rogers, 1962). Opinion leaders are individuals whom the members of the remaining categories approach for advice regarding an innovation. As well respected individuals within the social system, they are either sought by change agents (often product representatives) for support or become informal change agents themselves, triggering critical adoption mass in the systems adoption process (Mohr, 1969; Rogers, 2003).

Early Majority: Members of this category are held in high esteem by their peers, but they are rarely innovative leaders. At approximately midpoint in the diffusion process, these individuals provide interconnectedness within the interpersonal relationships and networks of a system (Rogers, 2003). Rogers characterized this category as a group of deliberate followers who are neither the first nor the last to try innovations.

Late Majority: Adopting immediately after the average members of a system, this group comprises approximately one third of the entire social group. Skepticism is the single most dominant attitude of this group regarding the value of a new idea or invention. Late-majority individuals require substantial proof of an innovation's value before adopting a new idea or product. Usually, peer pressure must be brought to bear on these individuals before actual adoption takes place.

Laggards: The most isolated social network within their social system, laggards are the last group to adopt an innovation. Rogers referred to them as “traditionalists,” with their focus centered on the past. Suspicious of innovations and change agents, these individuals demonstrate the least awareness of new ideas and take the longest to deliberate on the value of new ideas. Active resistance to change (in the form of innovation rejection) is quite possible in this category (Rogers, 2003). Often, a relative lack of resources is a prime motivation for resistance to new technology (Mehan, 1989). In his fifth edition of *Diffusion of Innovations*, Rogers (2003) recognized the negative connotations inherent with the term laggard, a recognition that was not acknowledged in his original text in 1962. He defended his position, however, noting that the negative connotation applies only to the diffusion process and not to the inherent worth of the individual. He also noted that the overall social systems are often to blame for the attitudes and resource levels in which laggards are found.

Over the years, various researchers modified these adopter categories. In a listserv discussion published in the higher learning journal, *Change*, individuals from industry, college and university faculty, and technology journalists participated in an evolving dialogue on means by which the technology usage gap between early adopters of information technology and mainstream faculty could be bridged (Best, et al., 1995). Moderated by S. Gilbert, Geoghegan of IBM was the initial contributor for this topic. Geoghegan placed all educators in higher education into two categories: Early Adopters and Mainstream Faculty. Geoghegan based a great deal of his discussion and terminology on Geoffrey Moore's 1991 book, *Crossing the Chasm*, based in turn upon Rogers diffusion work (Best, et al., 1995). Geoghegan categorized Early Adopters as

> a small subset of faculty (generally no more than fifteen percent) made up of techies, who experiment with every new technology that comes along, and the visionaries who see technology is something they can use to enable breakthrough improvements in teaching and learning. (p. 31)

Geoghegan (Best, et al., 1995) referred to Mainstream Faculty as more conservative in their approach to technology, focusing more readily on problems, processes, and tasks at hand than upon the tools that might be used to deal with these challenges. Geoghegan observed that most nonadopters within the mainstream faculty are educators who have yet to use technology to improve their teaching. Table 1 indicates cited differences between adopters and the mainstream faculty members.

Table 1.

Geoghegan's Adopter Categories within Higher Education Faculty

Early adopters	**Mainstream faculty**
Favor revolutionary change	Favor evolutionary change
Visionary	Pragmatic or conservative
Strong technology focus	Strong problem and process focus
Risk-takers	Risk-averse
Experimenters	Want proven applications of compelling value
Largely self-sufficient	May need significant support
"Horizontally" networked	"Vertically" networked

Note. From "An 'Online' Experience: Discussion Group Debates Why Faculty Use or Resist Technology," by R. Best et. al, 1995, *Change*, 27*(2)*, p.31. Copyright 1995 by R. Best, et al.

Though drastically altering Rogers' adopter categories, Geoghegan agreed with those Rogerians who observed early adopters inadvertently functioning as poor role models and change agents. Geoghegan particularly saw this within the social system of college and university educators (Best et al., 1995).

In his study of innovation adoption in postsecondary educational organizations, Kershaw (1996) used a modified set of four adopter categories. On his innovation acceptance chart, Kershaw combined two of Rogers' adopter categories, Innovators and Early Adopters (See Figure 1), into a broader grouping simply referred to as Innovators. This change not only served as a mitigation of negative characteristics attributed to early adopters as role models or informal change agents, but actually resulted in a more favorable perception of Early Innovators as a positive catalyst for change within the entire social group. Other examples of adopter category modification can be seen in the study by Brancheau and Wetherbe (1990).

It is important to note that these variations on the Rogerian adopter categories do not obfuscate the statistical representation of the diffusion process, as universally seen in the S-shaped curve characteristic of the data. Supplemental to the design of this study, but important to the full understanding of most adoption and diffusion models are the concepts of *change agents* and *opinion leaders*. A number of studies and texts offer more detailed explanations of their roles in the adoption and diffusion process (Carter, 1998; Dalton, 1989; Damanpour & Evan, 1984; Ely, 1990; Holloway, 1996; Katz, 1963; Leonard-Barton, 1984; Rogers, 1995, 2003; Tilton, 1971; Zaltman et al., 1973).

The Impact of Change and Reform on Education

Change is an inevitable byproduct of human interaction. Fullan and Stiegelbauer (1991) predicted “we can take it as a given that there will always be pressures for educational change in pluralistic societies” (p. 17). According to their observations, pressures to change an educational system increase as its society becomes more complex. Levin (1976) categorized three broad means by which educational policy is pressured into change: (a) through natural disasters such as earthquakes, famines, etc.; (b) through external forces including interaction with immigration, new values, and imported technology; and (c) through internal contradictions or conflicts (i.e., brought on by technological changes that resulted in new social patterns or needs). Levin expanded the third category, acknowledging a perceived discrepancy between educational values and actual educational outcomes within one or more internal groups. These discrepancies affect internal group members, as well as those external groups who have a vested interest in the educational system.

To date, the history of American educational reform presents a paradox. During the last two centuries, these educational change and reform movements failed more often than they succeeded (Sarason, 1990). The more limited successes of various innovation implementations were often the product of serendipity rather than thoughtful policy (Cuban, 2001; Fullan & Stiegelbauer, 1991; Levin, 1976). Some of the more controversial reform attempts centered upon the adoption and diffusion of educational technologies (Beynon & MacKay, 1993).

From Goodman and Reddy's (2001) perspective, the use of technology to create and communicate information or learning is a time-honored tradition as old as civilization. Utilizing extremely broad categories, they labeled the invention of writing as the catalyst for the first information revolution, occurring more than 5000 years ago. Their second informational revolution began with the invention of the printing press, allegedly invented approximately 450 years ago. In actuality, the printing press was known in China for centuries, but its perfection by the European, Gutenberg, circa 1450, brought it into widespread use (Grout & Palisca, 2001). Most researchers agree that this technological innovation produced a quantum jump in the advancement of instructional technology (Stallard, 2001). Goodman and Reddy (2001) identified the invention of computers as the origin of the third information revolution, a phenomenon that is still evolving, according to Fullan and Stiegelbauer (1991).

Between Goodman and Reddy's (2001) second and third informational revolutions lie a series of predigital, but electrically based innovations that significantly influenced the entire 20th century American education system (Thompson, Simonson, & Hargrave, 1996). In his historical commentary, *Teachers and Machines: The Classroom Use of Technology since 1920*, Cuban (1986) traced the lure of new technologies in education, from turn-of-the-century innovations such as film, through the first-generation microcomputers in the 1980s. The grandiose predictions and disappointing outcomes of these predigital, electrically based technologies offer many similarities to the current expectations of contemporary digital educational technologies (Fullan & Stiegelbauer, 1991).

Overcome by his enthusiasm for early film, Thomas Edison predicted in 1913 "Books will soon be obsolete in the schools . . . Scholars will soon be instructed through the eye. It is possible to touch every branch of human knowledge with the motion picture" (Cuban, 1986, p.11). This optimistic prophecy fell far short of reality during the 1920s and 1930s. Advocacy by noted individuals and educators claiming the demonstrable superiority of the motion picture as a teaching tool failed to bring about universal acceptance of the medium. Over the course of 40 years, three different surveys by the National Education Association (NEA) determined that film did not replace the traditional functions of books, chalkboards, and teachers in the classroom. These studies determined that approximately two thirds of school film use at the elementary level came from 14% of the teachers. Film use at the secondary level was significantly lower

(Cuban, 1986). Based on actual implementation, the motion picture functioned as an occasional enhancement, with students exposed to approximately one reel of film every 4 weeks.

The four main obstacles to frequent use of film in the classroom were similar to those cited in other technological implementation studies. They were (a) teachers' lack of skills in using equipment and film; (b) cost of films, equipment, and upkeep; (c) inaccessibility of equipment when needed; and (d) finding and accessing the appropriate film for the class. Though advocates eliminated many of these obstacles, the dreams and expectations of pedagogical and administrative progressives regarding the superiority of film as a teaching medium failed to materialize (Cuban, 1986, 2001; Thompson et al., 1996).

The attempted adoption and adaptation of radio to the classroom followed a similar sequence of events. William Levinson, one of the early directors of the *Ohio School of the Air* wrote in 1945, "The time may come when a portable radio receiver will be as common in the classroom as is the blackboard. Radio instruction will be integrated into school life as an accepted educational medium" (Cuban, 1986, p.19). As with film, obstacles to the initial implementation of radio revolved around the lack of reliable equipment and the insufficient availability of radios. By the late 1930s, increased production of improved and less expensive units solved these problems. The lack of actual use in the classroom, however, had yet to be determined accurately. After a number of limited surveys around the nation, the Federal Communications Commission (FCC) sponsored a survey in 1943, administered by the Ohio State University Bureau of Educational Research (Cuban, 1986). The FCC survey concluded that the radio was not an acceptable substitute for any of the traditional educational tools in the American curricula, as shown in Table 2 (Cuban, 1986).

The study also indicated that the initial estimates of audience size for educational radio programming were determined by counting the number of hours of educational programming offered by a station in relation to the number of students with access to radio sets in their schools. These estimates stemmed from biased sources, interested in the commercial success of this program as measured by audience size. In the state of Ohio, the initial estimates of 8 to 10 million students listening to weekly educational programs were reduced to a more realistic 1/2 to 1 million (Cuban, 1986).

Table 2.

FCC Survey of Educational Radio Use

Reasons for lack of classroom use	**Percentage of respondents**
No radio-receiving equipment	50%
School schedule difficulties	23%
Unsatisfactory radio equipment	19%
Lack of information	14%
Poor radio reception	11%
Programs not related to curriculum	11%
Class work more valuable	10%
Teachers not interested	7%

Note. From *Teachers and Machines: The Classroom Use of Technology since 1920* (p. 24), by L. Cuban, 1986, New York: Teachers College Press. Copyright 1986 by L.Cuban.

The sequence of emerging innovations predicting revolutionary value to American education continued throughout the 20th century. Instructional television was the reformer's preoccupation in the 1950s and 1960s, with teaching machines dominating their attention in the 1970s (Hefzallah, 1999; Thompson et al., 1996). Beginning in the 1980s, the development and practical distribution of microcomputers, otherwise known as personal computers (PC), led to the third information revolution. Preceded by the previously mentioned innovative hallmarks of the development of writing and the invention of the printing press, this current communication phenomenon still shows evidence of continuing as it impacts information storage, interpersonal communication, and educational formats. Major digital developments such as the Internet and innovative computer-based peripherals may yet constitute another level of digital evolution (Ely, 2000).

The General Impact of Post-World War II Technology on American Education

Moving from a broad historical view of the 20th century to a closer look at post-World War II electrical and digital technology in education, common themes dominated each innovative cycle (Carter, 1998). The consensus of many researchers was that education reformers continually seized upon one technical innovation after another, anticipating incredible gains for educational excellence with each succeeding innovation. Many evaluators and critics saw this push for innovations as the illusive promise of finally finding the "right" technology for securing significant educational reform (Sarason, 1990). However, the reality of the historical evidence proved that over the course of time, each new technological panacea produced less than satisfactory results (Ely, 1995; Fullan, 1982; Fullan & Pomfret, 1977; Fullan & Stiegelbauer, 1991;

Hefzallah, 1999; Kahn, 1995).

From the perspective of cost effectiveness, educational reform critics concluded that Americans spent billions of dollars on educational reform with disappointing results (Carter, 1998; Cuban, 2001; Sarason, 1990). The acquisition of digital and educational technologies represented a substantial portion of these funds. Yet the belief that educational improvements were inherent with the availability of educational technology failed to materialize in any substantial manner (Andrew, 1997; Dalton, 1989; Firek, 2003; Fullan & Pomfret, 1977).

In a lecture series at the University of Alabama, Ely (1995) succinctly identified the tension between the expectations of technology advocates and actual educational results by titling his keynote address "*Technology Is the Answer! But What Was the Question?*" Even in underfunded school districts, Ely pointed to the ubiquitous nature of educational technology, particularly computers. During the 1980s, educational reformers searched for means of acquiring sufficient digital technology for public schools and institutions of higher learning. This effort generally took the form of computer technology, including multimedia peripherals, computer networks or labs, and Internet access (Walker, Keepes & Chang, 1994).

According to Cuban (2001), "Reformers have been astonishingly successful in wiring schools and equipping them with computer stations" (p. 17). At the time of Ely's 1995 lecture, the student-to-computer ratio (microcomputer density) had increased from one computer per 75 students (kindergarten through 12th grade) in 1984 to one computer for every 12 students in 1994. In a later study, Peck et al. (2002) noted that by 1999, the student-to-computer ratio shrank to under six students per computer. By the year 2000, the student-to-computer ratio dropped to five students per computer. Between 1997 and 1999, student access to newer multimedia computers dropped from 21 students per machine to fewer than 10. An increase in the purchase of Internet-connected computers resulted in similar decreases in the student-to-machine ratios (Cuban, 2001).

Cuban (2001) summarized this phenomenal innovative technology growth within American education, stating

> These figures suggest only the barest outline of the major investments that have been pumped into the project of computerizing schools. In addition to start-up costs for hard infrastructure, there are soft infrastructure costs associated with technical support, scheduled replacement of obsolete equipment, and professional development. Altogether, these monies add up to a multi-billion dollar investment. (p.17)

According to a number of authors, the apparent success of achieving substantial classroom access to computers and software since the 1980s was offset by the lack of significant results in user productivity. This was particularly evident when comparing user productivity to the promised results of technology access (Best et al., 1995; Bradley, Cuban & Kurzweil, 2001; Cuban, 1986, 2001; Ehrmann, 1995; Peck et al., 2002; Schwab & Foa, 2001).

Other factors hindered the accurate measurement of user productivity related to technology acquisition. One of the difficulties in measuring technology productivity was the uneven distribution of equipment throughout the nation, particularly for economically disadvantaged school districts. According to Kondracke (1992)

> more-detailed research depicts a trend that shouldn't surprise anyone–the more affluent and well educated the child's parents are, the more likely it is that the child uses computers at school. And more white children use computers at school than do African-American or Hispanic children. (p. 236)

Later research revealed that the distribution data do not reflect the condition of school computers in different districts. Many of these units are old and outdated machines, more than two decades away from state-of-the-art computer models. These old machines, predominantly Apple IIes, have no connection with the computer technology of modern society and are incapable of running educationally relevant software. Many other units are in need of repair, but belong to school systems that lack the funds for technology updates and maintenance (Berz & Bowman, 1994).

Strategies for Overcoming Obstacles to Technology Implementation

As a matter of balance, these valid criticisms do not indicate a move against technology in the classroom. Many of these outspoken innovation critics still recognize the latent value of educational (instructional) technology as means of improving the educational process (Cuban, 2001; Fullan, 1982; Fullan & Miles, 1992; Fullan & Stiegelbauer, 1991; Sarason, 1990). The executive summary of Curry's (1992) report delineated the problems regarding innovative change within an organization, stating

> Hindsight is a broader view than the somewhat narrow and immediate views of organizational members in the midst of creation or innovation. Each party comes to the process of creation or innovation with a vision of his or her own and influences change accordingly. As a result, a process that often sounds simple is much more complex and requires high levels of skill and collaboration to be successful. (p. iii)

To assure a better rate of real personal and classroom implementation in various academic environments, educational reformers of the mid-1990s and early 21st century attempted to redress the implementation errors of the previous decades (Schwab & Foa, 2001).

Carter (1998) echoed the sentiments of a number of researchers who believe that the increased understanding for what does and does not motivate an individual's adoption of an innovation is essential to improving successful implementation of future educational technologies. Carter concluded, "To regard adoption of the innovation as rational and wise, and to classify rejection as irrational and stupid, is to fail to understand that individual innovation decisions are unique and distinctive" (pp. 24-25).

The recognition and application of a few broad, unifying principles concerning the challenges of each implementation cycle should help innovators and reformers to design efficient diffusion plans. This process depends upon analyzing the obstacles encountered during various stages of the educational change process and finding solutions to these challenges. The goal is to provide decision makers with better diagnostic tools for the development of more realistic and workable implementation projects (Collier, 2001; Curry, 1992; Kahn, 1995; Stallard, 2001).

Essential to this process is the need to understand three overlying obstacles or challenges. The first challenge is the identification of the average educator's general attitude towards the process of innovative or technological adoption. The solution to the second obstacle requires recognition and sensitivity to a variety of personal psychologies and affective reactions toward potential educational changes (Andrew, 1997; Baker & Herald, 2003; Whiteside & James, 1986). The solution to the final and possibly most crucial challenge necessitates the establishment of an optimum balance between curricular content and the delivery system (Ely, 1995; Young, J., 2004). Carter (1998) succinctly phrased it by stating "educators must balance the medium versus the message" (p. 36).

Educators' Attitudes toward the Process of Innovative or Technological Adoption

External observers agree that the educational community constitutes a significant market within the United States by virtue of its size and scope (Mcinerney, 1989; Vargas-Baron, 1998; Zaltman et al., 1973). One significant indicator of the substantial scope of the education market lies in the fact that most of the contemporary and comprehensive studies in educational research are produced by private commercial marketing research corporations, including those sponsored by the federal government (Bowers, 1988; Holloway, 1996; Peat Marwick Main & Co., 1987). The history of American commerce generally indicates that someone usually profits by the dissemination of a new educational technology (Cuban, 1986; Dizdar & Wandiga, 1998; Mahatoo, 1985).

Many organizations' decision makers or change agents fail to realize that most educators do not equate the purchase and implementation of a new instructional technology with a marketing or business activity (Holloway, 1977; Mahatoo, 1985). Corporate entities, however, tend to recognize the basic naiveté and susceptibility of individual educators or school system administrators regarding the process of technology acquisition and pursue these marketing targets relentlessly (Stelnikov, 1991). Nevertheless, the decision-making and acquisition processes of most educational entities are subject to the same parameters and patterns found in the business sector. This marketing characteristic directly impacts educational research concerning the adoption and diffusion of technological innovations (Daft & Becker, 1978; Holloway, 1996; Rogers, 1995, 2003).

Both Holloway (1977) and Mahatoo (1985) believed that negative attitudes displayed by many educators concerning this acquisition process are primarily due to their ignorance concerning the more comprehensive nature of markets. Stelnikov (1991) countered this perspective by suggesting that increased knowledge of the marketing process among educators led to a greater resistance to technological change. Stelnikov and other educational commentators believed that educators who gain experience in the business arena find the entire diffusion process even more distasteful, confirming their initial opinion that a profit orientation on the part of any involved educational representative violated the need for intellectual objectivity by their profession (Bowers, 1988; Stelnikov, 1991). Most educators believe that financial profit is an inappropriate variable when objectively determining the acquisition of an educational technology. This belief becomes reinforced when educators witness the results of inappropriate purchases by administrators or other decision-making bodies. Decision makers can be seduced by skilled marketing plans and possibly unethical benefits that accrue to them through company representatives (Holloway, 1996; Stelnikov, 1991).

From a different perspective, Emerson’s (1987) social exchange theory is a concept that promotes a broader definition of profit. This innovative model presents relatively new perspectives regarding the structural patterns of social relations as they relate to profit. Emerson's untimely death interrupted the development of this research, but several of his colleagues refined and presented his research in Cook’s (1987) *Social Exchange Theory*. Emerson's social exchange theory refined the more traditional economic view of value exchange (Ekeh, 1974). Emerson’s model suggested that whether through increased status, better public relations, or improved self-image, the exchange of a type of “currency” *does* take place within what is superficially a nonprofit interaction (Cook & Emerson, 1987; Friedman, 1987; Turner, 1987). This currency exchange may influence (positively or negatively) the actions of an administrator seeking advancement or an entire school system bent upon achieving a better reputation with a specific constituency within a community (e.g., local businessmen or parents). Whether positively or negatively viewed, the adoption and diffusion of innovations within an educational community still constitutes a market model, but one in which the subjective value (profit) is determined by the participants (Carter, 1998; Cook & Emerson, 1987, Ekeh, 1974; Friedman, 1987; Green & Gilbert, 1995; Turner, 1987).

Teachers' Affective Reactions toward Innovative Changes

Developing a recognition and sensitivity to the personal psychologies and affective reactions of individuals or organizations facing potential technological change is essential to successful implementation. Successful organizational diffusion requires effective implementation by the constituent members of the social group (Mohr, 1969; Rogers, 2003). The level of an individual's belief in his or her ability to produce a positive change by personally implementing a specific innovation inhibits or strengthens the innovative diffusion process (Baker & Herald, 2003; Kahn, 1995; Whiteside & James, 1986).

In a study on the factors relating to the effectiveness of computer-based *integrated learning systems* (ILS), Andrew (1997) referred to this belief as *self-efficacy*. Studying the organizational adoption of an ILS program in the Mt. Vernon School District, his population consisted of third and fifth grade teachers from four schools involved in the initial implementation of the ILS program. Each of these teachers participated in this innovative program for a minimum of three years.

The purpose of the ILS program was to discover whether its use would improve the test scores of students taking the Indiana State Test of Educational Progress (ISTEP) and the California Achievement Test (CAT). Andrew's (1997) study centered upon discovering whether a teacher's level of self-efficacy regarding the ILS system affected student results on these standardized tests. The study questionnaire sought information about the teacher's personal knowledge of the ILS system, the type of training each teacher was obtaining related to the system, and the ways the teachers were using the ILS in their classrooms.

Andrew's (1997) comparison of the survey results from the standardized test scores of each teacher's students supported his hypothesis regarding teacher attitudes towards a new technology and its effective use with students. He noted that among teachers using the ILS system, there was a high correlation between teachers with a greater self-efficacy and successful student achievement. Andrew concluded that it is a reasonable expectation to find student performance with any new technology directly related to the teacher's personal reaction toward that innovation, whether positive or negative. He reasoned, "It would be a contradiction in terms to expect a teacher to be dedicated to something he or she did not believe in, and it is a rare individual indeed who can persevere without confidence in their own ability" (p. 36).

Balancing the Medium and the Message

The third challenge to successful technological diffusion deals with the most severe criticism of 20th century innovative reform movements: the inappropriate fixation upon a technological medium rather than the educational message (Bradley et al., 2001; Carter, 1998; Cuban, 1986, 2001; Ely, 1995; Young, J., 2004). Innovators and reformers from previous reform cycles either overstated the expectations of their favorite technology or failed to give realistic timelines regarding practical implementation expectations within their respective educational scenarios (Green & Gilbert, 1995). Unfortunately, the tendency to make extravagant claims regarding the expected educational transformations available with the adoption of each new technology still exists, especially among product change agents. However, a growing number of more thoughtful advocates now realize the counterproductive nature of this tactic (Geisert & Futrell, 1995).

Using a case study of the transition from slide rule to calculator, Green and Gilbert (1995) suggested several major points about a more low-key approach to the integration of technology in education. While recognizing that the experience of the calculator was an unusual diffusion phenomenon, they used this instance to illustrate three realities concerning education in the diffusion of new technologies. First, truly compelling technological innovations are in no need of extensive analysis or evaluation prior to becoming widely adopted and integrated into academia (i.e., the programmable calculator).

Secondly, potential benefits and beneficiaries should be carefully identified before claims of productivity and positive educational impact are offered. Finally, "compelling technology may – or may not – have dramatic consequences for the curriculum" (Green & Gilbert, 1995, p. 9). Green and Gilbert suggested a balance between more realistic implementation timelines and the need for decisive action by decision makers to avoid the loss of meaningful productivity stemming from the inevitable obsolescence of a given technology.

The third and most difficult challenge is striking the proper balance between curriculum content and delivery system. As reviewed previously, many early innovative reform movements concentrated upon the inherent abilities of the technology rather than the innovation's adaptation to existing curricular needs (Cuban, 2001; Ely, 1995). However, many of these critics also conceded that the successful implementation of technology into a classroom setting inevitably affects the curricular presentation and outcome expectations of both teacher and student. Though successful technological integration occurs less often than is desirable, it does exist in isolated cases (Carter, 1998; Ely, 2000).

In an attempt to find evidence of a successful early integration of microcomputers in the classroom, Mehan (1989) conducted a thorough study on the curricular and social influence of computer technology on four elementary classrooms. Mehan investigated the two extreme predictions concerning the effects of microcomputers in the classroom. Advocates claimed once again that computer technology would transform the classroom. Skeptics, however, predicted that microcomputers would fall prey to the same forces that relegated technological innovations such as radio and educational television to impotency or obsolescence.

After a year of extensive observation at both the elementary and secondary levels, Mehan (1989) concluded that the introduction of the microcomputer into the teaching environment produced no significant change in the way the teachers arranged classroom space and used instructional time. The microcomputers were simply incorporated into the previously established instructional practices and time structure. These observations were consistent with all four teachers, regardless of each teacher's previous knowledge concerning computers. However, though the introduction of a computer into the classroom did not modify the previously established spatial and temporal structure of the classrooms, the curriculum *was* impacted. By incorporating Internet “student wire services” and specific writing software applications into the classroom, the technology provided the means by which previously unattainable goals could be reached.

Mehan (1989) postulated that both previously mentioned schools of thought regarding technology implementation within educational environments were flawed. Mehan suggested that computers are unlikely to change unilaterally the social organization of education, but neither will schools totally reject computer innovations. Mehan states, “to overcome both versions of the fallacy, it is necessary to distinguish between the computer as a piece of technology and the computer as a social practice” (p. 17). The study concluded with the suggestion that viewing computers as a social practice rather than simply a piece of technology is a more realistic alternative than the other two positions. The author suggested that from this innovative viewpoint, classroom organization and computer use could become mutually beneficial, mutually influential, and avoid becoming deterministic as to the role of technology.

Education Research in Instructional Technology

Within the United States, the first widespread involvement in research by educators began during the latter part of the 19th century. Communication studies were initiated to solve problems with educators using the *personal experience* method to share ideas through papers and addresses at conferences (Mark, 1992). This relatively new attempt at a formal methodology utilized surveys to determine specific facts concerning the status of a variety of subjects (Newman, 2000). During the past 50 years, research interest grew regarding the interaction between technology and instruction within a variety of educational environments (Clark, 1983; Ely, 2000; Peck et al., 2002). Though there have been a number of titles for similar designs in instructional technology, three basic study models have dominated educational research in instructional technology. They are (a) evaluation research, (b) intra-medium studies or media comparison studies, and (c) aptitude treatment interaction research (Thompson et al., 1996).

Evaluation research is typically the first study conducted when a new instructional technology is introduced. The primary inquiry of this research type investigates whether or not individuals can learn through a specific technological medium. Strongly linked to the psychological school of behaviorism, early researchers of traditional mass media in the classroom strongly favored this research method (Cuban, 1986; Goodman & Reddy, 2001; Thompson et al., 1996).

From the 1920s through the 1960s, *intra-medium studies* or *media comparison studies* focused primarily on research relating to instructional technology. This research design attempted to determine which of two instructional technology options (or one medium versus a traditional instructional model) attained the greater effect on learning (Salomon & Clark, 1977). According to Salomon (1974), researchers encountered problems with this model, stemming from deficient experimental designs and the lack of consistent statistically significant findings. Regarding the design problems, a number of authors concluded that (a) early media researchers asked the wrong questions, based on faulty pedagogical assumptions; (b) researchers incorrectly assumed that new technologies would replace status quo methodologies; and (c) comparative studies would automatically lead to better selection choices of one technology over another (Clark, 1983; Salomon, 1981). Thompson et al. (1996) criticized this study model, stating

> The most outstanding shortcoming of media comparison studies, as cited by researchers, was the results they yielded. Nearly 60 years of media comparison studies produced tenuous results. Most commonly, those studies that compared the relative achievement of groups receiving instruction from different media resulted in "no significant difference" of achievement between the groups. (p. 19)

While the body of research often showed a slight learning advantage for the newer media over the conventional instructional systems, researchers attributed this relatively temporary advantage to the novelty of the new medium. Meta studies in the reviews of computer-assisted instruction revealed that these gains tended to diminish as students became more familiar with the new technology (Clark, 1983). Clark noted that additional researchers found the novelty effect far less pronounced among college students compared to public school children. These critical reviews of the comparative research model in early instructional media design studies shifted the emphasis from the internal attributes of a technological innovation to the medium's effect on students and their tasks. The research question concerning "which technology was more effective" gave way to an inquiry of which instructional approaches best utilized the innovation (Salomon & Clark, 1977). Researchers gradually realized that studies involving gross media comparisons added little practical or theoretical value to the field (Clark, 1983; Salomon & Clark, 1977).

Aptitude treatment interaction research developed out of the research community's move away from the behaviorist theory of learning toward a cognitive model in the early 1970s. The cognitive learning theory maintained that learners actively and consistently engage in integrating new knowledge with old knowledge (Reimer, 1992; Thompson et al., 1996; Webster, 1992). Acknowledged by many instructional technology researchers, these studies examined types of interactions between the technology and the cognitive learning processes referred to as *aptitude treatment interaction* or ATI (Clark & Surgrue, 1988; Hobson, 2001). Thompson et al. (1996) defined aptitude as any characteristic that forecasts an individual's probability of success regarding the application of a given treatment. Clark and Surgrue (1988) cautioned that the assumption of a single, global learning ability usually produced skewed data. They insisted that effective use of this model required that each technology be subjected to the same task at hand with a minimum of two treatments, one for lower aptitude students and another for higher aptitude students (Cronbach & Snow, 1977; Salomon, 1981; Thompson et al., 1996).

While the majority of instructional technology studies in education correspond to one of the three previously mentioned categories, there is a growing body of research that differs from these models. Some researchers conduct what are referred to as *hypothesis-generating studies*; models aimed at properly developing appropriate research questions for further study (Thompson et al., 1996). Also referred to as *naturalistic research*, this model demonstrates greater concern for causality phenomena than typical empirical research (Culbertson & Cunningham, 1986). The naturalistic research model appears to be an adaptation of the basic qualitative research method (Bresler & Stake, 1992). Burnaford (2001) advocated a similar adaptation referred to as *teacher research*.

Also diverging from research models that normally originate within the university community, Burnaford (2001) further defined teacher research as having different purposes, incentives, and audiences than traditional academic methodologies. Seeking research topics and results directly applicable to the practical needs of public school teaching, the teacher research model involves elementary and secondary school teachers in an active, but less formal research methodology. Though less defined in design, this model's purpose and priorities appear to be related closely to the type of collaborative research recommended in a national survey of music education board members at the state level by MENC (Barry, Taylor, & Hair, 2001). These naturalistic research inquiries look for patterns and themes that suggest credible connections between phenomena (Guba & Lincoln, 1982). These nontraditional studies appear to be most closely related to qualitative research methodology, primarily seeking information that will positively influence future investigation into instructional technology. As a second and equally important goal, advocates of naturalistic research hope the results of their studies will provide guidance in the design of future instructional technologies, matching the individual needs of specific learners to the educational environments in which they are placed (Burnaford, 2001; Guba & Lincoln, 1982; Thompson et al., 1996).

Discipline specific instructional technologies can be seen as a subset of the broader category of instructional technology. Consisting of music applications for general instructional technologies (e.g., computers) and dedicated innovations (e.g., MIDI recording and performance hardware), music technology is similar in makeup to other technology-driven academic disciplines (Baker & Herald, 2003; Rudolph, 2004). As such, research studies involving the interaction and impact of these innovations upon music (composition, performance, and teaching) parallel analogous research categories in instructional technology. These studies tend to follow a similar historical path of inquiry found in general education research (Higgins, 1992; Mark, 1992; Thompson et al., 1996).

Early Research in Music Education

According to Mark (1992), “music education, like other professions, is composed of a diverse and complex grouping of subdisciplines that extend beyond the basic activity of instruction. Research is one of the subdisciplines” (p. 48). When compared with the research history of other academic disciplines, music education is a relatively new phenomenon. Prior to the 20th century, research activities were the purview of legislative bodies, government agencies, school systems, institutions of higher learning, and teacher associations. Very few research surveys collected data on music education (Mark). It was not until the 1920s that music education research began in earnest. Influenced by the general academic disposition towards the use of scientific principles to improve instruction, music education leaders began calling for researchers to reform or guide the practice of music instruction. Early topics of music research centered predominantly upon tests concerning the evaluation of musical ability and measurements of psychomotor skills in music and music achievement tests (Stubley, 1992).

The proliferation of graduate music education programs in colleges and universities in the first half of the 20th century provided new opportunities for research in the discipline. Mark (1992) indicated

> The growth of graduate study in music education from the 1930s has influenced music education research profoundly . . . . These new graduate music education programs greatly increased the number of music education faculty involved in research, adding their efforts to those of faculty of the research universities. (p.51)

According to Mark, however, the majority of music education research is the product of graduate students in the form of master’s degree theses and doctoral dissertations. Relatively few of these graduate students continued to pursue their research activities after obtaining their graduate degrees (Mark, 1992).

Mark speculated that many of these graduates ceased to conduct research due to their personal inexperience or a lack of comprehension regarding the real value of continued research in a single topic category. Regardless of the reason, many of these first-time researchers (often with potentially valuable contributions to the field) lacked the methodological expertise and finesse that comes from knowledge and experience gained through continued research (Leedy & Ormrod, 2005). For those who did find postdoctoral research activities professionally or personally rewarding, professional journals such as *The Journal of Research in Music Education* and *The Bulletin of the Council for Research in Music Education* provided two of the more prominent venues for research publication in music education. Organized in 1907, the *Music Educators National Conference* (MENC) assumed the role of an umbrella organization for music educators, promoting and developing standards for ongoing educational research (MENC, 2004).

Technology and Performance Practice Prior to the 20th Century

Known to exist since the third century B.C., music keyboard technology significantly impacted the development of Western music (Apel, 1972). The current online *Merriam-Webster's Collegiate Dictionary* (2001) defines technology as “the practical application of knowledge" and “the application of specialized aspects of a particular field of endeavor.” Applied to composition and performance practice, these definitions characterize the interdependence between keyboard music and the evolving nature of keyboard development (Apel, 1947; Sachs, 1940). Throughout various musical periods of Western culture, innovations in keyboard technology provided composers and performers with the capability of producing music of ever greater complexity and expressive content. New types of keyboard instruments and incremental improvements for existing keyboards always resulted in the need for new performance skills and increased technical virtuosity. Within one or two generations of each stylistic or mechanical innovation, pedagogues penned treatises to help aspiring musicians achieve the skills necessary to meet the new performance demands (Gordon, 2000).

During the early 1700s, the piano began attracting the attention of European society, a culture previously dominated by the harpsichord and organ (Grout & Palisca, 2001). As this keyboard innovation underwent further refinement and construction (the expansion of its range and expressive abilities), the piano gradually gained popularity throughout the century (Loesser, 1954). With this transformation in keyboard instruments came a change in the status of keyboard players. Prior to the introduction of the piano, keyboard playing was quite utilitarian, predominantly used for accompaniment and background music. By the late 1700s, however, elite performers such as Clementi and Mozart captured the public's fancy and helped create a new aesthetic in music making, giving pianists a higher status in European society (Brubaker, 1996; Kenyon, 1981). Western keyboard music of the 18th century gradually shed the perfunctory limitations superimposed upon musicians by the former arbiters of function and style (the clergy and to a lesser degree the nobility). By the 19th century, piano music came totally into its own as an art form for its own sake, no longer limited by social functionality (Apel, 1947; Gillespie, 1965; Grout & Palisca, 2001; Winter, 1990). In response to the increased improvements in the 19th century piano, pedagogical writings on performance practice increased accordingly (Gordon, 2000).

Throughout the history of the keyboard, performing and composing practitioners dominated pedagogically related writings. The informal 20th century designation for these practitioners was *artist teachers* (Apel, 1947, 1972; Gordon, 1996). According to Gordon (2000), the majority of these performance-practice treatises for keyboard instruments were influenced by three factors. First, performance practice literature for keyboard instruments totally depends upon the physical properties of each unique instrumental type. With substantial differences in physical characteristics between the various keyboard instruments of Western culture, Gordon cautioned the need to interpret every pedagogical treatise within the context of the instrument for which it was written, "its material, construction, and composite sound" (2000, p. 268).

Closely related to the first, Gordon's (1996, 2000) second factor suggested that the changes in physical characteristics from one keyboard genre to another obviously affected the goals and artistic expectations found in these performance-practice treatises. This was a critical consideration for 20th century pianists, who adopted a great deal of harpsichord and clavichord literature, as well as some organ transcriptions, into the performance repertoire of the piano (Friskin & Freundlich, 1973; Hinson, 2000; Magrath, 1995). While issues such as accommodating the sustain pedal to the performance of harpsichord literature on the piano requires judicious interpretation, the pedagogical issue is at least obvious. However, when dealing with subtle performance issues such as correct hand position or proper finger stroke, the blending of performance practices from older keyboard instruments with modern keyboard technique is far less clear. Careful discrimination concerning these issues remains an essential concern for the eclectic 21st century piano pedagogue performing music from other genres on modern keyboard instruments, including electronic keyboards (Gordon 1996, 2000; Rosenblum, 1988; Sandor, 1995).

The third factor recognizes the extramusical influence of each period's intellectual focus and philosophies on these authors throughout Western culture (Gordon, 2000). For more than a century, the intellectual climate following the Age of Reason and the Industrial Revolution focused on topics that could be investigated through scientific methodology (Paine, 1794; Stromberg, 1968). Whether stated or implied, the basic assumption regarding music research was the presumed validity of deriving pedagogical principles from fields of science, including performance-practice topics involving anatomical studies, the mechanics of physics, acoustical phenomena, psychology, and neurophysiology (Brubaker, 1996). Several artist teachers sought to emulate this type of scientific objectivity in their writings, but without a truly rigorous scientific methodology (Christiani, 1885; Gieseking & Leimer, 1932, 1938). Gordon (2000) gave recognition to this extensive body of literature, but observed that though these writings were impressive and often useful, most pedagogues "have been reluctant to attempt to achieve their musical goals by total commitment to any one approach" (p. 269).

The Origins of 20th Century Piano Pedagogy

In the developmental narrative of academic disciplines, piano pedagogy is a relatively new field of study within American institutions of higher learning. Growing out of the slightly older legacy of teacher training in music education, the developmental history of piano pedagogy remains difficult to document. This is due to a lack of extensive historical investigation among pedagogy researchers (Holland, 1996a; Kowalchyk, 1989). Originally embedded in the developmental process of general-education teacher training, the origins of both music education and piano pedagogy are traced predominantly through the chronicles of three mutually exclusive academic traditions: the private academy, the college or university system, and the normal school (Power, 1979). By the end of the 19th century, these fluctuating, but enduring traditions brought about a transformation in American education (Good & Teller, 1969).

Support for publicly funded schools in the first half of the 19th century was generally limited to a form of elementary education, usually referred to as *common schools*. Publicly supported secondary schools were not yet prevalent (Eby, 1952). Students desiring more than a rudimentary education had to rely upon privately funded schools referred to as *academies*. An alternative to the more traditional college preparatory programs that centered upon classical studies, academies were designed to offer students a more practically based, nonclassical postelementary education (Good & Teller, 1969). Academy curricula varied according to market demand, but documentation indicates that music was a popular subject (Power, 1979). By midcentury, courses in music appeared more frequently in the catalogues of these highly competitive private schools. Keene (1982) and Kowalchyk (1989) speculated that since many of these schools offered "school-keeping courses" (Power, 1979, p. 191), courses for training music teachers were probable.

As post-Civil War demand for public education grew, the deficit of qualified teachers continued to increase. This shortage resulted in the proliferation of the normal schools to meet the demand (Eby, 1952). Throughout the first half of the 19th century, teacher preparation was sporadic at best. Common schools were more often taught by individuals without adequate academic background and with no pedagogical training

(Eby, 1952; Power, 1979). The American *normal school*, a pioneering movement first advanced in the 1820s, allowed potential teachers to be fitted for their role as educators without a huge commitment of either public or private funds (Eby, 1952). As post-Civil War America began to insist on better schools, teacher shortages forced governments to phase in publicly funded normal schools to supplement the existing privately funded institutions. Founded throughout the country, these state-funded normal schools continued to emphasize rudimentary pedagogical training within a narrowly defined academic education, producing somewhat qualified, occasionally licensed teachers (Power, 1979).

As state-controlled normal schools proliferated, music teacher training for public elementary and grammar schools came into being as a supplemental addition to the training curriculum. Kowalchyk (1989) noted that music instruction had been offered at many private academies and normal schools from their inception. However, Uszler and Larimer (1984) indicated, “By the 1870s, specialized music curricula, often to train music supervisors, started to appear in the catalogs for some normal schools. Instrumental instruction in such programs was frequently piano education" (p. 9). Uszler and Larimer noted that intensive two- or three-week music courses known as normal *institutes* appeared in the latter half of the 19th century. From 1850 to 1880, these programs focused on group vocal instruction for application to school music methods. After 1880, the curriculum shifted to group instrumental methods courses. The primary thrust was piano instruction (Uszler & Larimer, 1984).

Influenced by John Dewey's progressive educational movement, supporters of class piano education embraced the advantages of group dynamics over private instruction, insisting that traditional piano lessons were inadequate for public school curricula. The purpose of class piano was to teach music, not “train” pianists. The term “traditional” became synonymous with private piano lessons (Montandon, 1998). Viewed as an elitist activity for the well-off, talented student, private instruction was antithetical to the function and democratic principles of public school education (Crowder, 1952). Additional criticism of private piano teachers stemmed from the supposition that they could only teach the way they had been taught, ignoring the advantages of educational psychology and newer teaching methods. Proponents of group teaching developed a distinction in terminology, referring to the private teacher as a “piano teacher” but designating group teachers as “music educators.” As with previous educational disciplines, qualified class piano teachers were in short supply (Montandon, 1998).

According to Montandon (1998) and Holland (1996a), “the greatest promoter and supporter of the class piano movement was the music industry” (Montandon, 1998, p. 22). By the late 19th century, “American piano manufacturing had attained technical superiority and commercial success” (Holland, 1996a, p.71). Publishing companies promoted new teaching methods and supplementary music geared towards the class piano consumer. The music industry continually offered promotional events to stimulate consumer interest in the piano, including recitals, professional concerts, competitions, and workshops (Crowder, 1952; Holland, 1996a).

A more detailed history of the class piano movement and piano pedagogy can be compiled from the writings of Crowder (1952), Johnson (2002), Milliman (1992), Monsour (1959), Montandon (1998), Richards (1962), Shook (1993), and Uszler and Larimer (1984). The purpose of this limited discussion of the turn-of-the-century class piano movement is to provide the background from which piano pedagogy as a discipline and field of research traces its impetus.

The Development of Modern Piano Pedagogy in Institutions of Higher Learning

Universities made significant changes in their curriculum and their professional focus during the last four decades of the 19th century. American universities began incorporating heretofore loosely affiliated and autonomous professional-training institutions into their programs, disciplines not traditionally associated with the university curriculum. This process resulted in the creation of new university programs, including music departments, schools of music, and university-affiliated performance conservatories (Good & Teller, 1969). From the perspective of educational focus, German universities of the time profoundly affected their American counterparts regarding curriculum and research. In Eby's (1952) words

> The German university professor was not a tutor in the English sense, or a teacher in the American sense of the term. He was a specialist in his field – chosen not because of his ability to impart knowledge, but because of his ability to organize and increase knowledge. No man could become a professor in a German university without having given evidence that he had mastered a certain subject of study and produced valuable new results as an investigator. (p. 571)

The federal government's increasing interest in creating a national model for American education helped foster these changes by encouraging university systems to focus on developing a tier system of higher education institutions (Good & Teller, 1969). In conjunction with external European influences on American universities, government endowments for the establishment of agricultural or technical colleges (land-grant colleges) laid the groundwork for the origins of a national model of higher learning (Eby, 1952).

Throughout much of this evolving process, the majority of American colleges and universities were indifferent, if not antithetical to teacher training (Power, 1979). This attitude included the ongoing development of music education. Institutions of higher learning were not only uninterested in teacher education, college and university graduates viewed the profession of teaching with distaste, seeing it as a demeaning and unprofitable career (Eby, 1952; Power, 1979). By the turn-of-the-century, the educational goals and focus of the three post-secondary institutional groups in America had diverged along different paths. The university fostered research scholars, the conservatory developed performers, and the normal school trained teachers (Johnson, 2002; Uszler & Larimer, 1984).

These differences were not permanently segregated, however. These three institutional models gradually coalesced throughout the 20th century, enabling music students to embrace a course of professional study that integrated training in scholarship, performance, and teacher education (Uszler & Larimer, 1984). During the final three decades of the 19th century, instrumental class instruction for voice, strings, and piano grew in popularity as an instructional model within normal schools and conservatories (Holland, 1996a; Uszler & Larimer, 1984). Designed for public school classrooms rather than individual studios or schools of music, class piano programs interacted with emerging educational philosophies supporting experience-oriented learning methods. The application of group dynamics to keyboard education gradually resulted in goal changes for piano study (Montandon, 1998).

While organized programs of piano teacher training began to appear within 19th century normal schools and conservatories, higher level curricula for training music teachers were essentially developed in the 20th century (Sturm, James, Jackson & Burns, 2001). According to Uszler and Larimer (1984), a few universities with dynamic music education departments actively developed performance curricula that embraced a substantially greater number of pedagogical components. The fact that this new discipline developed alongside the continuing artist teacher tradition in colleges and universities is noteworthy (Milliman, 1992). The most significant institutional leaders of this movement were the University of Wisconsin at Madison and the Teachers College at Columbia University (Uszler & Larimer, 1984). Other institutions soon followed this trend with pedagogy programs of significance, particularly at major universities in Bloomington, Chicago, and New York. Though the early 20th century piano pedagogy curriculum focused upon class piano, its popularity declined within public schools by the 1930s. By midcentury, interest in the independent piano teacher grew after decades of obscurity (Johnson, 2002).

During this time, piano pedagogy as a distinct field of study also began its rise to recognition. Frances Clark, an emerging leader in establishing piano pedagogy programs at the private, college, and university levels, centered her efforts upon developing curricula for independent music teachers (Holland, 1996a). From the 1950s through the 1980s, piano pedagogy degree programs proliferated at the undergraduate and graduate levels in many institutions of higher learning (Johnson, 2002; Montandon, 1998). Piano pedagogy research of this period either stemmed from or paralleled similar pursuits in music education (Young, B., 1990).

The Impact of Professional Organizations on Piano Pedagogy

The continued activities of professional umbrella organizations significantly impacted university artist teachers, class piano educators, and independent piano teachers throughout the 20th century. The most significant of these groups were the *Music Educators National Conference*, the *Music Teachers National Association*, and the *National Association of Schools of Music* (Uszler & Larimer, 1984). Midway through the 20th century, piano teachers became aware of a growing problem. Piano students who continued to study and perform more advanced piano literature were progressively limited to a few talented students and a relatively small number of professional pianists. Professional organizations identified two primary causes of this phenomenon: the social influence of new electronic technologies; and the continued persistence of unqualified piano teachers (Sturm et al., 2001).

Though the "baby boomers" of the 1950s had provided the profession with many beginning piano students, professionals were increasingly concerned by the declining number of intermediate- and advanced-level music amateurs (Sturm et al., 2001). In the 1920s through the 1950s,

> The piano lost much of its role of providing domestic musical entertainment to machines that could reproduce music with the effortless turn of a knob. Its competitors – the phonograph, radio, sound film, and later, the television – would move audiences away from the partner piano and toward an electronic machine's receiver or loudspeaker. (Brubaker, 1996, p 237)

Independent studies by Brubaker (1996) and Loesser (1954) observed that Americans were quickly becoming a nation of passive listeners and music consumers, preferring the more easily understood popular idioms to the more sophisticated music of the concert hall. In spite of the manufacturer's promotion of the piano as an indispensable tool for providing moral and emotional health within American society; the radio, phonograph, jukebox, and television provided effortless musical entertainment with no requirements of practice time (Loesser, 1954). The role of private piano instruction became an exercise in life enrichment rather than the production of parlor entertainers or virtuosos (Brubaker, 1996).

With competition from these technological innovations seriously diminishing the societal role of the piano, the ubiquitous presence of unqualified piano teachers further exacerbated the failure of most students to reach a mature level of piano playing (Uszler & Larimer, 1984). Students often began their lessons with the unqualified neighbor who once took piano lessons or the band director with one year of class piano instruction. However, another problem emerged during this period. Trained piano instructors tended to resist pedagogical change. Despite advances in piano-teaching techniques and curricula materials, many of these teachers persisted in teaching in the same manner they themselves had been taught (Sturm et al., 2001). Recognizing these challenges and deficiencies, piano teachers from the independent studios, colleges, and universities pressed for increased standards of professionalism at all levels of keyboard instruction.

Responding with numerous workshops, conferences, research journals, and regional infrastructure, professional umbrella organizations strove to strengthen the legitimacy of piano pedagogy programs at the college and university level (Johnson, 2002). Independent piano teaching and piano pedagogy as a legitimate academic discipline gained further momentum with the establishment of the National Conference on Piano Pedagogy (NCPP) in 1979 (Baker, 1981; Kowalchyk, 1989). For the following 15 years, these biennial conferences and their printed proceedings became a major channel for the presentation and dissemination of key ideas in current piano performance and practice. The conference also served as a communication organ for the exchange of ideas on piano teacher training and the dissemination of new pertinent research (Baker, 1981, 1983; Chronister & McBeth, 1985, 1989; Chronister & Timmons, 1991; Montandon, 1998). The NCPP produced two landmark editions of the *Directory of Piano Pedagogy Offerings in American Colleges and Universities*, which, to date, stand as the only dedicated compendiums of piano pedagogy programs for institutions of higher learning (Chronister & Timmons, 1991). With these directories and the conference's broad scope of interests and pursuits, the NCPP became a reference guide from which colleges and universities could refine their piano pedagogy programs, providing an ongoing chronicle of trends in the field of piano pedagogy (Johnson, 2002; Kowalchyk, 1989; Montandon, 1998; Shook, 1993; Uszler, 1992).

The professional vacuum left by the disbandment of the National Conference on Piano Pedagogy at its last meeting in 1994 gradually filled with the establishment of four new professional organizations for pianists and piano teachers. They were the 1996 National Piano Pedagogy Conference (renamed a year later as the World Piano Pedagogy Conference or WPPC), Pedagogy Saturday (a supplement to the existing MTNA conference beginning in 1997), the National Group Piano and Piano Pedagogy Forum (established in 2000), and the National Conference on Keyboard Pedagogy (originated in 2001). It is interesting that while the advent of the 20th century was a time when disparate educational forces were coalescing under primary umbrella organizations, the demise of the NCPP resulted in a 21st century divergence of piano pedagogy interests into more specialized areas.

Program emphases vary from group to group. Based upon the program offerings of its first eight conferences, the WPPC (the largest of the splinter groups from the original NCPP) rapidly narrowed its focus to performance practice pedagogy for the artist teacher (Holland, 1996b; Holland & Tan, 1997, 1998, 1999; Miller, 2003; Smith-Tarchalski & Anderson, 2002; Smith-Tarchalski & Sharp, 2000, 2001). To varying degrees, the other groups remain relatively focused on specific individual interests, from independent teaching to group teaching. While MTNA's Pedagogy Saturday appears to maintain the most diverse scope of topics, the number of participants in each group's conference has varied considerably (Johnson, 2002).

The newest professional piano pedagogy organization has been sponsored by the Frances Clark Center for Keyboard Pedagogy, founded in 1999 by Louise Goss and the late Richard Chronister. This new organization, the National Conference on Keyboard Pedagogy (NCKP), sought to reactivate the original National Conference on Piano Pedagogy (National Conference on Keyboard Pedagogy, 2004). Whether or not the NCKP succeeds in replacing the NCPP as the comprehensive umbrella organization for piano pedagogy remains to be seen.

Origins of Digital Technology Research in Music and Keyboard Instruction

The modern piano pedagogy movement is less than a century old. Piano pedagogy programs consist of a wide range of offerings, from individual courses, tracks, or emphases within traditional music degrees, to dedicated pedagogy degree offerings at the undergraduate and graduate levels (Kowalchyk, 1989; Johnson, 2002). As these degree offerings proliferated, dedicated research in piano pedagogy substantially increased. In the area of digital technology, however, piano pedagogy research remains relatively underdeveloped. During the past 80 years, most of the research connected with keyboard instruction focused on the development and analysis of teaching methods for independent piano teachers and piano pedagogues. Attempts to standardize the pedagogy curriculum from the many disparate pedagogical philosophies and focuses within colleges and universities also consumed a sizable portion of pedagogy research effort (Kowalchyk, 1989; Milliman, 1992; Uszler et al., 1991, 2000; Uszler & Larimer, 1984). Yet based upon the volume of research for the profession as a whole, studies in the development and application of digital technology are relatively limited in music education and rare in piano pedagogy (Albergo, 1987; Barry, 2004; Chronister & Timmons, 1991; Renfrow, 1991b).

With the mid-20th century emergence of electrically based media innovations such as television, audio recording, and video recording, fields of research pertaining to the adaptation of instructional technology to music entered a new phase of rapid expansion (Williams & Webster, 1999). Using television as a typical example of a predigital technology application, Higgins (1992) stated, “the history of the use of televised music instruction is a microcosm of the use of a technology in instruction" (p. 482). Propelled by unrealistic expectations connected with its potential, the rush to develop television resulted in little or no research on how it should be used. A number of telecourses were tested using a simple evaluation research model and to no one's surprise, it was determined that students could and did learn using this medium. However, there was no indicator as to the degree of effectiveness regarding this medium compared to other teaching styles. Additional studies on the impact of various higher quality programming selections such as the *Bell Telephone Hour* series produced no definitive findings other than concluding that television showed promising potential as an instructional medium (Higgins, 1992; Thompson et al., 1996).

Giles (1981) developed a 30-program telecourse for adult beginners in applied piano, accompanied by a textbook and student guidebook. The testing sequence was conducted in a piano lab via closed-circuit TV and broadcast on public television. The final conclusions were similar to previous studies, indicating that motivated adults could complete the first semester piano course with a success rate equivalent to traditional instruction in class or private study. Music education studies in the 1950s and 1960s, like their general education counterparts, usually revealed little or no significant difference in the educational efficacy of television over traditional methods (Giles, 1981). The extensive use of television in music education failed to materialize, along with the revolutionary promises of its advocates (Higgins, 1992). Once again, new technological innovations failed to produce the expected productivity touted by it advocates.

Digital Technology's Impact on Pedagogy Research

The development and proliferation of computer-based instructional technology brought about an explosion of information that unsettled the foundations of the American way of life (Combs, 1991). Regarding the computer's capacity for storing and manipulating large amounts of data, Scudder (1988) stated,

> Futurists explain that the speed of communication, transportation, and computation as well as the amount of power available to society since 1945 has increased by figures of ten to the seventh and eighth power over all the rest of human history. (p. 1)

Based upon an individual's viewpoint, Scudder indicated that the power of computers either managed or exacerbated this information overload. In addition to affecting the processes of mathematical and scientific computational capability, the innovations adapted from computer technology profoundly influenced music composition, performance, sound reinforcement, and sound recording at all levels of music education, including piano instruction. The advancement of digitally based computer innovations is inextricably linked to research regarding the modification, application, assessment, and ultimate diffusion of these innovations in music education (Dodge & Jerse, 1997; Fink, 1996; Rudolph, 1996, 2004; Todd, 1992).

Regarding the relationship between this digital proliferation and its integration into educational community, Berz and Bowman (1994) stated,

> Research and development of specific computer applications has followed definite cycles: development of a specific technology, usually unrelated to any educational goal, adaptation of the technology for educational use, conducting feasibility studies to determine development and implementation, and conducting effectiveness studies. (p. 3)

Berz and Bowman (1994) also suggested that conclusions from the effectiveness or assessment cycle of research often result in the next cycle of technology development. Webster (2002) indicated that a philosophy of use should, but does not always occur during the assessment phase. The research and development of musically related digital technologies presented in this section will follow this cycle model.

No single individual was responsible for the invention of the computer. Modern computer developers were indebted to mathematicians, engineers, and inventors encompassing thousands of years of the computational innovations necessary to bring modern computer technology into existence (Mobley, 2001). A thorough discussion on the history of computation and computers can be found in the studies of Connors (2000), Mobley (2001) and Scudder (1988). While many notable predigital calculating innovations exist, this study agrees with those historians that establish computer technology as having begun in the mid-20th century with electrically powered, digital calculating mainframes based upon vacuum tube technology (Alderman, 1999; Bellis, 2004b; Connors, 2000; Guinee, 1995; Scudder; 1988; Thurber, 1995). Based upon the design structure of the actual mechanisms, digital computer development can be traced through four generations of system hardware, as seen in Table 3.

Table 3.

Computer Generations

Computer generation	Design basis
First-generation computers	Based upon vacuum tube technology
Second-generation computers	Based upon transistor technology
Third-generation computers	Based upon integrated-circuit technology
Fourth-generation computers	Based upon microprocessor technology

Note. *Journey through the History of Information Technology* (chapter 8, para. 3), by K. Guinee, 1995, Princeton University, Retrieved November 20, 2004, from http://www.cs.princeton.edu/~kguinee/Thesis/Computer.html. Copyright 1995 by K. Guinee.

In 1946, the first full-scale, general-purpose digital computer went online. Built by John Mauchly and J. Presper Eckert, Jr., the 30-ton ENIAC (Electronic Numeral Integrator and Calculator) was the prototype for the modern computer (Thurber, 1995). Thurber described this as a monstrosity, stating, “It contained over 17,000 vacuum tubes, used some 500 miles of wiring, and occupied 15,000 square feet of floor space” (p. 8). Known as a *mainframe*, this prototype was quickly followed by improved units with names such as BINAC, MANIAC, and UNIVAC (Scudder, 1988). Although by today's standards, these innovations were awkward, large, and terribly expensive, the speed and accuracy of first-generation computers outperformed the mechanical calculators of the time by factors measured in the tens of thousands (Thurber, 1995).

The majority of these early mainframes were the result of collaboration between major American universities and the federal government (particularly the Defense Department). A few came about through partnering with large corporations such as IBM. University faculties accepted the continuing challenge to build better computers for a widening variety of interests (Connors, 2000). Lured by the financial potential of these new innovations, a number of faculty researchers left academia to join major business corporations or establish their own companies (Connors, 2000; Mobley, 2001; Scudder, 1988).

As with most educational disciplines, direct computer use for music education research was extremely limited at this stage of development. Rich corporations and the federal government were the only two entities with sufficient funds to afford computing power (Alderman, 1999). These systems were only available at large universities actually involved with computer design and research. Access priorities for mainframes were dominated by mathematical and scientific research, predominantly for defense projects (Scudder, 1988; Williams & Webster, 1999). The concept of personal computers had not yet entered the mind of most computer or educational researchers (Thurber, 1995).

Although access to early mainframe computers was extremely limited, the vacuum tube technology powering them was adapted to a broad spectrum of new consumer products, impacting both music and education. Initially developed by Thomas Edison, vacuum tubes became the basis of many extraordinary new innovations. A number of these inventions influenced the development of music, particularly music composition and performance (Williams & Webster, 1996). Oscillators based on vacuum tubes led to the development of amplifiers, electrically based phonographs, tape recorders, early electric guitars, and the Hammond electric organ (Webster, 2002). Popular music genres quickly adopted many of these new instruments (Fink, 1996).

Between the 1930s and the 1950s, prototypes of early analog keyboard synthesizers emerged. These early esoteric instruments were usually designed for the unique needs of university electronic-composition studios. The two earliest analog designs to gain notoriety were the *Theremin* and the *Ondes Martenot*. Progressive composers of serious music, including Hindemith, Milhaud, Messien, Varase, and Stockhausen, incorporated the sounds of electronic keyboards into their compositions (Naumann & Wagoner, 1985). Many film composers, intrigued by the unearthly quality of synthesized music, also used electronic sounds in their movie scores (Boom, 1987). The synthesizers of the 1940s through the early 1960s were generally large, expensive to build and maintain, and like the computer technology that spawned them, difficult to use (Rothstein, 1992). However, the proliferation, use, and influence of these the first-generation innovations gradually but inexorably altered perceptions for future music training at all levels of music education (Kostka, 1990; Webster, 2002).

First-generation computer research in music education was further hindered by the extreme complexity of the programming process. All computers, from the most primitive to the most sophisticated, utilize a basic programming code known as *machine language*, the only means of communication computers actually understand on the most fundamental level (Bellis, 2004a). Machine language consists of a digital binary code of zeros (0) and ones (1) in long and complex strings of numerals. Programming in machine language is seldom used by individuals other than those who design and repair computer hardware (Dodge & Jerse, 1997). In an effort to improve efficiency in computer programming, scientists developed a second-generation code known as *assembly language*, which converts the sequences of zeros and ones into basic human words such as *add*. Though it came closer to the desired goal, this *low-level* language was still too similar to machine language for general programming use (Reiser, 2001). The final goal was to develop a *high-level* language that was closer to the human language and could be programmed by individuals other than mathematicians and scientists (Dodge & Jerse, 1997). In 1954, this was accomplished by IBM researcher John Backus, who invented the first high-level language known as *FORTRAN*, a programming language still in use today for scientific and mathematical applications (Bellis, 2004a). As computers developed, specialized high-level languages and powerful interfaces were created to meet the programming needs of specific disciplines (Dodge & Jerse, 1997).

Most historians agree that the second major breakthrough in computer research was founded on the invention of the transistor. In 1947, three physicists at the Bell Telephone Laboratories (Bardeen, Shockley, and Brattain) completed their research on the *transistor* (Bellis, 2004a). Transistors performed most of the functions of vacuum tubes, but substantially faster. Texas Instruments improved upon the transistor in 1954 by using silicon as a more efficient substitute for germanium, the key element in the prototype transistor's construction (Guinee, 1995). Consuming only a small fraction of the energy required by heat prone vacuum tubes, computers became more reliable, less expensive, and smaller in size than their first-generation predecessors (Connors, 2000; Guinee, 1995). Between 1958 and 1964, greater numbers of these transistor-powered computers were built and marketed (Connors, 2000). IBM was the first of several companies in what is now known as Silicon Valley of California that produced a successful line of the second-generation mainframes (Scudder, 1988).

Second-generation mainframes opened the door to academic research as the more affordable IBM 700 series computers began to replace the larger first-generation models. Connors (2000) noted, “As academia entered the 1960s, computers had advanced and expanded; many smaller institutions began to receive the older machines as the government and leading institutions continued to develop newer faster computers” (p. 14). Even as microcomputers such as Digital Equipment Corporation's PDP-8 were being developed and gradually released, CAI research for mainframe systems was occurring on campuses such as Stanford University and the University of Illinois (Schwartz & Gottfried, 1993; Simms, 1996; Webster, 2002).

At the end of the 1960s and into the 1970s, there were four known research studies of note in the application of CAI programs for music education. Stanford University reported on the first CAI program project for the development of music performance testing, incorporating a prototype pitch discriminator into an IBM 1620 computer to extract and compare pitches with previously stored models. Student test subjects received feedback via a printout form. Alvin’s (1971) doctoral thesis was an evaluation research study using an IBM 1500 system to test the feasibility of teaching ear training and sight singing through CAI. The second CAI study was developed at Pennsylvania State University in 1969 and researched aspects of instrumental music performance. Also using an evaluation research model, the study centered upon the feasibility of using a CAI clarinet instruction program for the improvement of articulation, phrasing, and rhythmic performance. Too primitive to "listen" to the student, this model simply presented previously recorded examples for feedback with which students could compare their own recorded performances (Peters, 1974).

The third study in instructional research involved prototype transistor-based digital piano keyboards. An impressive consortium of organizations facilitated this project, consisting of the System Development Corporation; the Office of Education; the U. S. Department of Health, Education, and Welfare; the Wichita Public Schools; and the Wurlitzer Company. William Kent, the primary researcher, worked with 50 students at the Kellogg elementary school in Wichita, Kansas on three methods of computerized instruction that included "advanced" CAI programs. This 1970 project determined the feasibility of computer-controlled, elementary keyboard instruction (Peters, 1974).

The fourth and perhaps most widely known CAI research project of the period began in the 1960s with collaboration between the Computer Education Research Laboratory at the University of Illinois and the National Science Foundation. Best known by its acronym, PLATO (Programmed Logic for Automatic Teaching Operations), this long-term project developed an integrated mainframe-based system that allowed the simultaneous use of a variety of CAI applications from individual student terminals (Pagliaro, 1983). During 1948, the university attempted to purchase a digital mainframe. After numerous attempts were unsuccessful, the university created a design laboratory to construct their own computer. The institution's efforts resulted in the production of two new computer models, the ORDVAC (designed for the military) and the ILIAC I (built for campus research). The PLATO project was originally designed to function with the ILIAC I. Woolley (1994) attributed the success of this project to the collaboration of creative eccentrics ranging from University professors to high school students, concluding that PLATO was in many ways at least a decade ahead of its time. Originally capable of supporting only a single classroom of terminals, three major software revisions and computer software upgrades eventually allowed PLATO to support 1000 student stations with high-resolution graphic display terminals, simultaneously running different programs from different locations (Peters, 1974). Over the process of several years, continuing research in new compiler software resulted in a special-purpose programming language known as TUTOR, specifically designed to allow educators without previous programming skills to write educational software for PLATO.

Music education was among the disciplines that eventually pursued a CAI software research project using PLATO. Prior to Peters' (1974) research, no audio interface existed between the access terminals and the PLATO mainframe. Peters surmised that this audio deficit had previously inhibited the development of CAI in music education research. Aided by Dr. George Frost, who developed and produced a functional audio interface for the PLATO system, Peters' doctoral dissertation constituted an evaluation research study on the feasibility of computer-assisted instruction for teaching the skill of playing the trumpet "with precision regarding pitch and rhythm" (p. 2) using the PLATO system. According to Higgins (1992), Peters was one of the early computer researchers to recognize and offer a successful prognosis regarding computer use in music education. All of these second-generation research studies were basic feasibility studies, describing the development or implementation of specific applications (Berz & Bowman, 1994).

Transistor technology also opened a door for new keyboard innovations for performance, recording, and keyboard instruction. Transistors and early semiconductors brought about modular design, smallness, and electronic flexibility. After experimenting with electric pianos for more than a decade, Fender Rhodes introduced the first in a series of portable electric pianos. Used by popular recording artists such as Ray Charles and Aretha Franklin, the Fender Rhodes became supremely popular with professional and amateur musicians for the next two decades (Moinlycke, 1996). Other innovative performance keyboards included transistorized analog synthesizers like the ARP 2600, the Buchla, and the famous Moog, the first commercially successful music synthesizers (Williams & Webster, 1996).

Previously ignorant of synthesizers, the public became enamored with them after the release of Walter (Wendy) Carlos' highly successful album, *Switched on Bach*, consisting of Johann Sebastian Bach's music arranged specifically for and performed on a Moog synthesizer. As prices dropped and popularity grew, these analog synthesizers found their way into schools and home studios, becoming the catalyst for the study of sound synthesis (Webster, 2002). By the early 1970s, analog synthesizers had been incorporated into rock bands as well as school studios (Boom, 1987). On the educational front, companies such as Wurlitzer and Baldwin were developing electronic pianos for both performance and educational use. Between the years of 1967 and 1980, the Wurlitzer model 206 electronic keyboard, specifically designed for class piano laboratories, found its way into university group piano facilities across the nation (Brubaker, 1996). The Kent research project in the Wichita public schools utilized Wurlitzer keyboards of this type (Peters, 1974).

By the 1970s, the deployment of third-generation computer technology was well underway (Thurber, 1995). Jack Kilby's invention of the first integrated circuit in the 1950s quickly led to the first mass-produced integrated circuit or *chip*, resulting in the production of the microcomputer (PC) in the 1970s. This relatively inexpensive and easy-to-use computer technology finally afforded the average music educator the opportunity to play an active role in the development and research of instructional technology (Pan, 2001). However, as with computer research in general education, there was a noticeable time lag between the introduction of the PC and the beginning of applied computer research in music education (Fullerton, 1998; Hill, 1998).

Throughout the first half of the 1970s, research in music education still relied upon university mainframe computers, particularly with the PLATO and GUIDO learning systems (Alvin, 1971; Higgins, 1992; Hofstetter, 1980; Placek, 1974). As PCs became more readily available throughout the 1980s, music researchers began designing hardware peripherals and software specifically for these platforms (Berz & Bowman, 1994; Higgins, 1992). By 1977, a number of new microcomputers were marketed, including the Commodore Pet and the Radio Shack TRS-80 (Higgins, 1992). However, the 1978 release of Apple's revolutionary microcomputer, the Apple II provided the greatest impact on the third period of educational development and research (Berz & Bowman, 1994). Offering impressive educational discounts and instituting shrewd marketing strategies, Apple became the dominant educational platform throughout the next decade (McCarthy, 1989; Young & Blumenstyk, 1998). The IBM Corporation emulated Apple by producing its own personal computer, producing a model that was to become the most widely disseminated computer platform in the United States (Webster, 2002).

Microcomputer peripherals and dedicated systems, based upon the integrated circuit, also provided new avenues for research in music education. The invention of the digital-to-analog converter board (DAC) enabled these microcomputers to generate software-based sound in four-part polyphony, paving the way for the multimedia concept in computer workstations (Webster, 2002). In the mid 1970s, Illinois State University music department chairman, Dr. David Schrader, and David Williams founded Micro Music, Incorporated. They developed the first commercially successful library of CAI music software for microcomputers, including software support for melodic, rhythmic, and harmonic dictation, as well as software for error detection and music composition (Webster, 2002).

One of Micro Music's most widely disseminated products was Schrader's TAP Master rhythm learning system. Interfacing a uniquely designed computerized module with a stereo cassette tape recorder, the system provided a set of progressive rhythm-tapping drills, tied to a sophisticated audio and visual system of error detection. Later marketed by Temporal Acuity Products, the TAP Master system offered three series of rhythm drills for preschool, intermediate, and advanced levels of student instruction. This early drill-and-practice system demonstrated a high level of sophistication, incorporating a combination of tutorial presentation and drill-and-practice, with error-detection capabilities integral to the lessons (Schrader, 1975).

The TAP system found its way into all levels of music education and was the subject of a number of educational studies (Berz & Bowman, 1994). Bowman's (1984) dissertation investigated two different methods of remediation for precollegiate basic theory skills. The experimental group met three times a week for independent ear-training practice based on programmed instruction. Guided by the instruction manual, these sessions were based upon the integration of a series of CAI and drill programs that included the TAP system. The control group attended five weekly classes of traditional ear-training instruction. Though both approaches proved equally effective, Bowman surmised that the use of CAI instruction achieved results with less class time and less teacher intervention (Berz & Bowman, 1994; Bowman, 1984). Other experimental feasibility studies demonstrated the value of the TAP Master and similar CAI systems as supplements to traditional instruction in ear training (Berz & Bowman, 1994).

In the early 1970s, Intel Corporation released the world's first universal microprocessor. The microprocessor was a new programmable, general-purpose logic chip that was in essence a small computer, containing many integrated circuits in the space of a 1/8" by 1/6" wafer. This new microprocessor possessed more computing power than the entire first-generation ENIAC mainframe (Bellis, 2004b). From this point in the development of digital computer technology, new computer systems, computer peripherals, and other microprocessor-driven innovations appeared at an accelerated rate. Microprocessor technology spawned a new generation of electronic music instruments, including digital piano keyboards and synthesizers. Almost overnight, new companies sprang into existence to accommodate the voracious demand for new keyboard innovations by the consuming public (Rudolph, 2004).

During this period, professional and amateur musicians alike struggled with the lack of interconnectivity between digital keyboard instruments of different manufacturers. After much discussion and wrangling, company executives eventually recognized that proprietary keyboard interfaces were unacceptable to synthesizer consumers. After more than two years of development by key leaders in the industry, keyboard manufacturers introduced the first universal interface protocol (Rothstein, 1992). Known as the *MIDI* 1.0 standard, the *Musical Instrument Digital Interface* protocol, two companies immediately incorporated this innovation into the Sequential Circuits' Profit 600 and Yamaha's DX-7 keyboards. Over the years, additions and enhancements have been added to the MIDI protocol under the watchful eye of the International MIDI Association (Mager, 1997). It was soon recognized that the MIDI protocol enabled devices other than keyboards to interact. The development and production of the modular MIDI interface allowed computers to connect to a wide variety of peripherals, including keyboards, hardware sequencers, and drum machines (Boom, 1987).

Research on MIDI as it relates to music education curricula appears to be somewhat limited. However, there are a number of books published concerning the MIDI phenomena. These books tend to concentrate on a brief history of MIDI development, a detailed analysis of the technical specifications of its operation, and detailed procedures for configuring MIDI-related devices in a variety of scenarios, including various setups for musical performance, electronic studio recording, and home hobby use (Boom, 1987; Pellman, 1994; Rothstein, 1992). In like manner, educational studies and texts on the application of MIDI focused on the mechanistic procedures necessary for designing and implementing technology laboratories and studios for schools (Boom, 1987). References to educational use of MIDI were oriented more towards choosing hardware and available software, based predominantly on the characteristics and function of the products (Rothstein, 1992). All of these authors included unsubstantiated statements of optimism regarding the potential value of MIDI to education and their expectation for its successful integration into music education. They say very little, if anything about suggested educational applications for the technology. Sporadic workshops at pedagogy conferences offer the only actual attempt to find practical means for using MIDI in music educational curricula (Holland & Stampfli, 1999).

Graduate level research into MIDI is even more limited. Hunter-Armstrong's (1996) master's thesis, *MIDI Applications in Music Education*, briefly approached the subject in the same manner as Rothstein (1992) and Pellman (1994). Only two doctoral studies dealing specifically with MIDI were found by this researcher and only one on the general status of MIDI as it impacted some aspect of curricula in higher education (Beckman, 1994; Mager, 1997). It is noteworthy that most of the background information on the subject of MIDI for these studies was obtained by a survey of trade periodicals such as a *Keyboard Magazine*, *Mix*, and *Electronic Musician*, rather than educational sources.

Mager's (1997) study surveyed a cross section of music faculty teaching within institutions of higher learning. With the exception of music faculty teaching music technology courses, two thirds of the survey participants from the disciplines of music theory, music education, music composition, and performance rated a knowledge of MIDI theory, sequencing, and notational skills as only "useful" (number 2 on a 3-point Likert scale). Less than one third of the participants considered such knowledge "essential" (number 3 on the same scale). Participants who valued these skills viewed learning the use of MIDI technology through internships in music education as "somewhat important" (number 4 on a 5-point Likert scale), but rated hands-on laboratory experience “very important” (number 5 on a 5-point Likert scale).

Mager (1997) noted that the opinions expressed by the respondents in his study did not necessarily indicate their personal curricular practice regarding technology within their subject areas. He was also cognizant of the fact that the curricular objectives of different music programs and the implications for music technology and MIDI diffusion within the respondent’s curriculum were beyond the scope of his study.

Piano Pedagogy Research in the Last 20 Years

Following the development of the MIDI protocol, American market forces gradually standardized the computer industry by reducing the number of viable computer platforms in the United States to the Apple and PC platforms. The constant production of faster, more powerful computers, computer peripherals in the areas of audio recording and playback, video recording and playback, data storage, and telecommunication networks (the Internet) continually revolutionized all aspects of the culture, including music (Webster, 2002). Computer-assisted instruction rapidly evolved as multimedia capabilities became available. Interactive hypermedia format quickly followed the older linear multimedia capability, once again offering myriads of potential new applications to music education (Berz & Bowman, 1994; Johnson, 2002; Mager, 1997).

Technology researchers in music education and piano pedagogy struggled to keep up with the innovative output of the last 20 years. All of the categories of educational research are represented, but only on a limited basis. Feasibility studies regarding the adaptation of computer technology to music education continue to surface in research studies such as Smith’s (2002) effectiveness study of computer-assisted instruction for the development of rhythm reading skills within a middle school instrumental program.

Simple comparison studies between two differing instructional mediums also remain among the more prevalent forms of dissertation research in music education (Thompson et al., 1996). He's (1995) comparison study on the effects of two computer-based instructional programs in music is a typical example of this approach in keyboard education at the college level. One program methodology relied upon a traditional-approach program (TAP) while the other utilized a game-approach program (GAP). The programs were offered on the Internet to allow more access for college students in different locales. After administering a pretest to 52 students enrolled in music fundamentals or basic keyboard classes at four different institutions of higher learning, the researcher then exposed each student to one of two program approaches over the course of a semester. A posttest immediately followed the treatment. As had been previously found with similar studies in general education, the results indicated that both methods were effective in presenting the curricular material, but neither approach demonstrated a significant statistical difference (He, 1995).

Other feasibility studies using keyboard technology include Keenan's (1995) research on the adaptation of the *Yamaha Music in Education* keyboard hardware and software system for elementary music education to keyboard instruction for retired adults. One notable feasibility study researched new ways of using MIDI keyboard technology as a keyboard performance assessment tool (Beckman, 1994). Beckman used the MIDI protocol to track the patterns of dynamics and articulation found in the piano performances of a Bartok selection. Using a Disklavier as the performance vehicle, Beckman obtained and analyzed the performance data using Performer sequencing software and a Kurzweil K2000 synthesizer. When critiqued through analog means (e.g., the human ear), the measurement of performance interpretation is a subjective process, based upon the varying perceptions of different individuals. By using the digital binary data available through the MIDI protocol to convert these performances into discrete numerical sequences, the researcher quantifiably measured the rhythmic patterns, tempo, nuances of articulation, and dynamic contrasts with great accuracy. Comparisons of different performances by a variety of pianists were analyzed and discussed in a more objective manner (Beckman, 1994).

From the perspective of technology in piano pedagogy, Renfrow's (1991a) dissertation on the development and evaluation of objectives for the education of graduate piano pedagogy students in computer and keyboard technology is particularly pertinent to this current study. Renfrow (1991a) researched and developed a series of technology competencies that graduate piano pedagogy students should be expected to master. Supported by survey research and phone interviews with music technology experts in industry and higher education, this research laid the groundwork for the possible standardization of technological knowledge within the many, rather unique piano pedagogy curriculums (Kowalchyk, 1989; Renfrow, 1991a).

Case studies acknowledging music technology as a factor within the study are more numerous in piano pedagogy than studies focusing directly on technology. Shender (1998) conducted a qualitative analysis of a group keyboard program for children and adults at the Bronx House Music School. Its stated purpose was the evaluation of the strengths and weaknesses of a group piano instruction program that used CAI instruction in conjunction with digital keyboard technology. Though the title seemed to emphasize music technology, the study actually focused on every aspect of group piano teaching, of which the technology segment was only a small part (Shender, 1998).

During the last two decades, graduate research in piano pedagogy produced several valuable studies regarding the status of the profession. Some studies approached it from the perspective of piano pedagogy course content (Johnson, 2002; Milliman, 1992). Other researchers approached the profession by ascertaining the profile or status of pedagogy instructors from the perspective of personal education, competencies and experiences (Kowalchyk, 1989; Shook, 1993). Montandon (1998) researched the status of piano pedagogy through the proceedings of the National Conference on Piano Pedagogy. Each of these studies alluded to the importance of technology in the training of future piano pedagogues and the development of a comprehensive piano pedagogy curriculum for independent piano teachers in undergraduate and graduate pedagogy programs. However, none of these studies delved deeply into the specifics of technology development within the curriculum or the profession. Other than Renfrow's (1991a) feasibility study regarding the development of competencies for music technology for graduate piano pedagogy students, there are no definitive studies on the status adoption, personal use, or curricular implementation of technology within American piano pedagogy programs at the graduate and undergraduate level. The current study seeks to address this deficiency.

Summary of the Literature

The preponderance of the literature on the adoption and diffusion of an innovation demonstrates that individuals within social systems react to innovative change in a consistently predictable manner. Humanity appears to be quite comfortable with incremental improvements in technology; improvements that occur in small, relatively palatable bites that do not significantly disturb the status quo of an existing paradigm. Comprehensive changes of a more radical nature, however, usually require major readjustments by members of a group. These changes are generally uncomfortable and often resisted. The adoption and diffusion model regarding innovations provides a time-based means of tracking the acceptance and utilization of a new idea, procedure, or artifact within the social context to which it is introduced. On a given timeline, the diffusion of innovation within a specific social group can be tracked as individual members of the group adopt and utilize the innovation. The diffusion rate can be represented by a statistical graph that has consistently resulted in a predictable bell curve or an S-shaped curve.

The literature also demonstrates that individuals within a society or social system fall into a number of adopter categories, based upon the timeframe in which they choose to utilize an innovation. The characteristics of each category influence the others as the group moves towards the goal of total diffusion of a specific innovation. Individuals such as Innovators and Early Adopters, who quickly embrace new innovations, provide both positive and negative influences on their peers. At the far end of the adoption timeline, Laggards tend to resist innovative change the longest and often never truly adopt an innovation, even when it is forced on them. Outside influences such as change agents give varying degrees of help or hindrance in the adoption process, depending upon how the individual is viewed by the social group.

The electronic and digital innovations of the 20th century have radically impacted education at all levels, requiring a readjustment of existing teaching paradigms. Yet, in spite of the vast amounts of capital invested on classroom technology, the educational promise of instructional technology is not yet satisfactory. Issues such as adequate equipment availability, technical support, teacher training and substantive research all contributed to this lackluster performance. However, even more critical to the ongoing process is the need for a comprehensive philosophy regarding the *proper* use of technology in all its contexts. Educators need to use the technology as a tool to teach the student rather than teach to the technology itself. Teachers should examine the reasons why their own experiences with technology are either positive or negative.

While music educators at all levels are subject to the same challenges as general educators, they also contend with the fact that the current technology revolution has not only created new digital instruments and instructional technologies, but the need to define their place in the current artistic and educational paradigm. The difficulty then lies in accurately determining how and when these technological developments force a revision of the old paradigm. Regarding music education in general and piano pedagogy in particular, this revision may already have begun (Blocker, 1991). The history of the current trends in music technology may support that contention.

The development of microprocessors removed the obstacles of size and cost that had restricted most educators and the general public from the use of computers (Uszler, 1992). During the following decade, these microprocessors were adapted for use in the first practical digital pianos and music keyboards. MIDI offered practical connectivity between instruments and computers. While these innovations have gone on to dominate the consumer keyboard market, piano pedagogues and artist teachers failed to explore the potential for these technologies (Ferguson, 1998). Computer technology continues to develop at an impressive rate, with innovations often appearing faster than music educators and piano pedagogues can process them properly. Yet, the relative stabilization of computer operating systems and the MIDI keyboard protocol also offers piano pedagogy professionals an opportunity to reflect on the efficacy of the equipment's use for training piano educators. Greater efforts on the part of the profession are also needed to develop proper guidelines for research in the use of technology in music education.

Piano pedagogy research grew significantly in the past 20 years, but its output regarding technology in music is still not organized around a set of philosophical goals necessary to sustain substantive research. Technology research in piano pedagogy has been sporadic and unfocused when compared to the research interest shown throughout the last century regarding subjects such as teaching methods. The question as to whether this new technology will remain a part of the American culture appears to have been answered. It will. The current phase of music technology left the stage of infancy and toddles toward maturity. The question as to whether music technology is currently accepted by the piano pedagogy profession as a viable teaching tool has yet to be answered adequately. The degree to which music technology is being utilized in the training of future piano teachers also remains unanswered. It is the author's desire that this study respond to these questions by assessing the current state of music technology use in piano pedagogy. The current study provides a snapshot of the status of technology use within the graduate and undergraduate pedagogy community that may help guide further research efforts in the future.

Chapter 3

Methodology

The purpose of this study is to assess the current level of adoption and diffusion of specific digitally based instructional and music technologies by pedagogues in American graduate and undergraduate pedagogy programs. This study seeks to ascertain faculty attitudes related to the adoption or rejection of these technologies. Faculty attitudes regarding the support and training needed to utilize music technology effectively was also investigated. The following objectives need to be addressed to accomplish these goals:

1. Identify profiles of piano pedagogy faculty who use, and do not use, certain *generic digital instructional* technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject;
2. Identify profiles of piano pedagogy faculty who use, and do not use, specific *digital music* technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject;
3. Identify the specific attitudes of the overall sample, and of demographic and pedagogical subgroups of respondents, related to implementation or non-implementation of generic digital instructional or digital music technologies;
4. Examine the relationship between faculty instructional technology adoption and usage and digital music technology adoption and usage; and
5. Compare the patterns of generic digital instructional and digital music technology usage with the five-part adopter categories of the Rogerian typology concerning the adoption of innovations.

These objectives provide a framework by which further insight could be gained regarding diffusion of technology within the target population of piano pedagogues in American colleges and universities.

It was determined that a descriptive survey would be the most appropriate method of gathering the information necessary to fulfill these objectives. This study was based upon the results of a four-section survey instrument. The proposed survey instrument was primarily adapted by this author from the Music Education Technology Skills Inventory (METSI) questionnaire, developed for a study published in an article of the *Journal of Technology in Music Learning* (Barry, 2004). Barry's METSI was adapted from the Educational Technology Skills Inventory used by the Iowa Department of Education in 1996. It was developed to understand Iowa educators' current use of technology, their proficiency with technology, and to determine the level of need for technology training among Iowa educators. Related music technology studies and parallel studies in the implementation of general instructional technology influenced additional content and design factors (Babbie, 1990; Carter, 1998; Cohen & Forde, 1992; Holloway, 1977, 1996; Renfrow, 1991a).

In light of the objectives of this study and this researcher's collegiate and secondary school experience using and teaching music technology as a piano pedagogue, the author altered the content of the original METSI questionnaire to include more information regarding specific technologies used in music instruction. The author removed some of the more esoteric, advanced, or peripheral IT proficiencies to maintain the primary focus of the study on technologies that are more closely related to topics of concern within the piano pedagogy curriculum. The adapted instrument was limited in size to insure a satisfactory percentage of respondents.

Barry's (2004) study is considered an appropriate design guide for this current study. Although Barry's study investigated a relatively small sample ($N = 45$), the measures used and the scales and indexes for various types of technology used appear to display face validity in that they seem to address adequately the dimensions of each concept measured. These scales also exhibited high reliability coefficients, with three of the four sections producing Alphas of above .93. The fourth section yielded an Alpha of .85. The original METSI instrument, the Barry instrument, and the current study instrument are judged to be appropriate for determining attitudes about the status and diffusion of technology within the piano pedagogy community based upon the face validity of the measures and scales and the internal reliability results.

The two directories initially considered for the formation of the sample population focused exclusively on piano pedagogy, but they were either incomplete or outdated (i.e., the *Directory of Piano Pedagogy Offerings in American Colleges and Universities, 1991*, and the *Music Teachers National Association Pedagogy Course Listings, 1996*). Therefore, the researcher chose to rely upon the current *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2005-2006*, published by the College Music Society (CMS) in 2005. This CMS directory offers an "Index by Area of Teaching Interest" for all teaching faculty within its listings. Within this compendium, United States college and university faculty who listed piano pedagogy as an area of teaching interest numbered 695 individuals. The survey population consisted of the teachers on this list.

In January of 2006 a preliminary survey questionnaire was fielded. Eight individuals from three institutions of higher learning participated in the preliminary study. Three of these participants were piano pedagogy professors, one was a music education professor who also teaches class and applied piano, and one individual was a sociology professor who also taught group and private piano. The sociology professor was also extremely proficient with survey design and implementation, offering a valuable critique of the survey content, clarity and format. In addition, four graduate piano pedagogy students from the University of Oklahoma and four pedagogy students from Fisk University participated in the pilot. Each participant received either a cover letter or an e-mail, asking him or her to complete the questionnaire, recording the time necessary to complete the instrument. Five participants took the preliminary survey online and three took the survey from a paper copy. The author encouraged the participants to make suggestions for revisions regarding both clarity of presentation and content of the survey. Based upon the responses to this preliminary questionnaire, the survey instrument was revised, primarily in the area of formatting. At the suggestion of two faculty participants, the author shortened the questionnaire from 67 questions to 37 questions to avoid losing participants due to the time commitment required to complete the survey.

Upon completion of the pilot and revision process, a cover letter and a printed copy of the survey were mailed to the target population. The cover letter explained the purpose of and need for the study, contained the URL for the questionnaire (www.surveymonkey.com), and requested the faculty member's participation in the survey. The message encouraged participants to use the online survey as an easier means of taking and returning the survey. However, a paper copy of the questionnaire, along with a stamped self-addressed envelope for its return, was included with each cover letter for those who preferred this format. The cover letter informed participants of their complete confidentiality, gave instructions for the completion of the questionnaire, and indicated the average time (10 to 15 minutes) it took the participants within the preliminary study to complete the revised survey.

All participants were given an identifying code within the URL address displayed in the cover letter. A corresponding numerical code was placed inside the flap of each return envelope as well. These codes allowed the researcher to track who had completed the questionnaire and to eliminate them from the master list as the survey progressed. These identifying characteristics were used only to verify who had or had not completed the questionnaire.

After 14 days from the initial mailing, a follow-up e-mail containing the hyperlink to the online survey or a second request letter containing the online survey URL was sent to all members of the target population who had not completed the questionnaire. Three weeks later, all nonrespondents were sent another communication by e-mail or postal mail. The electronic and postal messages contained the hyperlink and instructions on how to obtain another paper copy of the survey. Forty days after the initial mailing, the online survey was closed and no further paper copies were included in the study.

The University of Oklahoma Office for Human Research Participant Protection approved the research protocols involving the development, future dissemination, and analysis of the proposed survey instrument. On April 15th of 2005, the author submitted a petition for a claim of exemption to the Institutional Review Board (IRB). On May 9, 2005, the Institutional Review Board for the Norman Campus of the University of Oklahoma Office for Human Research Participant Protection (FWA #00003191) issued a letter to this author exempting this current study from IRB review in accordance with the

Code of Federal Regulations, Title 45, Part 46, Sub-part 101 (b), Category 2 (see Appendix B).

Research Model and Variable Measurement

To facilitate the discussion of detailed data analysis procedures, the following research model illustrates the key study variables and variable relationships that were examined. Following this explanatory model, the variables identified in the model continue describing the essential details of variable measurement.

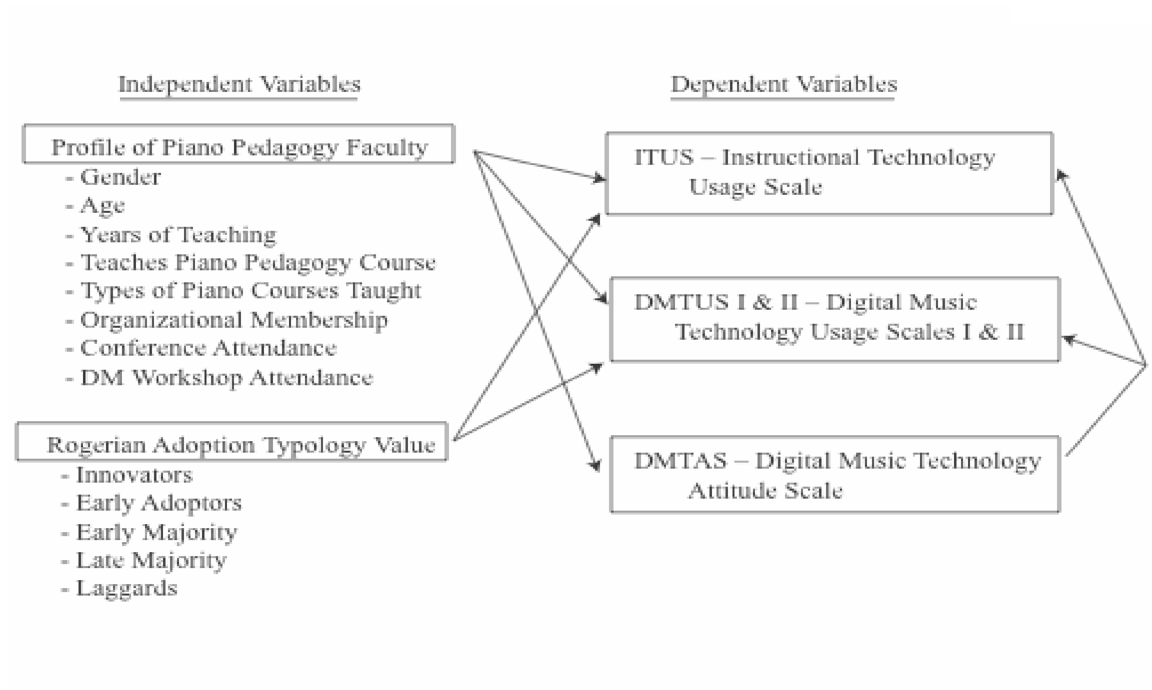


Figure 3. Research model.

The primary independent variable for the research, *Profile of Piano Pedagogy Faculty,* is actually a set of related variables which measure target characteristics of the respondents. Collectively, their use developed a profile of the profession. The dependent variables are four interval level summative scales which measure usage and attitudes for generic and digital music (DM) technology. The model in Figure 3 illustrates the relationships between these independent and dependent variables. In the research model, the arrows indicate the independent variables used to test relationships with the Instructional Technology Usage Scale (*ITUS*), the Digital Music Technology Usage Scales (*DMTUS-I* and *–II*), and the Digital Music Technology Attitude Scale (*DMTAS*) variables. The following explanation describes the nature and measurement of both independent and dependent variables. Each arrow in the model represents the manner in which the research objectives were tested.

Research Objective 1

The first objective is to identify profiles of piano pedagogy faculty who use, and do not use, certain *generic digital instructional* technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject. The testing of this objective is indicated in the research model by the top arrow from *Profile of Piano Pedagogy Faculty* that then flows to the *ITUS* variable in the upper right. Because the *Profile* variable actually represents a set of variables (*gender, age, years of teaching,* etc.), each subvariable listed under the *Profile* rubric was tested with respect to the *ITUS* variable, with specific tests identified in the statistical section which follows.

Research Objective 2

The second objective is to identify profiles of piano pedagogy faculty who use, and do not use, specific *digital music* technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject. The research model tested this objective as shown by the middle arrow originating from the *Profile of Piano Pedagogy Faculty* that flows to the *DMTUS-I & -II* box in the middle right. As described earlier, the *Profile* variable consists of a set of variables which were tested separately with respect to the dependent variables. The *DMTUS-I & -II* dependent variable designation actually represents two separate but similar scales that measure digital music usage in different ways. Discussion of their nature and measurement occurs at the end of this section.

Research Objective 3

The third objective is to identify the specific attitudes of the overall sample (3a), and of demographic and pedagogical subgroups of respondents (3b), related to implementation or nonimplementation of generic digital instructional or digital music technologies. The two angular arrows on the far right of the research model, originating from the *DMTAS* variable in the lower right and flowing to the *ITUS* and *DMTUS-I & -II* variables in the upper right, represent the testing procedure of this objective (3a). The *DMTAS* serves as an independent or explanatory variable rather than a dependent variable for this portion of the analysis. The lower arrow originating from the *Profile of Piano Pedagogy Faculty* and flowing to the *DMTAS* variable illustrates the testing procedures for the attitude subgroups being examined (3b).

Research Objective 4

The fourth objective examines the relationship between faculty instructional technology adoption and usage and digital music technology adoption and usage. The research model marks the testing procedure for this objective by the double-sided arrow on the right which flows between the *ITUS* and *DMTUS-I & -II* variables.

Research Objective 5

The fifth objective compares the patterns of generic digital instructional and digital music technology usage with the five-part adopter categories of the Rogerian typology concerning the adoption and diffusion of innovations (Rogers, 2003). The testing representation for this objective's analysis is indicated by the two lower arrows of the research model, originating from *Rogerian Adoption Typology Value* variable, that flow to the *ITUS* and *DMTUS-I & -II* variables on the right.

Measurement Procedures: Profile of Piano Pedagogy Faculty

With the completion of the discussion concerning the research model's design characteristics from the perspective of testing the research objectives, an explanation of the nature and measurement of the model's variables follows. The first variable of the model, the *Profile of Piano Pedagogy Faculty* variable, actually consists of a set of related subvariables which describe sociodemographic and teaching profile characteristics of the respondents. Some of these subvariables are relatively generic in nature, such as with *gender, age,* and *years of teaching*. The subvariables such as *DM workshop attendance* focus more specifically on the respondent's experience with digital music technology. The measurement of this set of independent variables appears relatively straightforward and can be seen by the survey questions which solicit this information, as follows in Table 4.

Table 4.

Measurement of Profile of Piano Pedagogy Faculty Variable

Subvariables	**Var. Type**	**Survey Question #**
Gender	N	1
Age	O	2
Years of Teaching	I	3
Types of Courses Taught	N	4a – 4e
Teaches Pedagogy Course	N	5
Organizational Memberships	N	6
Organizational Attendance	N	7
DM Workshop Attendance	I	8

Note. The "N" stands for nominal, "O" represents ordinal, and the "I" indicates interval.

Measurement Procedures: Rogerian Adoption Typology Value

The nature and measurement of the *Rogerian Adoption Typology Value* variable (*Rogers' ATV*) represents a complex and critical focus of this study. Its measurement depends on the final six items of the Section IV inventory on the survey, entitled "Inventory for Use of Generic Instructional and Music Technology Items." The first six items, 25 through 30, deal with generic digital instructional technology and are not included in the *Rogers' ATV* variable, but Items 31 through 36 specifically deal with digital music technology which is germane to this variable (see Appendix A).

In addition to these specific items, the questionnaire requested information concerning the number of years each respondent had used this technology. This provided the researcher with the ability to rate respondents on the Rogerian categories of adoption and diffusion by creating a distribution of "years of usage" to incorporate subsequently this data into Rogers' (2003) bell curve model. The Rogerian model subdivides the adopter categories by percentage of the total population as follows: Innovators, 2.5%; Early Adopters, 13.5%; Early Majority, 34%; Late Majority, 34%, and Laggards, 16%. Figure 4 illustrates this division by adopter category.

Since the respondent group is sufficiently representative of the professional population, a strict application of the Rogerian bell curve model implies that the data can be organized into a distribution of sample responses based on *years of usage* for each technology. This distribution allows for the grouping of all respondents into the five Rogerian adoption categories. The first 2.5% of reported users (those users reporting the greatest numbers of years of usage) should fall into the category of *Innovator,* and in a similar manner for the other four adopter categories. Figure 4 represents the division of adopter categories by percentage.

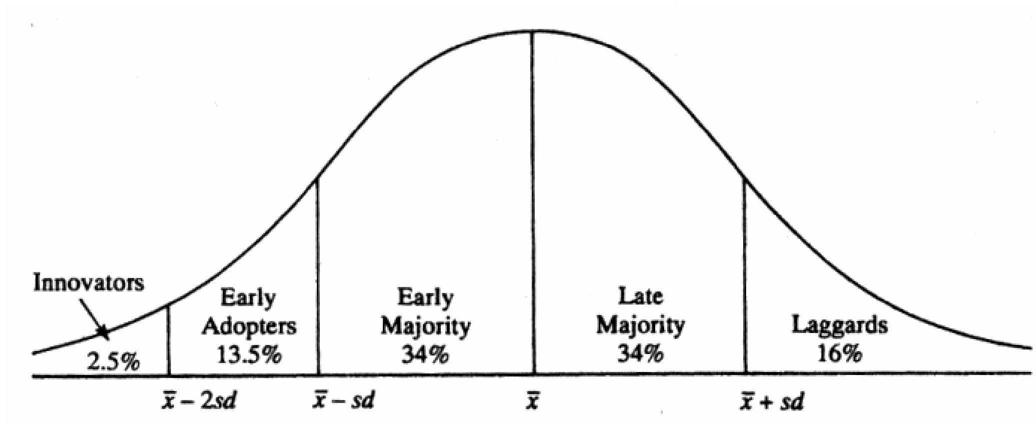


Figure 4. Frequency of new adoptions.

Note. From "The Adoption of Spreadsheet Software: Testing Innovation Diffusion in the Context of End-User Computing," by J. Brancheau and J. Wetherbe, 1990, *Information Systems Research, A Journal of the Institute of Management Sciences,1*(2), p.118. Copyright 1990 by J. Brancheau and J. Wetherbe.

This procedure allows for the use of a measurement technique grounded in the data and not determined on an *a priori* basis. This technique is consistent with Rogers' observation that adoption categories do not necessarily relate to the actual creation of the technology or its theoretical availability on the market. Adopter categories may be measured by observing the beginning of the actual diffusion process with the adoption of a particular digital technology by innovators, followed by the subsequent adoption by subgroups within a particular user community (i.e., musicians). By this method, the exact number of years of usage defining groups varies from one technology to another, as the data distribution fluctuates for each of the six questions. In each case, however, the groups are defined in the identical manner with respect to the distribution of responses.

This methodology, while being faithful to Rogers' original conception, may have its disadvantages, especially at the stage of interpreting the statistical data. For example, the application of Rogers' model works best for technologies with a sufficient market history to allow a particular social system to cycle through all of the adopter categories. Generally, only innovators initially develop awareness of new technological innovations, thereby given the earliest practical opportunity for adoption. However, the availability of the six technology indicators chosen for this study (Items 31through 36) extends to 20 years and beyond, allowing for a strong probability that at least some piano pedagogy teachers utilized these technologies within that time period. Therefore, the application of a bell-curve methodology appeared to be reasonably acceptable for the proposed categorization of respondents into Rogers' five adoption categories. The measurement of the *Rogers' ATV* variable originated with this analysis strategy.

Based upon the empirical distribution of the data, an alternative strategy of measurement was also pursued. The application of an S-curve type adoption and diffusion curve was examined as first advocated by Rogers in 1963 as being applicable for the adoption and diffusion of most technologies. The chart below, adapted by the researcher, suggests how this curve might correspond to the data and to Rogers' five adoption categories.

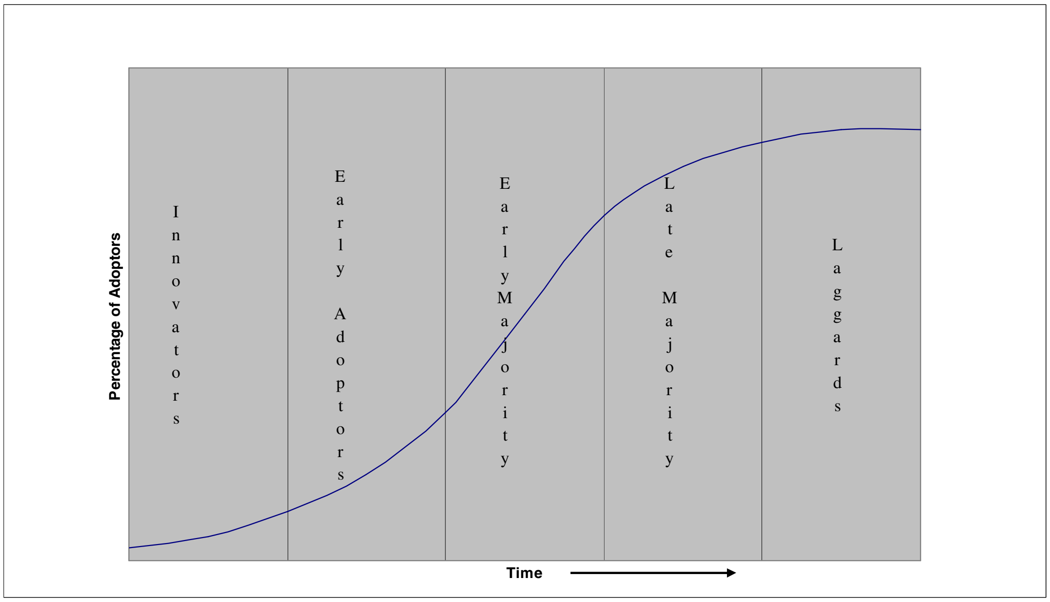


Figure 5. S-curve adoption curve for technology innovations.

Note. Adapted from *Diffusion of Innovation, 5th ed.* by E. M Rogers, 2003, New York: Free Press. Copyright 2003 by E. M. Rogers and the Free Press.

The relevance of this S-curve to the proposed measurement of the *Rogers' ATV* variable offered an alternative means of graphing statistically the adopter categories. Applying this model enabled the researcher to avoid using the pre-set percentages provided by the Rogerian model (2.5%, 13.5%, 34%, etc.). An S-curve methodology suggests an examination of the data to look for patterns of graduated then accelerated ascent as implied by the model. If the use of this model appears to be supported by the data, the grouping of respondents into adoption categories may proceed on this basis.

Finally, it should be noted that some individuals fit into an adoption category based on the usage of one technology alone while others also fit into two or even several categories of specified technology usage. An elaboration of Rogers' model suggests substantive consequences for both attitudes, as well as other behaviors with respect to digital music technology use for pedagogical purposes.

Measurement Procedures: ITUS, DMTUS-I & -II, DMTAS

The variable measurement section concludes with an explanation of the statistical manipulation of the four attitudes and usage scales. The measurement of these scale variables occurs at the interval level as composite variables (i.e., as variables which statistically combine answers to a series of questions), serving as dependent variables for virtually all analysis procedures, with two exceptions. The first exception relates to Research Objective 3, where the *DMTAS* functions as an independent variable when analyzing its relationship to the *ITUS* and *DMTUS*. The second relates to the analysis of Research Objective 4, requiring the use of the *ITUS* (generic instructional technology use) as an independent variable when examining its relationship to the *DMTUS* (digital music technology usage variable).

The scales, as composite measures, are designed to capture the range, intensity, or diffusion of professional technology usage. They may also indicate respondent attitudes toward technology use. The analysis of each scale includes a Cronbach's alpha test for the reliability of each construct. However, to the extent that some of the scales measure the use of discrete and nonoverlapping music technologies (e.g., *Finale*, MIDI keyboard and sequencer combinations), it may not logically follow that a respondent who marks high use on one item subsequently acknowledges high use on another item as well. There were alternative measures of testing for reliability. In addition to using Cronbach's alpha, testing methods included the identification of correlations between two technology use scales, examining the assumption that high users on one scale were the high users of the other related scale.

To facilitate this analysis, the first scale was formed to create a variable referred to as the *Digital Music Technology Usage Scale I (DMTUS-I)*, a composite variable created from Items 9 through 14 of the survey. Responses to these 6 items (from 0 [zero] "no use" to 10 "greatest possible use") represented the frequency with which respondents utilize each technology listed. The summation of these items produced the *DMTUS-I*, with a resulting scale of 0 (zero, no use) to 60 (greatest possible use).

The second scale, the *Digital Music Technology Attitude Scale (DMTAS),* consisted of Items 15 through 24 from Section III of the questionnaire. The scoring of these ten items depended upon the positive or negative wording of each statement. For example, the positively worded Item 18 stated, "I believe the quality of piano pedagogy education is improved by the use of MIDI-based keyboard technology." The scoring design for positively worded questions (Items15, 18, 20, 21, and 23) received the highest numerical score for an answer of "strongly agree." In Table 5 below, "Survey Answer" represents the numerical answer respondents chose on the actual survey and "Assigned Point Value" represents the *DMTAS* score that was assigned to each answer.

Table 5.

Positively Worded DMTAS Question Point Values

Survey answer	Label	Value
1	Strongly agree	5
2	Agree	4
3	Undecided	3
4	Disagree	2
5	Strongly disagree	1

Table 5 shows that answering with "Strongly Agree" to these positively worded items yielded larger positive scores on this attitude scale.

The five negatively worded questions included such statements as Item 17, "I do NOT believe the quality of piano pedagogy education is enhanced by the use of computer-based music technology." The scale design used a different scoring system for these negatively worded items. Table 6 shows that all negatively worded questions (16, 17, 19, 22, and 24) received different point scores, with values left unchanged so that strong agreement to the negative question yielded lower scores on the *DMTAS*.

Table 6.

Negatively Worded DMTAS Question Point Values

Survey answer	Label	Value
1	Strongly agree	1
2	Agree	2
3	Undecided	3
4	Disagree	4
5	Strongly disagree	5

After the completion of the value assignments for these positively and negatively worded questions, the computation of this procedure produced a scale from 0 (zero) to 50, with lower scores (e.g., 1 to 10) for respondents with the most negative attitudes toward digital music technology use and higher scores (e.g., 40 to 50) for those with the most positive attitudes (see Figure 6).

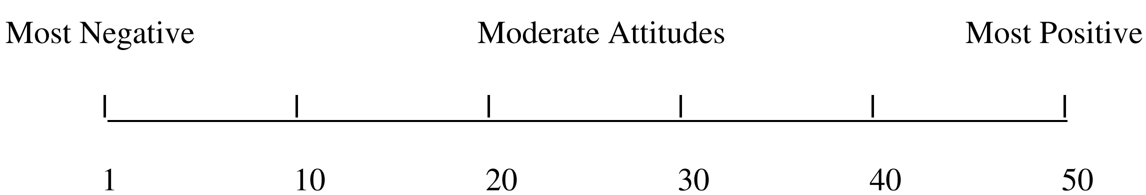


Figure 6. DMTAS continuum.

These actual scale scores on the *DMTAS* compare to respondents as they fit on Rogers' model of adoption and diffusion of an innovation, which also utilizes a bell curve model as one of its graphic indicators (see Figure 7). This configuration indicates that while the *DMTAS* is a measure of attitudes, the Rogers' model also applies to behavior. Nevertheless, professional interest continues as to whether there is a possibility of a correspondence between positive attitudes toward music technology use and its actual implementation.

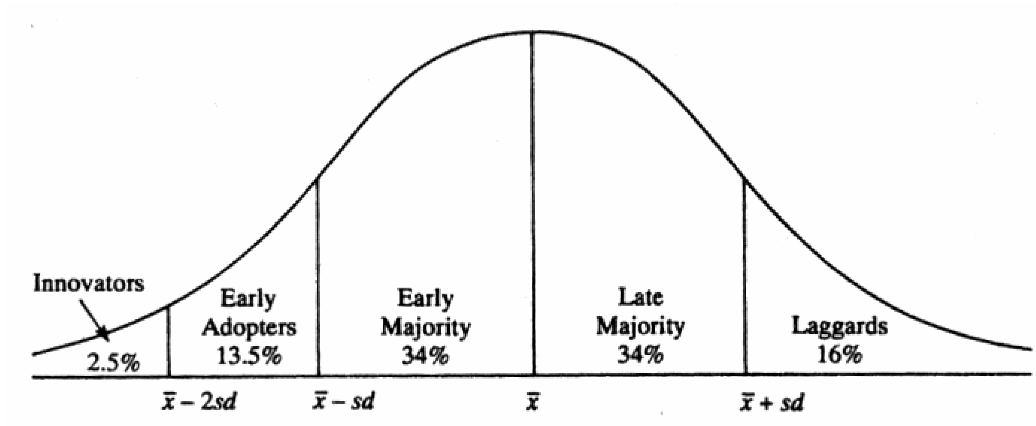


Figure 7. Frequency of new adoptions.

Note. From "The Adoption of Spreadsheet Software: Testing Innovation Diffusion in the Context of End-User Computing," by J. Brancheau and J. Wetherbe, 1990, *Information Systems Research, A Journal of the Institute of Management Sciences,1*(2), p.118. Copyright 1990 by J. Brancheau and J. Wetherbe.

Whereas the *DMTAS* focused on attitudes, the third and fourth scales derived from Items 25 through 36 in Section IV focus on behavior (the actual implementation or use of a technology). The third scale to be created was the *ITUS*, *Instructional Technology Use Scale*. Derived from Items 25 through 30, the *ITUS* measured the respondent's actual reported use of generic technologies such as word processing for pedagogical purposes. The fourth scale, the *DMTUS-II*, *Digital Music Technology Use Scale*, derived from Items 31 through 36, focused specifically on the actual reported use of music technologies for pedagogical purposes. Similar to the *DMTUS-I* described earlier, the *DMTUS-II* focused not only on faculty usage levels concerning specific applications of the designated technologies, but also on the total number of years the faculty used the item. This allowed for the sorting of respondents into Rogerian categories so that their group size and characteristics (including their attitudinal values on the *DMTAS*) could be compared to Rogers' model.

Each of these last two scales (*ITUS* and *DMTUS-II*) utilized a multiple-column format (columns A, B, C, and D), which asked the respondents to indicate the purpose for which they might use a specific technology. For example, in Column A, respondents indicated whether or not they use a technology for *professional productivity*, *class preparation, or class facilitation*. Technically speaking, each of these columns forms its own "scale." An example of this is the answer set given for the *Instructional and Music Technology Activity* scale in column A (forming the *ITUS-A* subscale which measured the professional productivity usage of a given technology). Other columns and answers functioned in a similar manner, yielding the following "subscales" with two "summative scales" as explained in the following Table 7.

Table 7.

Command and Area Usage

<u>Columns and Area of Usage</u>	<u>*ITUS* Subscales</u>	<u>*DMTUS* Subscales</u>
Column A. Professional Use	*ITUS-A*	*DMTUS-IIA*
Column B. Class Subject	*ITUS-B*	*DMTUS-IIB*
Column C. Years Used	*ITUS-Y*	*DMTUS-IIY*
Column D. Need for Training	Descriptive only	Descriptive only

For the first two columns (A and B), respondents were presented with the following options: “do not use,” “occasional use,” “regular,” and “no access.” For column C, “Years Used,” respondents indicated the number of years they previously used a specific technology. Regarding column D, “Need for Technology Training,” respondents chose L, “low”; M, “moderate”; H, “high”; or NA, “not applicable.”

For purposes of scale formation, Items for columns A and B were split into two categories. Because Items 25 through 30 pertain to generic instructional technology and Items 31 through 36 deal with digital music technology, the design included two subscales for columns A and B, thereby forming the *ITUS-A* and *ITUS-B* subscales (*ITUS* refers to “Instructional Technology Usage Scale”). The summation of these two scales produced the *ITUS*, an overall measure of generic instructional technology use.

Tabulation of the final six items (31 through 36) used a similar scoring system, forming two subscales (*DMTUS-IIA* and *DMTUS-IIB*). As with the previous scales, these subscales were summated, creating an overall measure of usage for digital music technology rather than for generic technology. The summation of the *DMTUS-IIA* and

DMTUS-IIB subscales resulted in a new scale entitled *DMTUS-II*, representing the overall extent and frequency of usage for the six specific digital music technologies.

The exact point or scoring system for the analysis of the *ITUS* and *DMTUS-II* was based on the following: “do not use” and “no access” both scored as 0 (zero) since both responses represent no usage; responses of “occasional use” received a score of one; and responses for “regular use” received a score of two, representing the greatest degree of usage for each individual item. A summation of the item scores occurred across all six items, yielding a maximum score of 12 for all subscales. The *ITUS-A* and *DMTUS-IIA* represented usage for their respective six items in column A (“professional use, class preparation, or class facilitation”) while *ITUS-B* and *DMTUS-IIB* represented the usage for the same respective six items, but related to column B (“taught as a class subject”). The previously mentioned comprehensive usage indicators (*ITUS* and *DMTUS-II*) originated from the summation of the *ITUS* and *DMTUS-II* subscales (each a 12-point scale), respectively measuring generic digital technology use and digital music instructional technology use.

Column C, “Years Used,” represented the number of years entered by respondents regarding their usage of different technologies. For the purpose of comparing the study data with the Rogers’ (2003) model of technology adoption and diffusion, the researcher incorporated only the *years of use* variable for this present study. The analysis procedure equated the *years of use* variable with the longest period of time a respondent used a particular technology. After the calculation of this variable, a distribution of this variable subsequently compared the data results to Rogers’ model of adoption and diffusion. In these instances, behavior (actual use of technology) was compared with Rogers’ model.

Finally, the respondent users of DM technologies were sorted into categories, based on the *years of use* variable. The adopter categories resulting from this analysis were subsequently compared to Rogers' theoretical category designations of Innovators, Early Adopters, Early Majority, Late Majority, and Laggards.

The inclusion of column D in the questionnaire, "Your Need for Technical Training," served as descriptive and reference material for future studies and was not used to test any of the five research objectives.

Data Analysis

The data were tabulated and analyzed using the *Statistical Package for the Social Sciences*, SPSS 13.0, and the data analysis involved both univariate and bivariate procedures. The univariate procedures, as the first step in the analysis, involved the calculation of frequencies and application of exploratory data analysis for the key variables as specified by the research model. This included the independent variables, *Profile of Piano Pedagogy Faculty* and *Rogerian Adoption Typology Value,* and all dependent variables (the *ITUS, DMTUS-I, DMTUS-II,* and *DMTAS*). The measurement of these variables was explained in the preceding section.

The protocols concerning the data analysis followed typical conventions regarding the description of the nominal, ordinal, and interval variables. The analysis of nominal variables, such as *gender* and the *Rogerian typology*, used frequencies and graphs. For interval variables such as *years of teaching, DM workshop attendance,* and all dependent scale variables *(ITUS, DMTUS-I & -II, DMTAS)*, exploratory analysis included the calculation of descriptive statistics such as means and standard deviations. Some strategic recategorization of these interval variables into logical groups occurred to facilitate the use of crosstabs with chi-square and other techniques as alternatives to *t*-tests, *F* tests, and other tests which require that the dependent variable be an interval measurement.

The use of these exploratory procedures necessitated a careful description of the variables, a procedure which possesses value in and of itself. An example of this is the value of knowing what percent of the surveyed teaching faculty demonstrate involvement in conference attendance, attend digital music workshops, and how many respondents fall into Rogers' five categories of technology adoption. However, none of the five research objectives could be completely satisfied by univariate analysis. These objectives all required bivariate analysis involving two or more variables. The procedures in this second stage of analysis directly addressed the research objectives which made use of sets of independent and dependent variables. The following explanation of statistical procedures is organized by the research objectives to be tested, as indicated by Table 8.

Table 8.

Statistical Tests by Research Objective

Independent Variable		Dependent Variables					
Profile of Faculty	Var. Type	Obj. #1 *ITUS*	Obj. #2A *DMTUS-I*	Obj. #2B *DMTUS-II*	Obj. #3 *DMTAS*	Obj. #4A *DMTUS-I*	Obj. #4B *DMTUS-II*
Gender	N	*t*-test	*t*-test	*t*-test	*t*-test	-	-
Age	O	*F* test	*F* test	*F* test	*F* test	-	-
Years of Teaching	I	corr / regr.	corr / regr.	corr / regr.	corr / regr.	-	-
Teaches Pedagogy Course	N	*t*-test	*t*-test	*t*-test	*t*-test	-	-
Types of Courses Taught	N	*t*-test	*t*-test	*t*-test	*t*-test	-	-
Organizational Memberships	N	*t*-test	*t*-test	*t*-test	*t*-test	-	-
Organizational Attendance	N	*t*-test	*t*-test	*t*-test	*t*-test	-	-
DM Workshop Attendance	I	corr / regr.	corr / regr.	corr / regr.	corr / regr.	-	-
ITUS	I	-	-	-	-	corr / regr.	corr / regr.
Rogerian Typology Value	I	-	-	-	-	-	-
- *Innovators*		-	-	-	-	-	-
- *Early Adopters*		-	-	-	-	-	-
- *Early Majority*		-	-	-	-	-	-
- *Late Majority*		-	-	-	-	-	-
- *Laggards*		-	-	-	-	-	-

Note. The “N” stands for nominal, “O” represents ordinal, and the “I” indicates interval. “*t*-test” indicates *independent sample t-tests;* “*F* tests” equals *one-way ANOVA tests;* “corr” tests are *Pearson’s r correlation tests;* “regr.” tests are *bivariate linear regression tests.*

In Table 8, the first four research objectives are labeled in the columns at the top. In some cases, the objectives are subdivided if different variables or procedures are involved in their testing. Most of these tests seek to discover significant relationships that exist between faculty profile characteristics and the respondents’ technology use, as well as their attitudes toward that use. The purpose includes the discovery of significant and consistent patterns or differences between heavy users, light users, and nonusers of digital music technology. The intended research goals include the discovery of whether or not the Rogers' typology holds promise as an aid to understanding the adoption posture individuals take toward digital music technology use. The research also investigates whether or not certain types of individuals fall into Rogers' classification schematic. This includes the possibility that Rogers' theoretical scheme can be modified, improved, or elaborated based upon the findings of the present study.

Finally, the descriptive profile of the sample serves as an estimator of the teaching population after the data are analyzed. As mentioned earlier, the profile subvariables allowed for sorting the sample population into categories for descriptive or inferential analysis (e.g., a comparison of responses from conference attendees to nonattendees regarding their use of technology through *t*-test or chi-square procedures, or comparing their scores on one of the indexes or scales). Regarding variables related to scenarios for music technology use in class, individual items also functioned as dependent variables, in addition to the grouping of these individual items into the numeric indexes or scales as previously mentioned.

From the bivariate testing procedures described, the analysis explored those factors related to the use or non use of digital technology. The set of independent variables reveal certain things about the respondents such as their attendance or nonattendance of professional conferences, their attendance of technology-related workshops, and their attitudes toward music technology as an appropriate form of pedagogy). These variable sets allow for a cross tabulation procedure with other variables that indicate low, moderate, or heavy use of music technology for professional purposes. These procedures and methods constitute a descriptive study based on the survey of all individuals who indicated piano pedagogy as an area of teaching interest in the *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2005-2006*.

As a summary of the analysis design, this study structures the analysis from the perspective of primary goals or research objectives. These include a descriptive analysis of key variables in the research model, with an explanation of the sociodemographic or pedagogically related characteristics of those taking the survey. Categorization or profiling these independent variables (e.g., *gender*, *years of teaching*, and *DM workshop attendance*) takes place to establish their association with the specified dependent variables. These dependent variables include specific types of generic or digital music technology use, and composite variables represented by the *DMTUS*, *DMTAS*, and *ITUS*. These scales respectively target digital music technology use, attitudes toward digital music technology use, and generic instructional technology use for pedagogy.

In relation to the stated study objectives, the data profile piano pedagogues as to their use of generic and music instructional technologies and the means by which these technologies are applied (e.g., in the classroom, during lessons, for personal preparation or productivity, etc.). Analysis using these profile variables further explores the relationship between the adoption and usage of music technologies, comparing such usage with the Rogers' (2003) typology of adoption categories (i.e., Innovators, Early Adopters, Early Majority, Late Majority, and Laggards). It is also hoped that some theoretical modification or elaboration of the Rogerian typology may result from this study.

Summary

The researcher hopes that this study successfully adds to the body of knowledge regarding the role of technology in music education, particularly from the perspective of piano pedagogy. Digital instructional and music related technologies have been available and relatively affordable for more than 25 years in this country. Their diffusion extends into the business sector, all levels of education, the entertainment industry, and the very fabric of our culture. Yet the promise of digital technology use in piano pedagogy still remains incomplete. The understanding as to why some piano pedagogues embrace the technology while others avoid it is still unclear. Studies such as this one should provide further insight into the attitudes and needs of piano pedagogues as they grapple with the technology itself and the best ways to use it in the classroom.

Piano pedagogy, as a field of study, has grown rapidly over the last 30 years, but some believe (and this author would concur) that the profession's use of technology is still in a process of adoption and implementation. Digital technology, whether generic instructional or music related, still presents opportunities and challenges to the profession as aids or deterrents for teaching, performing, and other creative activities. The categorization of music technology regarding its appropriate use in various areas of music still remains a matter of debate and conjecture. Assessment studies such as this one provide possible inroads into greater comprehension as to the role of digital technology in piano pedagogy and music for the 21st century.

Chapter 4

Results of the Study

Introduction to the Data

Data for the study were collected through a questionnaire (see Appendix A) designed to gather information on the current level of adoption and diffusion of specific digitally based instructional and music technologies by pedagogues in American graduate and undergraduate pedagogy programs. The 37-item questionnaire was divided into four sections:

I. Background Information

II. Scenarios for Using Music Technology in Class

III. Attitudes toward Technology in Music, and

IV. Inventory for Use of Generic Instructional and Music Technology Items.

Consisting of eight questions, Section I solicited personal and professional information as independent variables of the previously presented research model under the label, "Profile of Piano Pedagogy Faculty." The relevant faculty profile includes information concerning each respondent's gender, age, and the number of years he or she taught in higher education. The professional information requested in this section included the categories or types of piano teaching in which the respondent engaged, whether or not the respondent taught at least one undergraduate or graduate piano pedagogy-related course in the last five years, whether or not the respondent belonged to a professional organization that encourages the use of digital music technology by offering general sessions and workshops in music technology, and identification of the specific professional organizations to which the respondent claimed membership.

Additional questions from this section addressed how often the respondent attended professional organization conferences and the average number of digital music technology-related sessions or workshops the respondent attended per conference.

Sections II through IV of the research questionnaire introduced four digital technology usage and attitude scales as presented in chapter 3. The questions presented in these sections posed a set of digital music technology usage scenarios to determine the respondents' use or disuse of specific modes or categories of digital music technology. Individual scale items and summative scales typically function as dependent variables in the presentation and analysis of the data.

Research Model of Digital Music Technology Attitudes and Implementation

The following research model in Figure 8, illustrating the hypothesized variable relationships with arrows was tested.

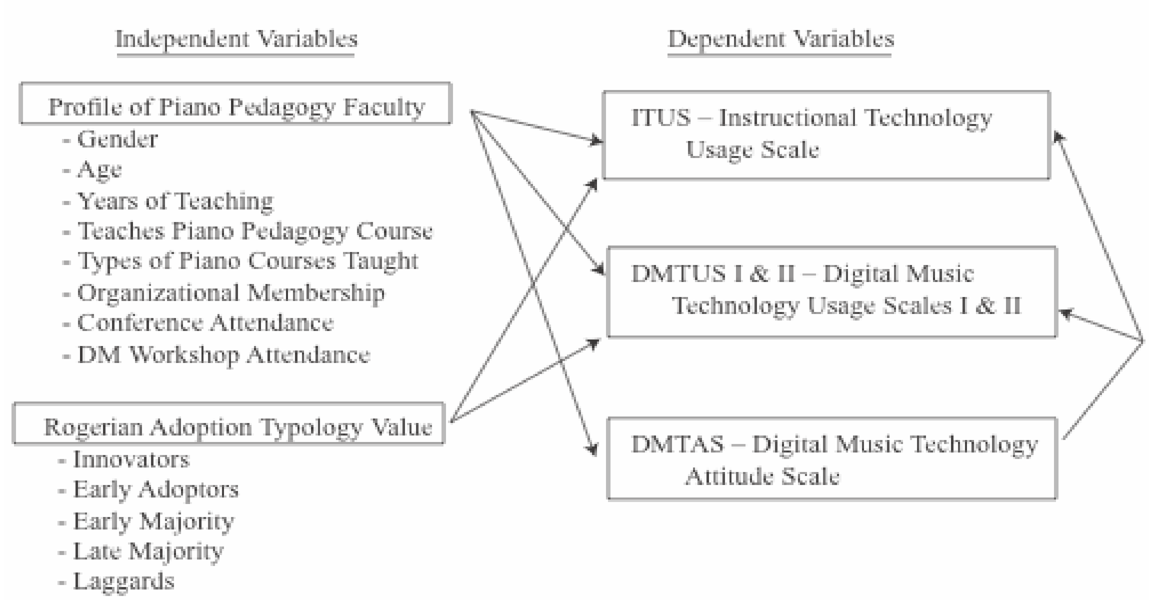


Figure 8. Research model.

The independent variables tested by the model in Figure 8 are listed on the left-hand side of the diagram, and the dependent variables appear on the right. Data analysis procedures were organized around the five research objectives presented in chapters 1 and 3.

Sample Description: The Faculty Profile Variables

On February 16 of 2006, the researcher mailed a total of 695 surveys to all faculty members who listed piano pedagogy as an area of teaching interest in the *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2005-2006*. Two weeks later, a follow-up e-mail reminder containing the online website URL was sent to those for whom an e-mail address was obtained by phone call or via institutional website. For those individuals whose e-mail addresses were unobtainable, a follow-up letter was mailed approximately two weeks following the initial mailing of the surveys. Three weeks after the follow-up mailing, all respondents were sent a final reminder by e-mail or postal service.

Profile Variables 1 and 2: Gender and Age

Out of 695 faculty who were sent a survey, 238 provided useable survey responses via either Internet (online survey) or mail service for a return rate of 34%. Ninety-four of these participants were male faculty members (39.7%) and 143 were female faculty members (60.3%). All but three reported their ages, yielding the following breakdown (See Table 9).

Table 9.

Age of Respondent

	Age	Frequency	Percent	Valid %	Cumulative %
Valid	25-34	22	9.2	9.4	9.4
	35-44	68	28.6	28.9	38.3
	45-54	74	31.1	31.5	69.8
	55-64	61	25.6	26.0	95.7
	65 or over	10	4.2	4.3	100.0
Total		235	98.7	100.0	
Missing		3	1.3		
Total		238	100.0		

Other faculty profile variables include the respondents' years of teaching in higher education, types of piano courses they taught, as well as information about their professional organizational membership, attendance, and workshop participation.

Profile Variable 3: Years of Teaching

The average number of years teaching in higher education (n = 236) was 17.9, with a range from 1 to 47 years. As seen in Figure 9 which follows, 74.8% reported teaching 10 years or longer, 58% reported 15 years or longer, and 46% reported 20 years or longer. The sample population represents a seasoned population of educators, with ample opportunity to become familiar with different generic and digital music technologies.

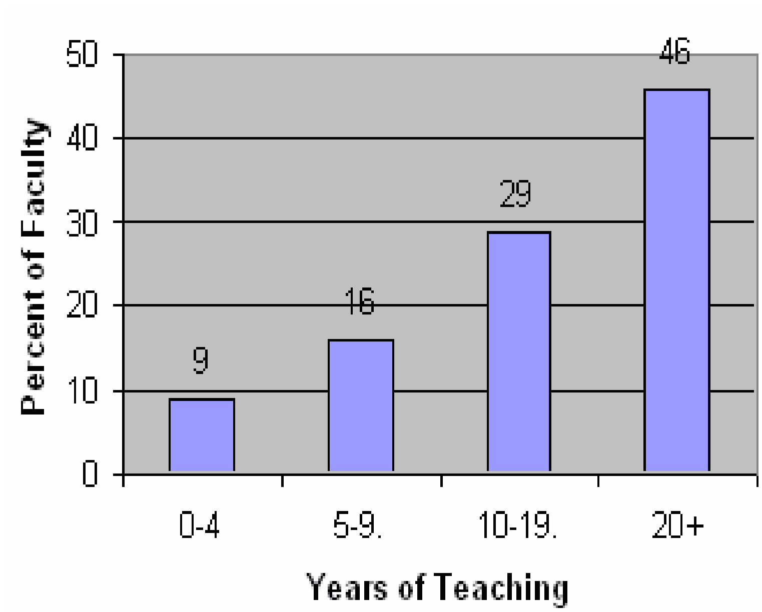


Figure 9. Years of teaching in higher education.

Profile Variable 4: Types of Piano Courses Taught

The respondents also reported the different types of piano courses they were currently teaching. Table 10 describes the percentage of the sample population who taught in each of the six types of piano courses typically found in colleges and universities.

Table 10.

Percentage of the Types of Piano Courses Taught by Respondents

Piano course type	Yes	No
Class piano	68.8	31.2
Applied lessons	91.1	8.9
Preparatory school	32.1	67.9
Undergraduate pedagogy	75.1	24.9
Graduate pedagogy	29.1	70.9

n = 237

Applied lessons constituted the modal category with 91.1% of the respondents indicating they were involved in this form of teaching. This was closely followed by undergraduate pedagogy classes (75.1%) and class piano (68.8%). A minority of respondents taught in preparatory school programs (32.1%) or graduate pedagogy-related courses (29.1%).

Profile Variable 5: Teaches Piano Pedagogy Course

One of the concerns regarding the validity of using the sample population for this research was the possibility that too many of the teachers who listed piano pedagogy as a teaching interest in the current *Directory of Music Faculties in Colleges and Universities, U.S. and Canada, 2005-2006* might not actually teach piano pedagogy-related courses. Question 5 was created to determine what percentage of the respondents taught a piano pedagogy-related course in the last five years; all but one of the respondents (*n* = 237) answered this question. A majority of the sample (81%) taught a pedagogy-related course during the last five years at either the graduate or undergraduate level (see Table 11 below). This indicated that the topic of research (the use or nonuse of generic or digital music technology for pedagogical purposes) was relevant to the majority of the respondents.

Table 11.

Taught a Pedagogy Course in Last 5 Years

Answer		Frequency	%	Valid %	Cumulative %
Valid	Yes	192	80.7	81.0	81.0
	No	45	18.9	19.0	100.0
	Total	237	99.6	100.0	
Missing		1	.4		
Total		238	100.0		

Profile Variable 6: Organizational Memberships

Since conference attendance and participation offer important venues for the dissemination of knowledge for both generic and digital music technologies, three questions (Items 6 through 8) queried respondents regarding *organizational memberships, conference attendance*, and *DM workshop attendance* (DM = digital music), respectively. A broad distribution of responses regarding the number of professional memberships held by respondents can be seen in Table 12.

Table 12.

Table of Conference Memberships

Status	Frequency	%	Valid %	Cumulative %
No membership	74	31.1	31.6	31.6
One membership	83	34.9	35.5	67.1
Two memberships	61	25.6	26.1	93.2
Three memberships	13	5.5	5.6	98.7
Four memberships	3	1.3	1.3	100.0
Total	234	98.3	100.0	
Missing system	4	1.7		
Total	238	100.0		

Table 12 indicates that most of the respondents to Item 6 (68%) reported memberships in one or more professional conferences, but a sizeable minority (32%) reported no conference memberships. Over a third of the respondents (35%) reported one membership and one third (33%) reported two or more memberships.

The largest group of respondents claimed membership in MTNA, Music Teachers National Association (*n* = 139, 59.4%), and others (including some of the same respondents) reported memberships in other organizations. Table 13 below provides a breakdown of the number and percentage of faculty pedagogues who claimed membership in specific professional organizations.

Table 13.

Conference Membership by Organization

Acronym	Conference	Population	%
MTNA	Music Teachers' National Association	*n* = 139	59.4%
MENC	Music Educators National Conference	*n* = 13	6.0%
WPPC	World piano pedagogy conference	*n* = 5	2.0%
NCKP	National Conference on Keyboard Pedagogy	*n* = 14	6.0%
	Other conferences	*n* = 85	36.0%

Profile Variable 7: Conference Attendance

The frequency of conference attendance by piano pedagogy faculty suggested potential opportunities to gain technological training through various conference activities. Based on Item 7 from the questionnaire, Table 14 provided the data regarding the question , "How often do you attend professional organization conferences?"

Table 14.

Frequency of Professional Conference Attendence

	Answer	Frequency	%	Valid %	Cumulative %
Valid	Annually	130	54.6	54.9	54.9
	Every 2 years	35	14.7	14.8	69.6
	Every 3-5 years	39	16.4	16.5	86.1
	Every 6-7 years	4	1.7	1.7	87.8
	Seldom	25	10.5	10.5	98.3
	Never	4	1.7	1.7	100.0
	Total	237	99.6	100.0	
Missing		1	.4		
Total		238	100.0		

As illustrated in Table 14, the majority of these respondents (55%) reported annual attendance, while another 15% reported biennial attendance. The next largest subgroup of the respondents attended every 3-5 years (16.5%). Those who seldom or never attended conferences constituted 12.2 % of the sampled population. Combining those who infrequently attended professional association conferences (every 3 years or more) with those who never attended resulted in a total of 30% of the population (the sum of the lowest four categories). However, 69.6 % of the piano pedagogues surveyed attended a professional conference at least every other year, with the largest category attending yearly.

Profile Variable 8: DM Workshop Attendance

Conference attendance alone appeared insufficient to explain a conference attendee's training or use of various digital technologies, whether generically instructional or music related. Music conferences for most professional organizations offer a wide variety of workshops and sessions that do not deal with digital technology. Item 8 addressed this concern by allowing pedagogy teachers to report how many digital music technology-related sessions or workshops they actually attended per conference. Table 15 displays the frequency of attendance at such workshops.

Table 15.

Number of Digital Music Technology-Related Sessions Attended

	Number	Frequency	%	Valid %	Cumulative %
Valid	None	76	31.9	32.5	32.5
	One	101	42.4	43.2	75.6
	Two	37	15.5	15.8	91.5
	Three	12	5.0	5.1	96.6
	Four	4	1.7	1.7	98.3
	Five or more	4	1.7	1.7	100.0
	Total	234	98.3	100.0	
Missing		4	1.7		
Total		238	100.0		

The data in Table 15 indicated that piano faculty who attended one digital music (DM) technology-related workshop or session per conference constituted the largest group (43.2%) from the sample population, followed by 32.5% who attended no such workshops. Only 24.3% of respondents indicated attending two or more digital music workshops per conference. These data, presented for the variable *DM workshop attendance,* suggest that a majority of faculty pedagogues had some interest in digital music technology, since a solid majority (67.5%) of respondents reported attendance for at least one digital music workshop for each professional conference attended.

DM Workshop Attendance by Organizational Memberships

Since organizational culture may be one factor in influencing attendance at digital music technology-related workshops, an analysis was conducted to investigate whether or not there was an association between *DM workshop attendance* and reported *organizational memberships*, as well as attendance at professional conferences.

Table 16 presents the association between *DM workshop attendance* and the two profile variables of *organizational memberships* and *conference attendance.* The columns down the left side of the table includes percentages of faculty respondents in different professional organizations (MTNA, MENC, etc.) who attended DM workshops with a given frequency rate (none, one, two, etc.). The right side of the table indicates the number of DM workshops attended per conference, within columns which indicate the frequency of conference attendance.

Table 16.

Percentage of Digital Music Workshop Attendance by Two Profile Variables

DM work-shops	Percentage of professional organizational membership					Percentage of frequency of conference attendance				
	MTNA	MENC	WPPC	NCKP	Other	An-nual	Bi-annual	3-5 yrs	6+ yrs	Total
None	25	23	40	14	20	31	29	32	45	32
One	47	23	40	36	44	42	46	47	42	43
Two	18	23	0	36	25	20	11	13	7	16
Three +	10	31	20	14	11	7	14	8	6	9
Total	100	100	100	100	100	100	100	100	100	100
n	139	13	5	14	84	130	35	38	31	234

The data in Table 16 indicate that there is little apparent association between DM workshop attendance and the organizational membership(s) claimed by respondents. Where greater differences occurred, the sample size was quite small per organization. Though attendance at DM workshops appears to be lower for those who attended conferences less frequently, a contingency table chi-square test revealed no significant difference between *DM workshop attendance* and *organizational memberships* or *conference attendance.*

Objective 1 Findings: Generic Technology Use by Profile Variables

The first research objective was to identify profiles of piano pedagogy faculty who use, and do not use, certain generic digital instructional technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject. This section presents the nature and distribution of *generic technology use*, the dependent variable under consideration. An exploration of the relationship of this variable to the sociodemographic and professional profiles of faculty members follows.

The Dependent Variable: Generic Technology Use

The dependent variable, *generic technology use*, referred to the professional or pedagogical use of six specific digital instructional technologies of a generic nature: desktop publishing software, database software, presentation software (e.g., *PowerPoint*), classroom management software (e.g., *Blackboard*), web browsing of the Internet, and web page creation. Items 25 through 30 measured respondent usage of these six technologies in two categories: Column A regarding their use for professional activities, class preparation, or class facilitation, and Column B for use as a class subject. Participants responded to each technology item in both category columns with “do not use,” “occasional use,” “regular use,” or “no access.” While a description of respondent usage for each individual item occurs later in the chapter, the overall usage patterns for generic instructional technology as a whole are initially explored by examining the distribution of a summative scale.

Measurement 1: the ITUS variable.

The *ITUS* variable (Instructional Technology Usage Scale) was created by combining responses to all six technologies in both categories by assigning the choices “do not use” and “no access” a usage score of zero, “occasional use” a score of one, and “regular use” a score of two. This yielded an *ITUS* with a theoretical range of 0 (zero) to 24 (six technologies measured in two categories for a total of 12 areas, with two possible points assigned to each technology area). Respondents who used none of the six technologies with any frequency received a score of zero on the *ITUS* and those who regularly used all six technologies received a maximum score of 24. A reliability analysis with the *ITUS* yielded a Cronbach's alpha of .785.

Figure 10 shows the distribution of responses on the *ITUS*, indicating that a large majority of the respondents utilized generic digital instructional technologies with some regularity. The approximately bell-shaped distribution in Figure 10 indicates that the sample population is somewhat normally distributed with respect to generic instructional technology use, although there was a positive skew to the distribution represented by the three top outliers with scores of 22, 23, and 24, respectively (skewness rating = .369). Sample respondents scored across the entire range of possible scores, from 0 (zero) to 24, with a mean of 9.2 and a standard deviation of 4.8.

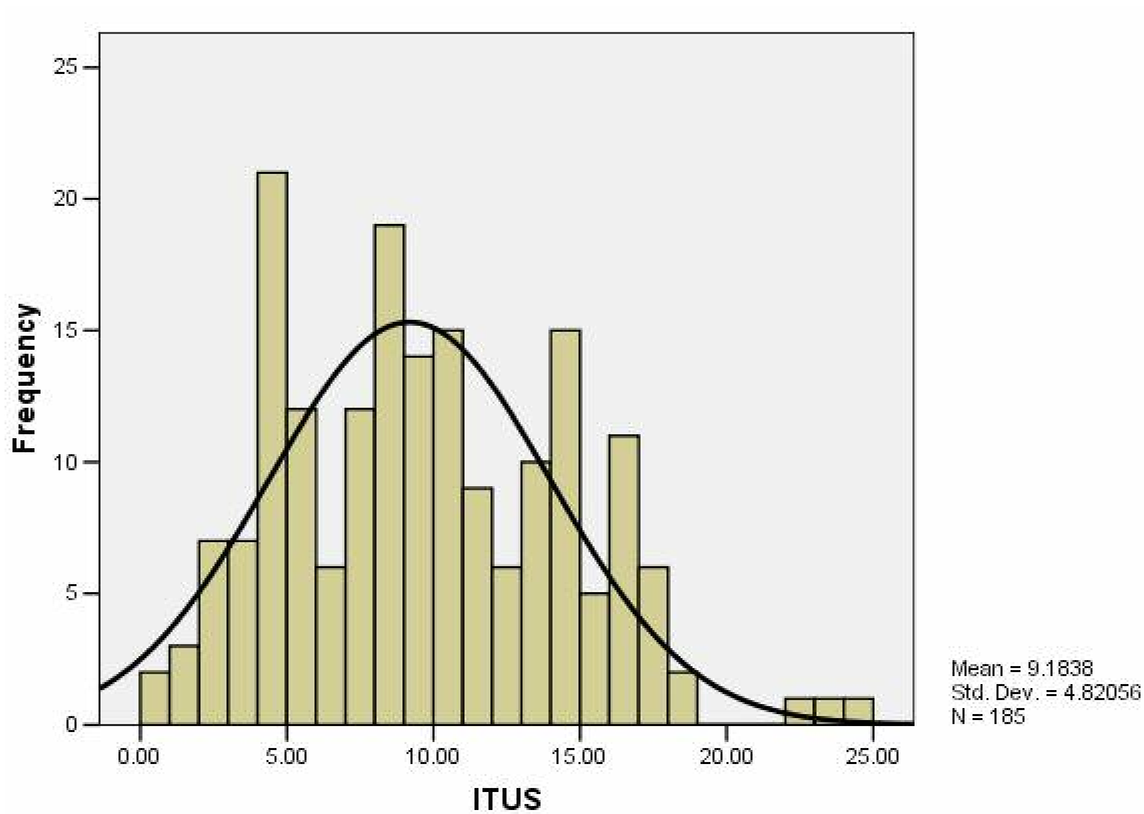


Figure 10. Frequency histogram for the *ITUS*.

Generally speaking, the data in Figure 10 suggest that most respondents appeared to be relatively well acquainted with the six specific generic technologies comprising this scale and used them for pedagogical purposes (with a normal degree of variation across the respondents in the sample). Only two respondents (1.1%) reported “no use” of any of these technologies. Even those respondents categorized between 0 (zero) and the mean utilized generic digital technologies to some extent, and most respondents (90% had a score of 4 or above) displayed frequent use of several such technologies, as indicated by their placement near the middle or to the right of the distribution.

Measurement 2: the individual ITUS items.

In addition to examining the overall pattern and magnitude of generic technology usage (i.e., as measured by the *ITUS*), it is helpful to see which specific generic technologies piano pedagogues reported using. Table 17 illustrates the specific digital instructional technologies most often utilized by the respondents, categorized by *gender*.

Table 17.

Percent Use of ITUS for Professional Use by Gender

	Item	*n*	Regular use M	Regular use F	Some use M	Some use F	No use M	No use F	χ^2 Sig.
25	Desktop publishing	212	64	58	19	19	17	23	--
26	Data base activities	210	25	23	32	42	43	36	--
27	*PowerPoint*	210	22	26	36	29	42	46	--
28	*Blackboard* software	212	34	36	8	9	59	55	--
29	Internet/WWW	212	79	83	17	15	4	2	--
30	Web page creation	211	22	15	26	13	52	72	.012*

Note. * Significant at .05 level, **Significant at .01 level

This table only covers the use of these technologies in Column A, which indicated usage for "professional use, class preparation, or class facilitation." Table 17 reports the results of contingency table chi-square procedures which tested for significant association between *gender* and Items 25 through 30 (column A only). Item 30 demonstrated the only statistical significance related to *gender,* $x^2(2, n = 211) = 8.893$, $p = .012$. As indicated, the highest percentage of respondents reported regular use of the Internet for web browsing (M = 79%, F = 83%), followed by desktop publishing (M = 64%, F = 58%), and class management software such as *Blackboard* (M = 34%, F = 36%). A minority of respondents regularly used the other generic technologies (database, presentation software and web page), but a fourth to a third of the population acknowledged "some use" of these items.

Therefore, well over half of all respondents reported use of at least four out of six of the listed technologies for pedagogical purposes, with only *Blackboard* (or other classroom management software) and web page creation software technologies being listed as unused by a majority of respondents. With the exception of web page creation software (where male faculty in the target population were significantly more likely than females to report use of this technology for teaching-related purposes), data analysis indicated no significant differences in generic instructional technology use between male and female faculty members.

Table 18 indicates the use of the same six technologies, but from the perspective of "teaching as a class subject" (Column B on the survey; see Appendix A). The far right column of Table 18 reports the results of contingency table chi-square analysis which tested for significant association between *gender* and Items 25 through 30 (column B), respectively and in sequence, also reporting the *p*-values and statistical significance where present. In this case, unlike the significant association seen in Table 17, an analysis detected no significant associations.

Table 18.

Percent Use of ITUS as a Class Subject by Gender

	Item		Regular use		Some use		No use		χ^2
	Item	*n*	M	F	M	F	M	F	Sig.
25	Desktop publishing	203	15	16	37	25	48	58	--
26	Data base activities	200	9	7	21	23	71	71	--
27	*PowerPoint*	202	5	12	25	17	70	71	--
28	*Blackboard* software	200	12	21	9	6	80	74	--
29	Internet/WWW	202	27	38	33	27	40	35	--
30	Web page creation	200	8	6	15	12	77	83	--

The data in Table 18 indicate a much lower percentage of faculty respondents using these technologies as a teaching subject (in contrast to the data in Table 17 which showed a greater use of the same technologies for professional activities, class preparation, or class facilitation). While many faculty members used these technologies for conducting the personal or professional activities just mentioned (Column A of the survey; see Appendix A), the data revealed that only a minority of the respondents directly shared their generic technological expertise with their students as a curriculum subject. In contrast to these usage figures, over half of the sample population reported "some use" or "regular use" of Internet and web browsing technologies as a teaching subject (M = 60%, F = 65%), and approximately half reported some usage of desktop publishing (M = 52%, F = 42%). The chi-square analysis uncovered no significant differences by gender for use of these technologies as a class subject.

From the aggregate results of the univariate descriptive analysis of *generic* *technology use* as a dependent variable, most faculty members clearly utilized a broad range of generic (i.e., not exclusively music related) digital instructional technologies for professional use, class preparation, or class facilitation, and in a few cases, as a curricular offering. The data also clearly indicated few differences by gender in the use of such technologies, with the possible exception of web page creation where male faculty respondents reported significantly greater usage.

Testing the Effects of Faculty Profile Variables on Generic Technology Use

Testing for gender.

Independent samples *t*-tests, one-way ANOVA tests, and correlation and regression tests were employed to explore possible connections between the profile variables describing faculty respondents and their use of generic technologies for pedagogical purposes. These profile variables included *gender, age, organizational memberships*, *conference attendance*, and *DM workshop attendance*.

The first of these five profile variables studied was *gender*. While earlier analysis examined *gender* with respect to specific technologies, this analysis procedure investigated *gender* from its relationship to the *ITUS* variable (made up of responses to the six technologies). Further analysis tested this summative scale through an independent samples *t*-test, revealing no significant difference by *gender* (p = .988). Interestingly, the average *ITUS* score for both males and females was 9.2 (a score identical to the overall average), thereby indicating no differences between males and females in the sample population regarding the overall use of generic instructional technologies.

Testing for age.

The next analysis tested the relationship between *age* and generic technologies by conducting a one-way ANOVA or *F* test between *age* and the *ITUS* variable. As predicted, an interesting pattern emerged from the examination of the *ITUS* variable within the categories of respondent age. On the 24-point scale, younger faculty members generated consistently higher scores than older faculty members. Table 19 provides the group means for five age groups concerning generic instructional technology use, followed by a report of the coefficients and testing details.

Table 19.

Average Generic Instructional Technology Usage Scores by Age

Age	*n*	Group *M*	*SD*
25-34	17	10.2	4.50
35-44	55	10.5	4.61
45-54	62	9.3	4.84
55-64	44	7.7	4.73
65 or over	5	4.8	3.42

The data in Table 19 reveal that both of the two younger age groups (25 to 34 and 35 to 44) had mean scores of over 10 and that usage scores steadily diminished in descending order to 4.8 for the oldest age group (65 or over). When subjected to a one-way ANOVA test, these differences were significant at the .05 level ($F = 3.542$, $p = .008$). A Scheffe post-hoc analysis revealed no significant differences between specific pairs of groups, leading to the conclusion that the significance was evidently generated by the overall pattern of descending scores. However, in deconstructing the *ITUS* into its component parts (subscales A and B, which examine technology use for professional use and for teaching as a class subject, respectively), the post-hoc analyses revealed significant differences between the initial three age bracket groups compared to the oldest age group, 65 or over ($p = .005$, $p = .005$, $p = .015$, respectively), corroborating the observation that younger age groups tend to use more actively instructional technologies.

Testing for organizational memberships.

Based on the assumption that *organizational memberships* are an important indicator of professional involvement and development (thereby affecting the use of digital technology), a Pearson's correlation was conducted between generic instructional technology use (the *ITUS*) and the number of organization memberships reported by the respondents (Item 6). This correlation was not significant at the .05 level ($r = .10$, $p = .09$), indicating that single or even multiple conference memberships are not significantly related to the use of generic instructional technology among piano pedagogues.

Testing for conference attendance.

Another assumed indicator of professional involvement and development was frequency of *conference attendance*, as measured by Item 7 of the survey, with response options of annually, every two years, every 3 to 5 years, every 6 to 7 years, seldom, and never. Because the data yielded low frequency counts for the latter three categories, statistical accuracy of the results improved by collapsing them into a single category of *every 6 years or more*. On the 24-point *ITUS*, more frequent conference attendees appeared to have higher usage scores, as represented in Table 20 below.

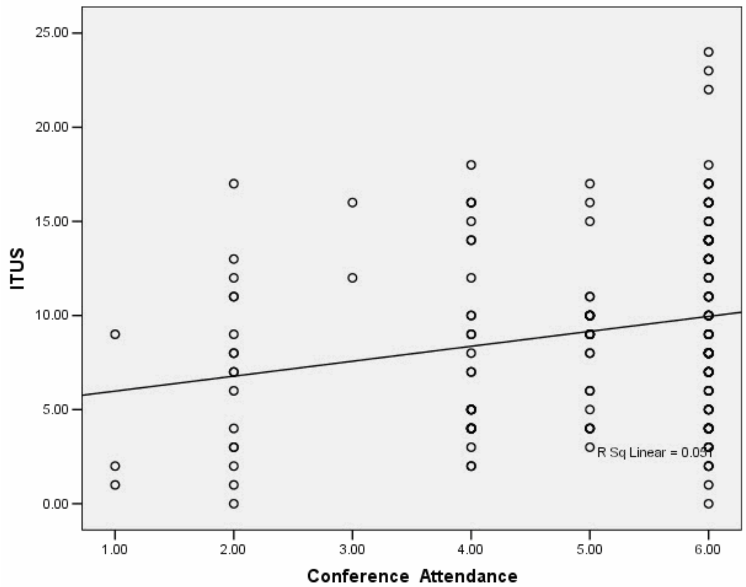
Table 20.

Average Generic Technology Use by Conference Attendance

Attendance	*n*	Group *M*	*SD*
Annually	104	10.0	4.94
Every two years	28	8.8	3.53
Every 3-5 years	31	7.9	4.84
6 years or more	22	7.4	4.97

Table 20 shows that faculty members who attended professional conferences on an annual basis demonstrated the greatest use of generic instructional technology on the *ITUS* (10.0), with scores decreasing progressively to the lowest score of 7.4 for the group of faculty who attended least often. Subjected to a one-way ANOVA test, these differences were significant at the .05 level ($F = 2.97$, $p = .033$). Of the two *ITUS* subscales, only subscale B (where respondents teach the technology as a class subject) displayed significance ($F = 2.83$, $p = .04$). Those who attended professional conferences more frequently reported a significantly higher average use of generic instructional digital technology. This was particularly evident among those who taught these technologies as a class subject. Using the *conference attendance* variable in its original interval format, a Pearson's correlation test revealed a significant positive correlation ($r = .134$, $p = .029$) and a linear regression test yielded a significant positive linear relationship ($b = .794$, $p = .002$).

Both of these tests (Pearson's *r* and bivariate linear regression) indicated a positive and statistically significant relationship between frequency of professional conference attendance and comprehensive use of generic instructional technology. The following scatterplot in Figure 11 demonstrates this positive relationship, yet illustrates the significant variation of responses at each frequency level of conference attendance.



1 = Never; 2 = Seldom; 3 = Every 6-7 years; 4 = Every 3-5 years; 5 = Biannually; 6 = Annually

Figure 11. ITUS by *conference attendance*.

The scores on the left side of Figure 11 depict those who never attended professional organizational conferences; those on the right illustrate those who were annual attenders.

Testing for DM workshop attendance.

The final profile variable to be examined regarding its influence on generic instructional technology use is the explanatory variable measuring frequency of *DM workshop attendance*. The comparison of these variables presupposes the possibility that more frequent participation in digital music technology-related workshops resulted in a higher use of generic types of instructional technology as well. Table 21 displays the mean scores on the *ITUS* (see Group *M* column) within rows of the *DM workshop attendance* variable, where each represents the number of digital music workshops attended, from "0" (zero) to "5 or more."

Table 21.

Average ITUS Scores by DM Workshop Attendance

Sessions attended	*n*	Group *M*	*SD*
0	56	7.9	4.80
1	77	8.5	4.26
2	31	11.2	5.21
3	11	12.0	4.17
4	3	13.3	1.53
5 or more	4	14.8	3.86

As seen in Table 21, a steady increase in generic instructional technology use occurred as respondents reported more digital music technology workshops attended. Those who attended no DM workshops had the lowest *ITUS* mean score (again, the *ITUS* measures the breadth and frequency of generic technology usage). Scores increased consistently for each group as respondents reported additional DM workshops attended at professional conferences. The analysis demonstrated that those who attended 5 or more workshops received an average *ITUS* score of 14.8, which is an 87% increase above the lowest score of 7.9 for those who attended no workshops. A one-way ANOVA test revealed significant differences between all of these subgroups, with an F value of 4.937, and a p value of .000. The two *ITUS* subscales (for columns A and B, respectively) were also significantly related to *DM workshop attendance*, with F values of 3.21 for subscale A and 4.31 for subscale B and significant p values (for subscale A, $p = .008$ and for subscale B, $p = .001$).

A Pearson's correlation between the same two variables was both positive and significant ($r = .334$, $p = .000$), as depicted in the linear scatterplot shown in Figure 12.

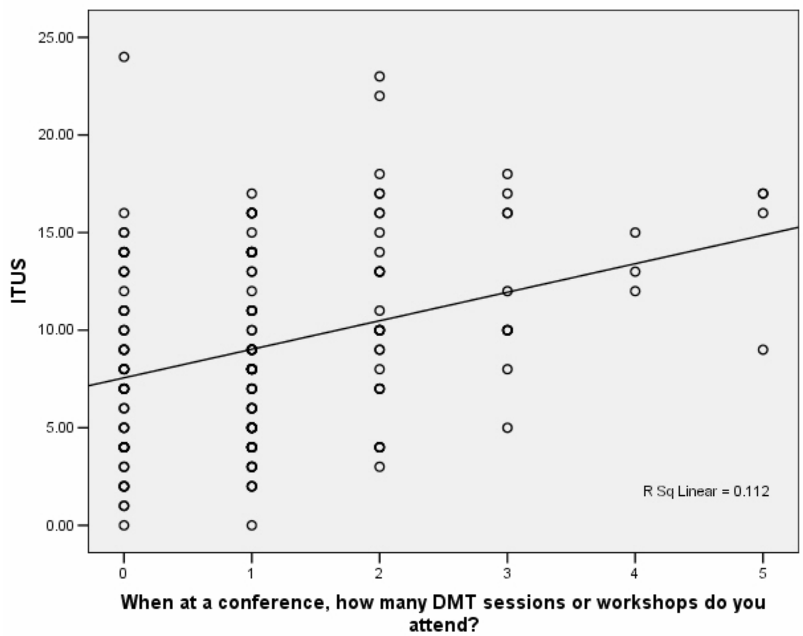


Figure 12. ITUS by *DM workshop attendance*.

The bivariate linear regression test for the scatterplot above is significant at the .001 level ($b = 1.46$, $p = .000$). The slope of approximately 1.5 indicates that for every additional DM workshop attended, there is an average 1.5 point increase on the *ITUS* per respondent. The results of these tests demonstrated a positive and significant relationship between these variables. Therefore, it seems clear that those within the target population who more frequently attended digital music technology workshops demonstrated a greater likelihood of utilizing even generic digital technologies more broadly and more often for pedagogical purposes.

To summarize regarding the influence of faculty profile variables on generic instructional technology use, the data lead to the conclusion that while *gender* and *organizational memberships* did not appear to be useful as explanatory variables, certain categories of faculty members demonstrated a significantly greater likelihood to use generic digital instructional technology for pedagogical purposes. These categories included younger pedagogues, those who attended professional conferences more frequently, and particularly, faculty who attended a greater average number of digital music technology workshops when attending professional conferences.

Objective 2 Findings: DM Technology Use by Profile Variables

The second research objective was to identify profiles of piano pedagogy faculty who use and do not use specific *digital music instructional technologies* for professional productivity, for class preparation, for class facilitation, or for use as a class subject. The following analysis addresses this objective by initially exploring the nature and distribution of the dependent variable, measured by the *DMTUS-I* and *DMTUS-II* (where *DMTUS* refers to "digital music technology usage scale"). A subsequent exploration followed with an analysis of the relationship between the sociodemographic and professional profiles of faculty members related to both the summative and individual items of *DM technology use*.

The Dependent Variable: DM Technology Use

Two sections of the survey (see Appendix A) served as summative indicators of *DM technology use*, yielding two usage scales: *DMTUS-I* and *DMTUS-II*. As the nature and construction of *DMTUS-II* directly parallels the *ITUS* analyzed in the previous section, its treatment precedes that of the *DMTUS-I* which follows in a later section.

Following the same procedure used for the previous treatment of the *ITUS*, Items 31 through 36 asked respondents about their use of these technologies in two categories of the *DMTUS-II*: column A for professional use, class preparation, or class facilitation, and column B for the teaching of these technologies as a curricular subject. The survey participants responded for each technology in each category (A and B) with the same “do not use,” ”occasional use,” “regular use,” or “no access.” After the exploration of the overall usage patterns through the examination of the distribution of the summative scale, the sample usage of each individual technology item is presented.

Measurement 1: the DMTUS-II variable.

The *DMTUS-II* is a summation of respondent answers to all six technologies in both usage categories for Items 31 to 36 on the survey (see Appendix A). As with the *ITUS* previously described, the *DMTUS-II* was created by assigning a usage score of zero to “do not use” and “no access,” a score of one for “occasional use,” and a score of two for “regular use.” Applying this procedure to the first category, column A (Professional Use, Class Preparation, or Class Facilitation), produced the *DMTUS-IIA* subscale. When used with the second category, column B (Taught as a Class Subject), this same procedure yielded the *DMTUS-IIB* subscale. Added together, these two subscales created a composite measure of digital music technology instructional usage, the *DMTUS-II.*

The *DMTUS-II* had a theoretical range of 0 (zero) to 24, with the six technologies measured in two categories for a total of 12 areas and each technology assigned a maximum of two possible points per area. Therefore, respondents who used none of the six technologies with any frequency received a score of zero and those who regularly used all six technologies received a maximum score of 24. A reliability analysis with the *DMTUS-II* yielded a Cronbach’s alpha of .861.

Figure 13 shows the distribution of responses on the *DMTUS-II* and illustrates that a large majority of the respondents utilized digital music instructional technologies with some regularity.

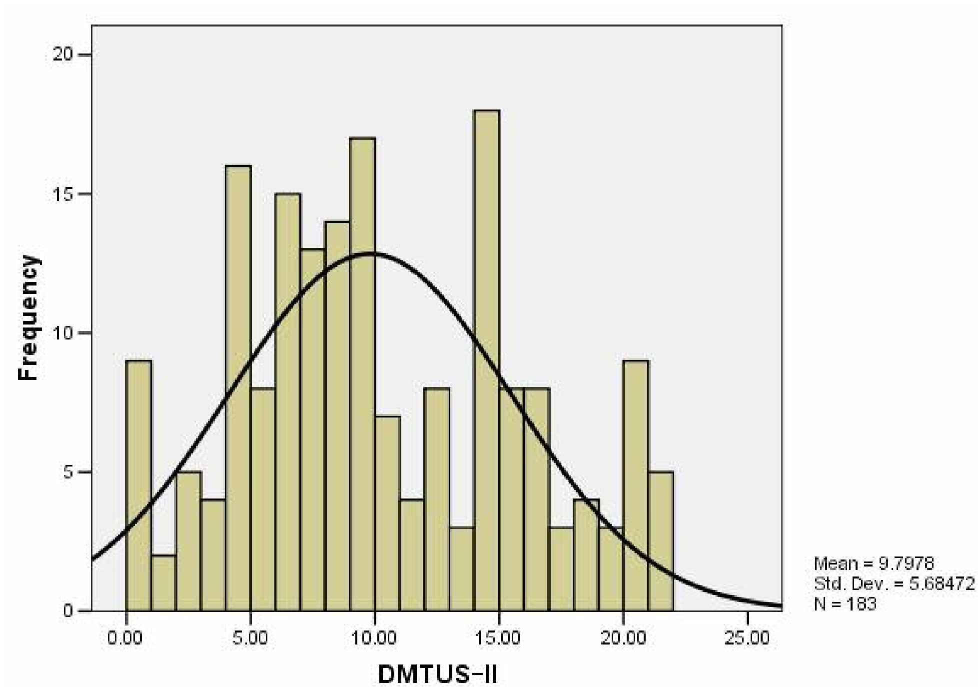


Figure 13. Distribution of the *DMTUS-II* variable.

The *DMTUS-II* data pictured in Figure 13 present a somewhat jagged array of categories, but it is still generally distributed in a normal manner, with a positive skewness rating of .309. Sample respondents received scores across most of the range of possible scores for usage levels, from 0 (zero) to 24, with a mean of 9.8 and a standard deviation of 5.7. One observation regarding the *DMTUS-II* distribution of digital music scores stems from its remarkable similarity to the distribution of the *ITUS* described earlier. Two thirds (66.7%) of the sample fell within the first half of the scale with usage scores from 0 (zero) to 12, but one third (33.3%) fell into the upper half with usage scores of 13 to 24, thereby indicating extensive use of digital music instructional technology. This usage level of digital music technology equaled and surpassed that of the digital generic instructional technology usage, since the 33.3% in the high end of the *DMTUS-II* (scores 13 to 24) may be compared to only 28.1% of those in the upper portion of the

ITUS.

Therefore, faculty pedagogues within this survey population utilized a broader variety of digital music technologies for pedagogical purposes with more frequency than they used generic instructional technologies. Clearly, a sizeable proportion of the sample population was relatively well-acquainted with the six specific music instructional technologies comprising the *DMTUS-II* and used them for pedagogical purposes.

Measurement 2: the individual DMTUS-II column A items.

Table 22 depicts the specific digital music technologies (Items 31 to 36) most often utilized by the sample respondents, categorized by *gender*. This table only covers the use of technologies listed in column A, which indicated usage for "professional use, class preparation, or class facilitation." The far right column reports the results of contingency table chi-square procedures which tested for significant association between *gender* and column A for Items 31 through 36, respectively. The chi-square procedures did not reveal any significant differences.

Table 22.

DMTUS-IIA Technology for Professional Use by Gender

		Regular use		Some use		No use		χ^2
Item	*n*	M	F	M	F	M	F	Sig.
31 Computer-based instruction	211	24.7%	19.2%	35.8%	37.7%	39.5%	42.1%	--
32 Music notation software	209	45.0%	34.1%	31.3%	31.8%	23.8%	34.1%	--
33 MIDI sequencing	210	19.8%	24.8%	27.2%	20.9%	53.1%	54.3%	--
34 Class piano use of MIDI keyboards	208	75.9%	77.5%	10.1%	10.9%	13.9%	11.6%	--
35 Applied lesson use of MIDI keyboards	208	14.8%	13.4%	34.6%	29.1%	50.6%	57.5%	--
36 Performance use of MIDI keyboards in ensembles	206	10.1%	11.8%	38.0%	30.7%	51.9%	57.5%	--

Note. * Significant at .05 level **Significant at .01 level

Table 22 shows that respondents used a number of digital music technologies to varying degrees by a sizeable proportion of the sample population. Item 34 emerged as the technology with the respondents' highest percentage of regular use (M = 75.0%, F = 77.5%). The second most regularly used digital music technology was Item 32, "Music Notation Software (e.g., *Finale*) for composing, arranging, or in-class tool," (M = 45.0%, F = 34.1%). Item 33, dealing with the use of MIDI sequencing in various teaching scenarios, ranked third in regular usage (M = 19.8%, F = 24.8%), with Item 31 (Computer-based instruction) following closely behind (M = 24.7%, F= 19.2%).

The percentages of regular use for the other two technologies ("Use of digital keyboards or other digital/MIDI support in applied lessons" and "Use of MIDI keyboards in a student performance ensemble") represented a minority of respondents (10.1% to 14.8%). In the category of "Some Use" related to Items 31 though 36, approximately 30% to 40% of the respondents indicated a use of all six of these digital music technologies. A summation of the "Regular use" and "Some use" categories showed that over half of all respondents reported using one of the following three technology categories: "computer-based instruction in a class or private lesson" (Item 31, 58%), "music notation software for composing, arranging, or as an in-class tool" (Item 32, 70%), and "digital keyboards, synthesizers, or digital pianos in a class piano setting" (Item 34, 88%). Faculty respondents also reported using the remaining three digital music technology items (Items 33, 35, and 36) at the rate of 42% to 49%. As a corollary, more than 50% of the respondents did not use these technologies to any extent in their professional and teaching activities. No significant differences between males and females emerged regarding the usage of these specific technologies.

Measurement 3: the individual DMTUS-II column B items.

Table 23 presents the same six technologies (Items 31 to 36) from the perspective of their use in "teaching as a class subject." Categorized by *gender,* contingency table chi-square tests again revealed no significant differences in usage rates for males and females.

Table 23.

DMTUS-IIB as a Teaching Subject by Gender

		Regular use		Some use		No use		χ^2
Item	*n*	M	F	M	F	M	F	Sig.
31 Computer-based instruction	200	19.0%	15.7%	35.4%%	35.4%	45.6%	48.8%	--
32 Music notation software	200	17.9%	21.3%	25.6%	21.3%	56.4%	57.0%	--
33 MIDI sequencing	199	11.4%	20.8%	29.1%	19.2%	59.5%	60.0%	--
34 Class piano use MIDI keyboards	198	61.0%	67.8%	19.5%	12.4%	19.5%	19.8%	--
35 Applied lesson use of MIDI keyboards	196	9.1%	12.6%	29.9%	29.4%	61.0%	58.0%	--
36 Performance use of MIDI keyboards in ensembles	194	6.6%	12.7%	36.8%	24.6%	56.6%	62.7%	--

Table 23 confirms that Item 34 ("Used digital keyboards, synthesizers, or digital pianos in a class piano setting") was the technology most regularly taught as a class subject (M = 61.0%, F = 67.8%). As seen in both Tables 22 and 23, the evidence suggests that Item 34 represented the most heavily used technology in the *DMTUS-II* in both categories: for professional use and as a class subject. These results provided evidence that the use of digital keyboards in class piano instructional settings appears to have widespread acceptance within the sample population, with the majority of piano pedagogues reporting their use of this technology in similar venues. Unlike the results from Table 22, however, Table 23's Item 31 (computer-based instruction) replaced Item 32 (music notation software) as the second most used technology for curricular use. The data ranked the other technologies closely together, with about one third of the respondent population reporting regular use (30% to 36%).

A summary of the findings pertaining to the individual items included in the *DMTUS-II* suggests that a majority of the respondents reported use of three of the six technologies (at least some of the time) for "professional use, class preparation, or class facilitation," but far fewer respondents indicated using the same technologies for "teaching as a class subject." However, a majority of respondents used only two of the six technologies (class piano use of MIDI keyboards and computer-based music instruction) as a class or curriculum subject. This summary completes the findings regarding the nature and distribution of the *DMTUS-II*.

Measurement 4: the DMTUS-I variable.

The other summative indicator of digital music technology use was the *DMTUS-I*, consisting of Items 9 to 14 from the survey questionnaire (see Appendix A). Following the previous analysis procedure, this section describes the nature and distribution of this summative variable as a precursor to the testing of the *DMTUS-I* for relationships with the independent variables. The *DMTUS-I* contains six digital music technology related scenarios to which respondents submitted a usage score from 0 (zero) to 10. The summation of these six individual scores resulted in the *DMTUS-I*, using the same scoring system as the individual items comprising the scale. A reliability analysis with the *DMTUS-I* yielded a Cronbach's alpha of .788.

The six scenarios involving the digital music technologies in *DMTUS-I* incorporated a greater specificity of pedagogical applications than seen in the relatively general scenarios found in the *DMTUS-II*. Figure 14 below illustrates the distribution of *DMTUS-I* scores for the survey population. This variable distribution differed markedly from that of the *DMTUS-II* presented earlier. While the *DMTUS-II* fit a reasonably bell-shaped distribution, the *DMTUS-I* shows a distribution heavily concentrated at the lower end of the scale (near zero), with a steadily diminishing level of usage toward the higher scores on the scale (those near 60).

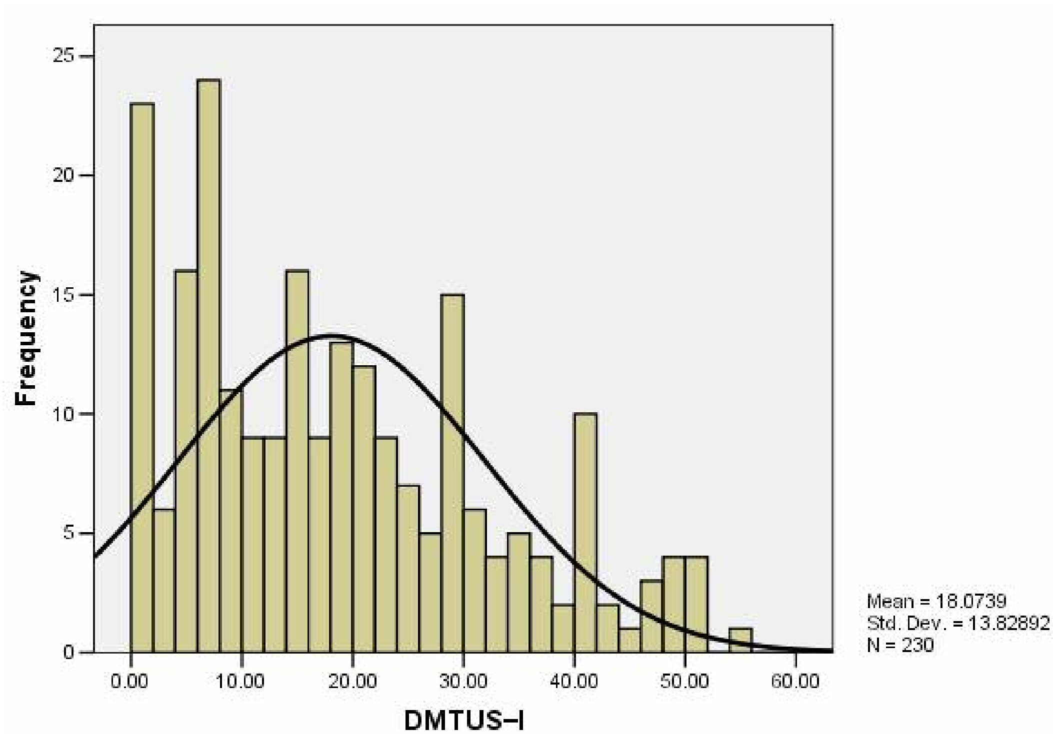


Figure 14. Distribution of the *DMTUS-I* variable.

Twenty-three respondents (10%) generated a score of zero (the modal response for the distribution) while 114 (50%) generated usage scores of 15 or less (the lowest fourth of the scale). Only 11% of the sample produced a score of 40 or higher. The mean of the distribution was 18.1, with a minimum usage score of zero and a maximum of 55.

The researcher predicted the possibility of this "bottom heavy" distribution, given the more advanced and specific application scenarios presented in this set of items.

Measurement 5: the individual DMTUS-I items.

Subsequent to the description of the *DMTUS-I*, the following analysis pertains to the usage of the six specific items in the scale. As previously mentioned, Section II of the survey questionnaire consisted of Items 9 through 14, measuring DM technology use on a 10-point scale. The point system subdivides as follows: a score of 0 (zero) refers to "no use of the technology in any setting," scores of 1 to 2 signify "some use in a single class setting," scores of 3 to 5 refer to "frequent use in a single class setting," scores of 6 to 8 indicate "some use in multiple settings," and scores of 9 to 10 represent "frequent use in multiple settings." These choices offered response options for six relatively specific pedagogical scenarios, each utilizing one or more of the music technologies found on the *DMTUS-I* (for example, Item 11 read, "Accompanied a student's solo or duet music with an orchestral or electronic sound from a keyboard instead of a piano.")

Table 24 reports the percentage of respondents who utilized the six pedagogical applications comprising the *DMTUS-I*, specifying the population's level of use or nonuse of the scenarios within this scale. Table 24 includes the percentage of respondents who used these technological scenarios in either a single teaching setting or in multiple settings.

Table 24.

DMTUS-I Percentages of Reported Usage for Overall Sample

Item #	Reported usage of digital music technology (in %)	No use	Any use	Single setting	Multiple settings	Valid *n*
9	MIDI equipment to record student performance for playback analysis/archives	30.6	69.3	38.7	30.6	235
10	Electronic music technology to support student playing (scales, musicianship, etc.)	21.9	78.1	36.1	42.1	235
11	Keyboard accompaniment for students' solo or duet music using electronic sounds	52.6	47.4	25.6	21.8	234
12	Sequenced accompaniment for practice and improvisation of right-hand melodies	48.9	51.1	31.1	20.0	235
13	Strategy for integrating CBM software into K-12 applied or group piano lessons	57.4	42.6	32.8	9.8	235
14	Notation program to prepare, facilitate or enhance all lesson formats (applied, group, etc.)	34.3	65.7	33.5	32.2	236

Table 24 reveals that a majority of faculty respondents reported some level of usage for four of the six specified applications (Items 9, 10, 12, and 14), with over 40% reporting at least some use of the other two applications (Items 11 and 13). The most often used application was Item 10 (using electronic music technology to support student playing, e.g., scales, musicianship, etc.), with 78.1% of the sample reporting some level of use for this technology. Item 9 (used MIDI equipment to digitally record student performance for playback analysis/archives) and Item 14 (using a "music notation program to prepare, facilitate, or enhance" all lesson formats, i.e., applied, group, etc.) ranked second and third in frequency of use, with reported percentages of 69.3% and 65.7% for any level of use, respectively. Table 24 shows usage levels that declined moderately for the remaining three technology scenarios in percentage of use.

Relationships of the Profile Variables to DM Technology Use

Subsequent to the description and summarization of the *DMTUS-I* and *DMTUS-II* regarding their scale distributions and individual component items, an analysis explored the relationships between the faculty profile variables and these two usage scales. Specifically, the analysis examined the relationships between the variables *gender*, *age*, *organizational memberships, conference attendance*, and *DM workshop attendance* with respect to each of the summative scales measuring *DM technology use* (*DMTUS-I* and *DMTUS-II)*. The first profile variable relationship examined was *gender*.

Testing for gender.

The relational examination of *gender* to the *DMTUS-I* and *DMTUS-II* commenced with the application of independent samples *t*-tests to the data. The *DMTUS-I* mean scores were 17.4 for males and 18.6 for females, resulting in no statistical significance (*t*

= -.663, *p* = .508). The *DMTUS-II* mean scores were 10.1 for males and 9.7 for females, again yielding no statistical significance ($t = .456$, $p = .649$). A series of independent samples *t*-tests conducted for all *DMTUS-I* and *DMTUS-II* subscales, as well as contingency table chi-square tests with the individual items comprising the scales, produced no significant differences related to gender. Therefore, the aggregate analysis offered no statistically significant differences between males and females when related to the use of DM technologies.

Testing for age.

The examination of relationships between *age* and various digital music technologies began with a one-way ANOVA test between categories of age and the *DMTUS-II* variable. Unlike the results relating the *age* effect to the *ITUS*, where younger faculty members had consistently higher average scores than older faculty members, the association between *age* and the *DM technology use* means appears inconclusive.

Table 25.

DM Technology Use Scores (DMTUS-II) by Age

Age groups	*n*	Group *M*	*SD*
25-34	20	10.9	6.13
35-44	54	10.2	5.18
45-54	60	10.4	5.49
55-64	43	8.0	5.78
65 or over	4	10.5	10.60
Total	181	9.8	5.70

The means for the different age groups of *DM technology use* (*DMTUS-II*) were approximately equal, with a slight decrease in use for the 55 to 64 age bracket. This differs greatly from the *ITUS* means, which decreased from 10.2 to 4.8 across age groups (see Table 19), a difference which was statistically significant. In Table 25, however, the differences in the group means above show no clear pattern and demonstrated no statistical significance when subjected to a one-way ANOVA (F = 1.542, p = .192). The means for subscales A and B (*DMTUS-II*) also were not statistically significant. Therefore, test results indicated that no differences by *age* existed for these relatively common and established DM technologies.

Depending upon the same testing regimen used previously with the *DMTUS-II*, the exploration of the relationship of *age* to the *DMTUS-I* variable proceeded, but with the emergence of more substantial differences. Table 26 below shows the differences in the group means for *DMTUS-I* by age group. The possible scores for the *DMTUS-I* below ranged from 0 (zero) to 60.

Table 26.

DMTUS-I by Age Groups

Age groups	*n*	Group *M*	*SD*
25-34	23	23.3	13.91
35-44	66	17.8	13.92
45-54	70	19.3	12.94
55-64	59	16.7	14.75
65 or over	10	6.6	8.20
Total	228	18.1	13.89

Table 26 shows a general pattern of decreasing usage for digital music instructional technology over the five age groups, from a high of 23.3 for the youngest age group (25 to 34) to an average score of 6.6 for those 65 years or older. While not showing a consistent pattern of decline when considered separately, the middle age groups nevertheless presented scores in the midrange of the two extremes. Using a one-way ANOVA test, these age-related differences in technology usage were significant at the .05 level ($F = 2.9$, $p = .023$). While the earlier presentation of the *DMTUS-II* showed no significance related to *gender*, the *DMTUS-I* showed a significant decline of usage by *age*, with older faculty members of this population exhibiting lower rates of digital music technology usage. It should be remembered that the *DMTUS-I* presented DM technology applications of a more specified and sophisticated nature than found in the *DMTUS-II*.

Testing for organizational memberships.

The analysis continued with the application of a Pearson's correlation between the *DMTUS-I* and *DMTUS-II* related to the number of *organizational memberships* reported by respondents. The correlation between the *DMTUS-I* and *organizational memberships* showed significance at the .05 level ($r = .145$, $p = .014$). The results indicate the possibility that faculty members belonging to one or more professional organizations are modestly but significantly more likely to use these relatively specific and sophisticated pedagogical DM applications.

For the *DMTUS-II*, the correlation with *organizational memberships* also showed significance at the .05 level ($r = .164$, $p = .014$), indicating the population's single and multiple conference memberships were modestly but significantly correlated to the *DMTUS-II* variable, representing broader and more established DM technology applications. When conducting correlations for these variables, differing statistical results were noted regarding the two subscales forming the *DMTUS-II*. The correlation of *organizational memberships* to the first subscale (subscale A, measuring DM technology usage for professional use) showed no significance (r = .108, p = .066), but its correlation to subscale B (measuring usage when teaching these technologies as a class subject) was significant (r = .186, p = .006). The *organizational memberships* variable demonstrated modest but significant correlations to both summative measures of DM technology use (*DMTUS-I* and *DMTUS-II*).

Testing for conference attendance.

Analysis of the variable of *conference attendance* also yielded a small positive, but significant correlation with both the *DMTUS-I* (r = .124, p = .030) and *DMTUS-II* (r = .157, p = .017). These results suggest a relationship between frequent conference attendance and greater DM technology use.

Testing for DM workshop attendance.

Stronger correlations emerged between the variables of *DM workshop attendance* (Item 8) and the individual measures of *DM technology use* (*DMTUS-I* and *DMTUS-II*). The correlation between the *DMTUS-I* and *DM workshop attendance* was positive and moderately strong (r = .492, p = .000). The correlational relationship between *DM workshop attendance* and the *DMTUS-II* produced almost identical results in magnitude and significance (r = .472, p = .000). Correlations for both *DMTUS-II* subscales (A and B) also showed significance at the .001 level (r = .485, p = .000; r = .401, p = .000, respectively).

Bivariate linear regression tests using the same variable sets revealed a similarly strong and positive linear relationship between *DM workshop attendance* and the

DMTUS-I, measuring the more specialized DM pedagogical applications. Figure 15 illustrates this linear relationship.

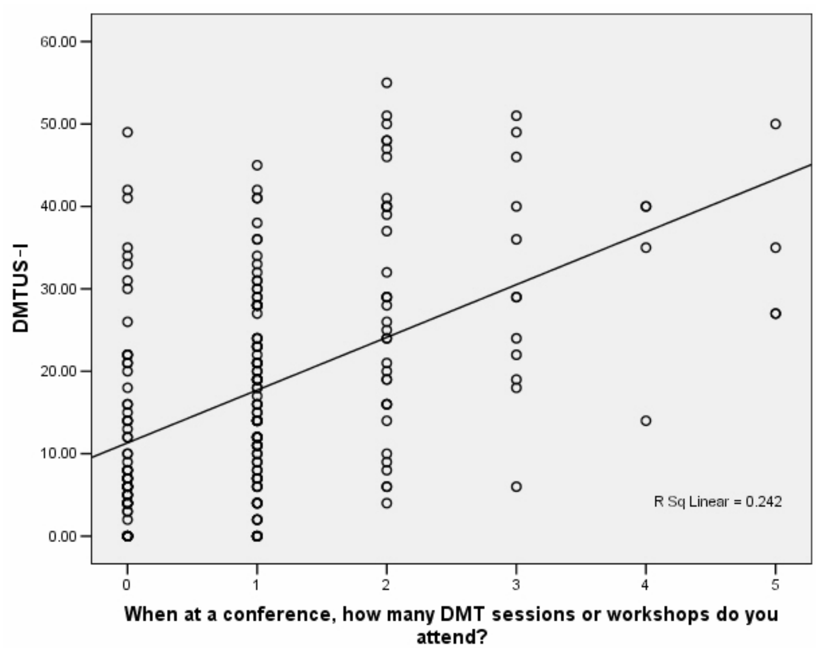


Figure 15. Regression of *DMTUS-I* by *DM workshop attendance*.

Despite the considerable variation of scores within categories of workshop attendance, the data in the scatterplot in Figure 15 clearly display an upward drift. The bivariate linear regression test for these variables produced a slope value of 6.4, with a significance of .000. This indicates that for every additional digital music workshop attended, the average respondent scored 6.4 points higher on the *DMTUS-I*.

A similar linear relationship may be seen when examining the influence of digital music technology workshop attendance with *DMTUS-II*. The scatterplot in Figure 16 illustrates the relationship of *DM workshop attendance* and *DMTUS-II*, representing a broad range of commonly used DM technologies and applications.

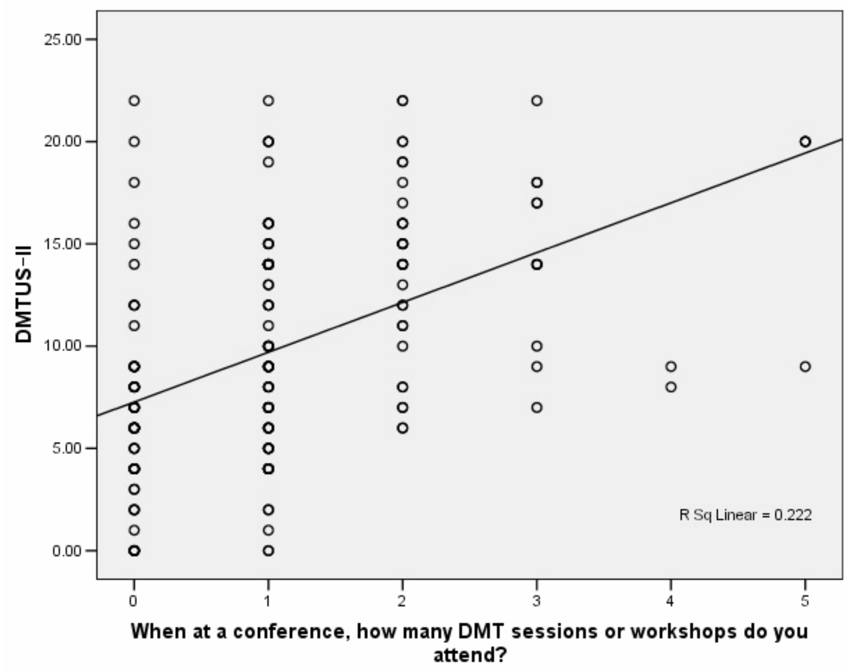


Figure 16. Regression of *DMTUS-II* by *DM workshop attendance*.

The scatterplot in Figure 16 above illustrates the results of a bivariate linear regression test, showing the slope is positive and significant ($b = 2.4$, $p = .000$). The slope on the 24-point *DMTUS-II* is 2.4, almost as strong as the slope of 6.4 in Figure 15, which pertains to the earlier regression results on the 60-point *DMTUS-I*. Further evidence for the similar level of strength between these two relationships appears in the standardized slopes for the two regressions, which are $b = .492$ for *DMTUS-I* and $b = .472$ for *DMTUS-II*. These standardized slopes are equal to Pearson's correlation coefficients, which were significant at the .001 level ($p = .000$).

However, considerable variation of digital music technology usage scores exists within each category of workshop attendance, as indicated by the dots above and below the best-fitting line. Therefore, while the relationship between *DM workshop attendance* and *DMTUS-II* is linear, positive, and moderately strong, the observed pattern certainly refutes the possibility of applying this to all respondents. Nevertheless, as an independent variable representing all piano pedagogues as a group, *DM workshop attendance* consistently related to *DM technology use* in a moderately strong and positive way. These results indicate that those who attended a greater number of digital music workshops during each professional conference generally used a greater variety of DM pedagogical applications for both private professional use and as a class subject.

Summary of Findings for Objective 2

A summary of the findings relating to an examination of the distributions of the *DMTUS-I* and *DMTUS-II* variables revealed that many faculty pedagogues showed relatively widespread and frequent use of digital music technologies. When considering the characteristics of faculty members reporting the greatest use of DM technology as measured by these two scale variables, *gender* produced no statistically significant relationship among the faculty members. The *age* variable also failed to demonstrate a significant relationship to *DMTUS-II* (measuring the use of established DM technologies), but *was* significantly related to *DMTUS-I* (measuring more specialized and sophisticated DM applications). Regarding the *DMTUS-I*, faculty members in the younger age groups displayed the greater DM technology usage.

O*rganizational memberships* and *conference attendance* (the two variables measuring involvement in the field and professional development) both produced positive, significant, and yet moderate correlations to the *DMTUS-I* and *DMTUS-II* variables. However, the faculty profile variable *DM workshop attendance* showed the strongest correlational relationship to digital music technology use, as measured against both *DMTUS-I* and *DMTUS-II* variables. The application of both correlation and linear regression tests revealed these positive and significant relationships.

Objective 3 Findings: Attitudes toward Digital Music Technology

The third research objective, as previously described in chapter 3, was to identify the specific attitudes of the overall sample, and of demographic and pedagogical subgroups of respondents, related to implementation or nonimplementation of generic digital instructional or digital music technologies. The analysis addressed this research objective in two ways.

First, measurement of attitudes toward digital music technology usage or hypothetical usage was based on Items 15 to 24 on the survey questionnaire (see Appendix A). The creation of a summative scale referred to as the *Digital Music Technology Attitude Scale* (*DMTAS*) included these responses. The point system for the *DMTAS* consisted of 10 items receiving a total of five possible points per item. Aggregate attitude scores on the *DMTAS* ranged from a minimum of 10 to a maximum of 50. Higher scores on this scale represented higher levels of positive attitudes toward digital music technology use. The distribution of the *DMTAS* variable served to characterize the attitudes of the entire sample population.

Second, the exploration of the relationship of respondent attitudes to generic instructional use and DM technology use (the *ITUS* and *DMTUS*) began with a presentation of the nature and distribution of the *DMTAS* as a dependent variable. An examination of its relationship followed regarding the sociodemographic and professional profiles of faculty members with profile variables again serving as independent variables. Unlike previous analyses involving scale variables used exclusively as dependent variables, the *DMTAS* also served as an independent variable to explore relationships between both generic and DM technology usage.

The Dependent Variable: The DMTAS

This phase of the analysis begins with the nature and distribution of the *DMTAS*, measuring faculty attitudes toward DM technology. The *DMTAS* encompassed 10 attitudinal statements in a five-part Likert answer format (Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree). Item topics included positively worded statements such as, “Music technology should be used to improve learning throughout the piano pedagogy curriculum” (Item 15). Negatively worded statements included, “Music technology is of little value in the piano pedagogy classroom because its use is too difficult or time-consuming” (Item 22).

Figure 17 shows the *DMTAS* variable distribution in a histogram based on 217 valid responses, with scores ranging from 11 to 50 on a possible scale of 10 to 50. The histogram below portrays relatively positive attitudes within the sample population toward the usage of digital music technologies for piano pedagogy.

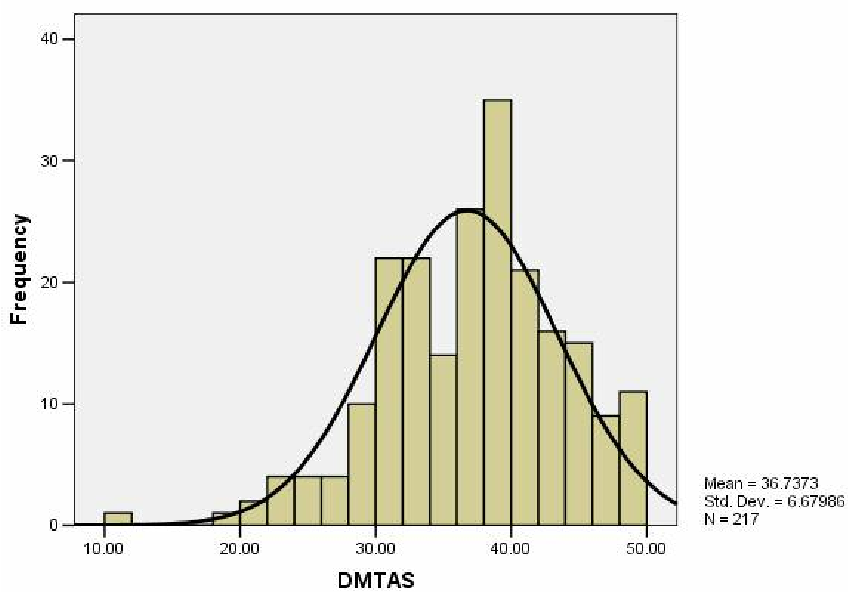


Figure 17. DMTAS scores toward digital music technology.

The mean of the *DMTAS* distribution displayed in Figure 17 is 36.7, with a standard deviation of 6.68. The negative skewness rating (evidenced by a long tail to the left) is -.416, and the kurtosis (referring to the tall peak) is .494. The histogram above portrays a definite positive attitudinal inclination toward DM technology use for piano pedagogy applications. The skewness rating makes intuitive sense since only three respondents (1.4%) scored in the lowest 25% of the scale range (that is, from 11 to 20) while 62 respondents (28.6%) scored in the highest 25% (with scores from 41 to 50). The positive kurtosis rating appears reasonable since the modal response was 39 (with 18 respondents, or 8.3%), and 50 respondents (or 23%) fell within a 3-point interval, with scores of 37, 38 or 39.

Another approach to further documentation of the general positivity of respondent attitudes examined the relationship of the data to the midpoint or "neutral point" on the distribution. The *DMTAS* midpoint is 30, which is also the score received by respondents who hypothetically selected a "3" or "undecided" response for every item choice. However, the mean of 36.7 placed well above this neutral position on the scale. Only 16.6% of the sample population (or 36 of 217 respondents) received a score of 30 or below while 83.4% received scores above 30, locating them in the "positive" section of the scale. Generally speaking, a majority of the respondents within the sample population held favorable attitudes toward the use of digital music instructional technologies. Yet sufficient numbers of pedagogues responded with generally negative attitudes to facilitate analysis of how positive or negative attitudes systematically varied or related to key faculty profile variables (n = 36, or 16.6%). Another possibility is that that those respondents totally disinterested in this topic simply did not respond to the items.

Relationships of Profile Variables with the DMTAS

Helpful to the description of the analysis of the profile variables is the recognition that very few had any statistically significant relationship to the respondent attitudes. An independent samples *t*-test related to personal profile variables and attitudes produced mean *DMTAS* scores of 36.6 for the males and 37.0 for females. These mean differences showed no significance ($t = -.434$, $p = .665$). Respondent *age* also failed to be significantly related to mean differences on the *DMTAS* when using a one-way ANOVA test ($F = .490$, $p = .743$). Means for the five age groups (from youngest to oldest) were 36.5, 36.3, 37.6, 36.5, and 35.1, respectively.

Most of the professionally oriented profile variables also failed to exhibit statistically significant relationships to the *DMTAS*. The number of *organizational memberships* to which a respondent belonged had little impact on the mean scores for the *DMTAS*. The one-way ANOVA means for various groups (from "no memberships" to "four memberships)" were 35.9, 36.5, 38.0, 37.9, and 35.0, demonstrating no statistical significance ($F = .881$, $p = .476$). A one-way ANOVA for *conference attendance* produced no statistical significance related to the *DMTAS*. Mean scores for all groups, from "annually" to "6+ years" were 37.4, 36.4, 35.6, 35.8, respectively. The resulting mean differences indicated no statistical significance ($F = .950$, $p = .417$). The relationship between *conference attendance* and the *DMTAS* also showed no statistical significance ($r = -.102$, $p = .133$) when tested with a Pearson's *r*.

However, the final professional profile variable of *DM workshop attendance* revealed a statistically significant relationship with the *DMTAS*. Using a Pearson's *r* correlation, the result was positive and fairly strong ($r = .496$, $p = .000$). A coefficient of determination value (r^2 = .246) indicated that about 25% of the variation in *DMTAS* scores suggested an association with the variation of *DM workshop attendance* scores.

Therefore, respondents who attended digital music technology related workshops displayed a greater likelihood for achieving higher *DMTAS* scores with more positive attitudes toward the use of digital music technology for piano pedagogy. A scatterplot of the relationship between digital music workshop attendance and the *DMTAS* follows in Figure 18.

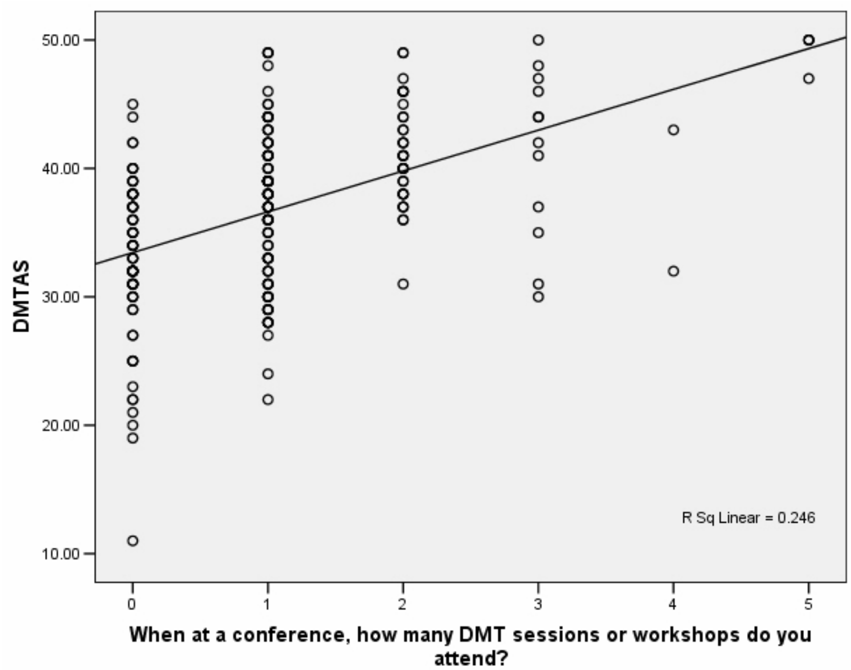


Figure 18. Regression of *DMTAS* scores by *DM workshop attendance*.

A bivariate regression analysis revealed a strongly positive linear relationship that is significant at the .001 level (b = 3.18, p = .000). The upward drift of cases indicates that the greater the number of digital workshops attended, the higher the positivity of attitude scores on the *DMTAS*. The slope of 3.18 indicates that for every digital music workshop attended at professional conferences, the average attitude score moves upward by more than 3 points on the *DMTAS*. Nevertheless, while considerable variation of attitude scores exists within categories of workshop attendance, the standardized beta (slope) of .496 (which is the same coefficient as the Pearson's *r*) suggests a good linear fit for the data.

Relationships of the DMTAS with Technology Usage Scales (ITUS, DMTUS)

The testing of Research Objective 3 concluded with an analysis of a possible relationship between the *DMTAS* variable and *ITUS* and *DMTUS* variables, which measured generic instructional and DM technology use, respectively. This analysis revealed some of the statistically strongest relationships observed in the research thus far between variables. In this set of tests, the Digital Music Technology Attitude Scale (*DMTAS*) served as an independent variable related to the dependent variables of Instructional Technology Usage Scale (*ITUS*) and the two Digital Music Technology Usage Scales (*DMTUS-I* and *DMTUS-II*).

Table 27 lists the statistical results of one-tailed Pearson's correlations, linear regression coefficients, and corresponding significance values for the *DMTAS* in relation to all technology use scale variables. An examination of the data in Table 27 reveals that the *DMTAS* variable is highly correlated and linearly related to all summative measures of instructional technology use. All observed relationships are significant at the .001 level, and the correlation coefficients and linear slope values are all positive and moderately strong.

Table 27.

Relationship of the DMTAS to Technology Usage Scales

Dependent variables	*n*	*r*	sig.	*b*	sig.
ITUS	175	.369	.000	.264	.000
DMTUS-I	212	.573	.000	1.17	.000
DMTUS-II	173	.664	.000	.552	.000

The linear relationships among the variables in Table 27 are depicted in the following scatterplots. The first (Figure 19) shows a gradual average increase in the use of generic instructional technology (*ITUS*) as attitudes toward the use of digital music instructional technologies (*DMTAS*) become more positive.

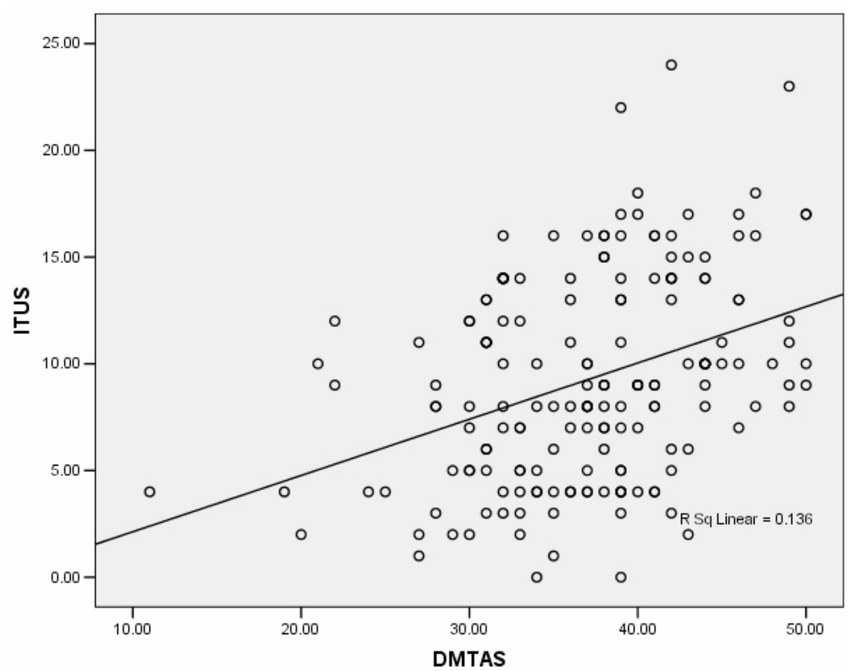


Figure 19. Regression of the *ITUS* with the *DMTAS*.

In Figure 19, the best-fitting slope line shows a moderate and statistically significant increase ($b = .264$, $p = .000$) of 2.6 *generic technology use* units for every 10 units of positive increase regarding *DM technology attitudes*. Usage scores vary within each attitude category shown, but a moderate correlation value ($r = .369$) indicates a relatively good linear fit of the model. The digital music technology and generic instructional technology categories differ qualitatively, but are empirically related. Participants who responded with more positive attitudes toward digital music technology generally reported greater usage of digital generic instructional technologies as well.

The following scatterplot in Figure 20 depicts the relationship of the *DMTAS* to the *DMTUS-I*, which measured the usage of relatively recent applications of digital music technology. This scatterplot reveals a steeper slope, and displays a stronger correlation between variables.

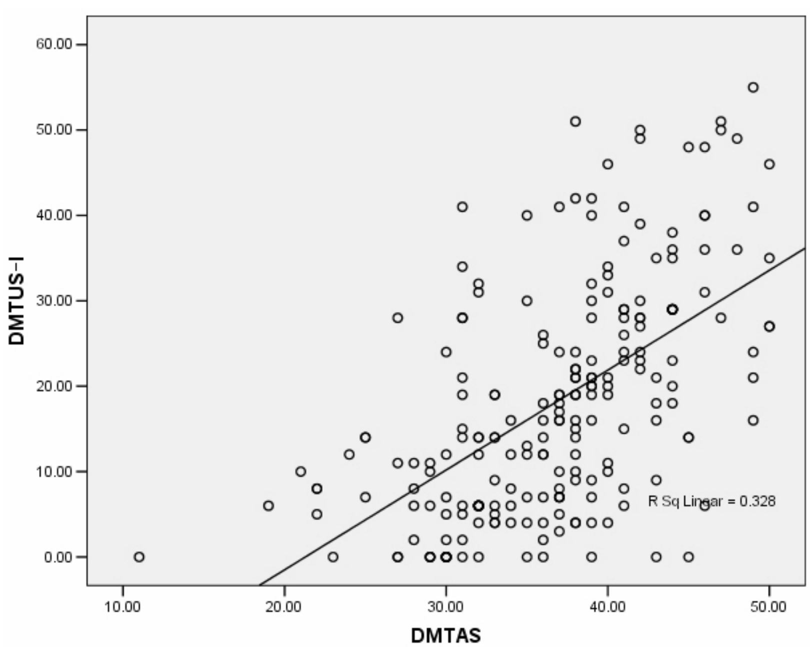


Figure 20. Regression of *DMTUS-I* with the *DMTAS*.

The slope in the scatterplot in Figure 20 is 1.17 and is significant at the .001 level ($p = .000$), representing an almost 12-point increase on the *DMTUS-I* for every 10 positive attitude units on the *DMTAS*. This linear regression displayed stronger standardized slope coefficients for *DMTUS-I* than the analysis yielded for the previous relationship with generic technology. A stronger relationship was expected, since the attitudinal predictor variable has a logically intuitive relationship to the dependent variable of digital music technology. The standardized beta and Pearson's correlation coefficient of .573 (p = .000) documents the increased strength of this relationship and suggests the appropriateness of a linear fit for the data. The coefficient of determination (r^2 = .328) indicates that about 33% of the variance in digital music usage scores is related to the variation in scores on the *DMTAS*.

The final scatterplot in Figure 21 displays the linear relationship of the *DMTAS* to the *DMTUS-II*, consisting of the six areas of more general and established applications of digital music technology. The slope in the scatterplot below is .552 and is significant at the .001 level (p = .000), indicating a 5.5 point increase on the *DMTUS-II* for every 10 positive attitude units on the *DMTAS*.

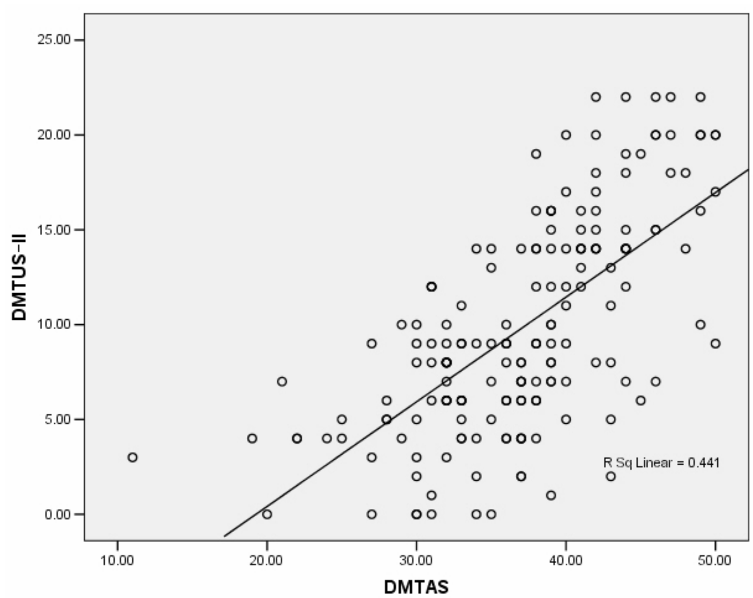


Figure 21. Regression of *DMTUS-II* with the *DMTAS*.

An appreciation of the magnitude of slopes and linear relationships between the variables of these last two figures requires a conversion of the slope values to account for the differing point scale construction between the *DMTUS-I* and *DMTUS-II*. The *DMTUS-II* shown in Figure 21 has a scale range of 24 points, whereas the *DMTUS-I*, shown in Figure 20, has a scale range of 60 points. The calibration of the *DMTUS-II* to the same 60-point scale allows for useful comparative analysis. The converted scores now show a 13-point increase for the *DMTUS-II,* compared to the 12-point increase described earlier for the *DMTUS-I,* per 10 units of attitude change on the *DMTAS*. This comparative judgment regarding the strength of the slope coefficient for the *DMTAS* and *DMTUS-II* regression is corroborated by the standardized slope and correlation of .664 ($p = .000$). This coefficient represents the strongest relationship noted thus far in the research and translates to a coefficient of determination over 42% ($r^2 = .425$). This relationship supports the conclusion that respondent attitudes (as measured by the *DMTAS*) are directly and significantly related to the usage of specialized digital music technology (the *DMTUS-I)* in a substantial way.

Summary of Findings for Objective 3

The purpose of Research Objective 3 was the exploration of the attitudes of the sample population and subgroups toward digital music instructional technology, and the connections between such attitudes and instructional technology usage (both generic and digital music related). The data analysis revealed the following generalizations related to this objective. First, the distribution of attitudes toward digital music slants heavily in a positive direction, with over 83% of the piano pedagogues displaying attitudes on the positive side of neutral (i.e., above a neutral score of 30). Second, most profile variables (*gender*, *age*, *organizational memberships*, and *conference attendance*) showed no significant relationship to this variable. Only *DM workshop attendance,* a variable with a logical association towards digital music technology usage, indicated a significant and substantial correlation to the *DMTAS* (r = .496, p = .000).

A summary of the analysis revealed that the *DMTAS* exhibited a positive and moderately strong correlation to the *ITUS* variable (r = .369, p = .000), with even stronger correlations to the digital music technology variables of *DMTUS-I* (r = .573, p = .000) and *DMTUS-II* (r = .664, p = .000). Linear regression analyses also yielded significant relationships between *DMTAS* and the *ITUS* (b = .264, p = .000), the *DMTUS-I* (b = 1.17, p = .000), and the *DMTUS-II* (b = .552, p = .000). These sets of connections or relationships were both statistically significant and substantial. The strongest linear relationship observed through the examination of this research objective occurred between the *DMTAS* and the *DMTUS-II* (r = .664, p = .000).

Therefore, while attitudes toward digital music technology clearly demonstrated significant and noteworthy relationships toward the use of generic instructional technology, the data revealed even stronger attitudinal connections to the actual usage levels of digital music technology. In conclusion, those respondents expressing more positive attitudes toward the role of digital music technology in piano teaching activities, as well as those who attended music technology conference workshops with greater frequency, showed greater likelihood of employing any and all types of digital instructional technologies.

Objective 4 Findings: Digital Music Usage by Generic Technology Usage

The fourth research objective was to identify the relationship between faculty generic instructional technology adoption and usage and digital music technology adoption and usage. The manner of testing for these relationships involved the summative scales created for this purpose, the *ITUS* and the two scales for the use of digital music technology, the *DMTUS-I* and *DMTUS-II.*

A Brief Overview of Test Results

The investigation of possible correlation and linear relationships between generic technology use (measured by the *ITUS*) and digital music technology (measured by the *DMTUS-I* and *DMTUS-II*) proceeded with a Pearson's correlation and bivariate linear regression test. All test results are summarized in Table 28.

Table 28.

Test Results for the ITUS and DMTUS

Dependent Variables	*n*	*r*	sig.	*b*	sig.
DMTUS-I	181	.501	.000	1.49	.000
DMTUS-II	172	.595	.000	.698	.000

Table 28 first presents the results of two Pearson's correlation tests (see middle columns), and shows that usage of generic instructional technology (*ITUS*) is correlated strongly and positively with usage of digital music technology, as measured by the *DMTUS-I* and *DMTUS-II*. The correlation coefficients (r = .501, p = .000; r = .595, p = .000) are significant, positive, and moderately strong, yielding coefficients of determination of between 25% and 35% (r^2 = .251, r^2 =.354, respectively).

The bivariate linear regression tests for the *ITUS* and both *DMTUS* (see right-hand columns) also yielded significant coefficients (b = 1.49, p = .000; b = .698, p =

.000), indicating the presence of significant and positive linear relationships between the use of generic and digital music technology. The following scatterplots in Figures 22 and 23 graphically illustrate these relationships.

Linear Relationship of the ITUS with DMTUS-I

The first scatterplot, Figure 22, shows the linear relationship of the first digital music scale variable (*DMTUS-I*) as a dependent variable and the summative measure of generic instructional technology (the *ITUS*) as the independent variable. The steep slope of the relationship ($b = 1.49$, $p = .000$) is noteworthy.

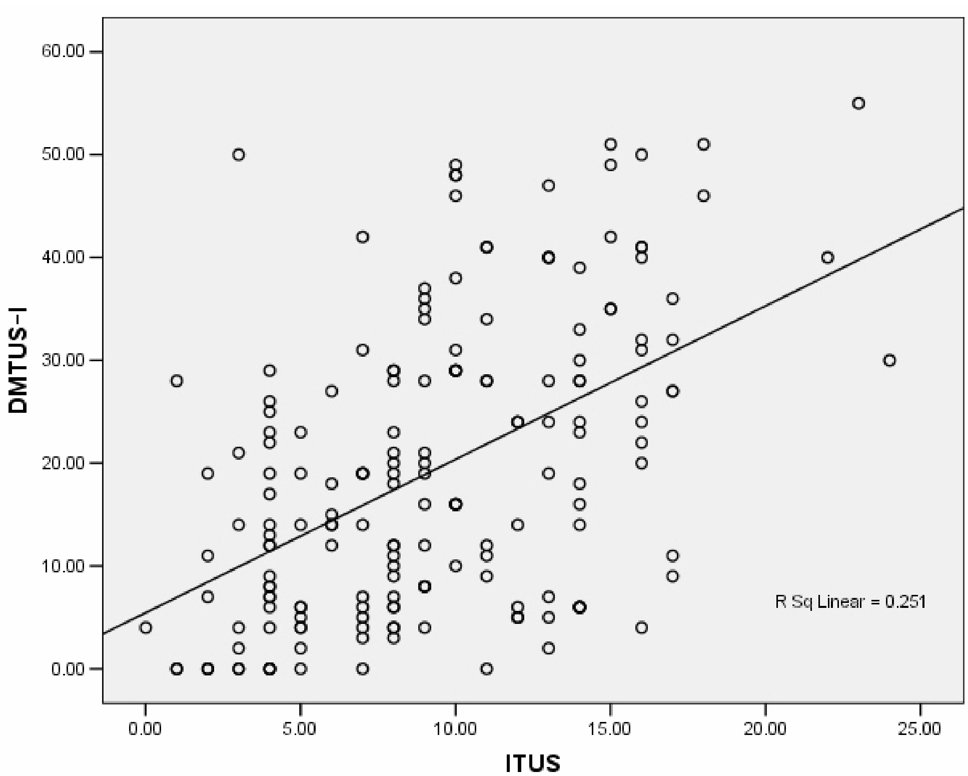


Figure 22. Regression of *DMTUS-I* with the *ITUS*.

Figure 22 displays a slope of 1.49, showing an approximately 15-point increase in *DMTUS-I* scores for each 10-point increase on the *ITUS*. The correlation of .501 (p = .000) suggests a linear fit for the data, and the *ITUS* values (as determined by r^2) are associated with a 25% variation in digital music usage scores. Therefore, piano pedagogues who made greater use of generic digital instructional technologies were also more likely to use some of the newer and specialized digital music instructional applications as well.

Linear Relationship of the ITUS with DMTUS-II

The final scatterplot in Figure 23 indicates an even stronger linear relationship between generic instructional technology usage and digital music instructional technology usage, as measured by the *DMTUS-II*.

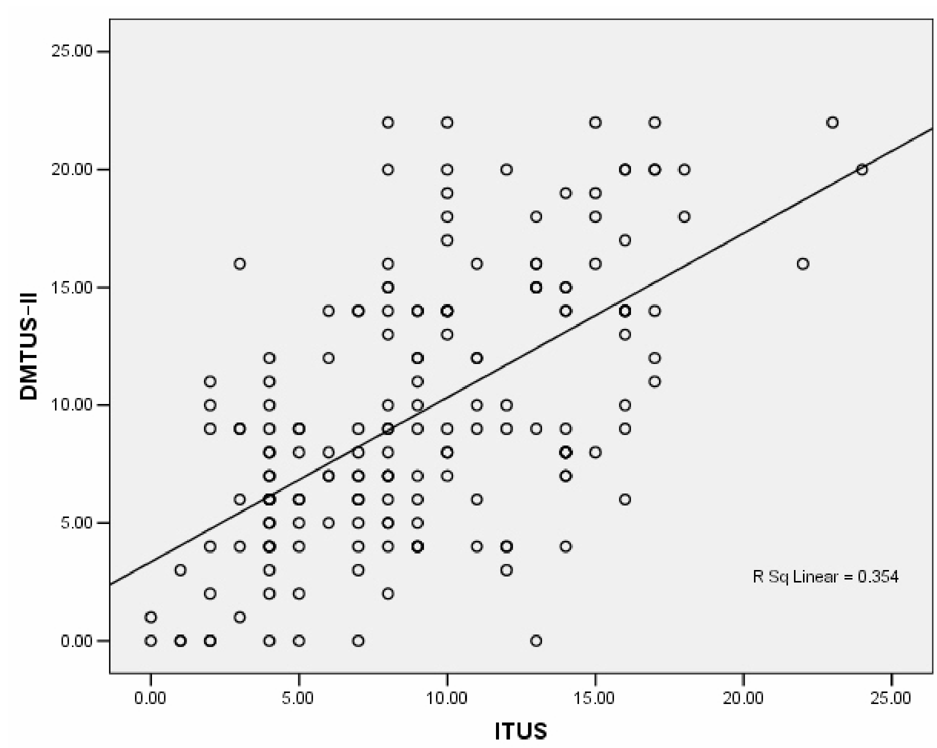


Figure 23. Regression of *DMTUS-II* with the *ITUS*.

The regression slope for the scatterplot in Figure 23 is .698, which is significant at the .001 level (p =.000). The standardized slope of .595 equates with the Pearson's correlation for these two variables at (p = .000). This significant and strongly positive correlation indicates an association between *ITUS* and approximately 35% of the variation in the *DMTUS-II* as the dependent variable. These findings signify that there is a direct and statistically significant relationship between faculty pedagogue's generic technology use and their DM technology use for instructional purposes.

Summary of Findings for Objective 4

Research Objective 4 concludes with the analysis results clearly showing that usage of generic and DM technologies are directly and significantly related. The usage of generic digital instructional technologies by piano pedagogues, coupled with positive attitudes toward digital music technology, is directly related to higher levels of usage for both established and specialized types of digital music instructional technology.

Objective 5 Findings: Assessing the Rogerian Model

The fifth research objective was to compare the patterns of instructional and digital music technology usage with the five-part adopter categories of the Rogerian typology concerning the adoption of innovations. Rogers' (2003) first model of the adoption and diffusion of technology is based on the characteristics of a bell curve, and postulates that specific percentages of a population fall into the five adoption categories shown in Figure 24.

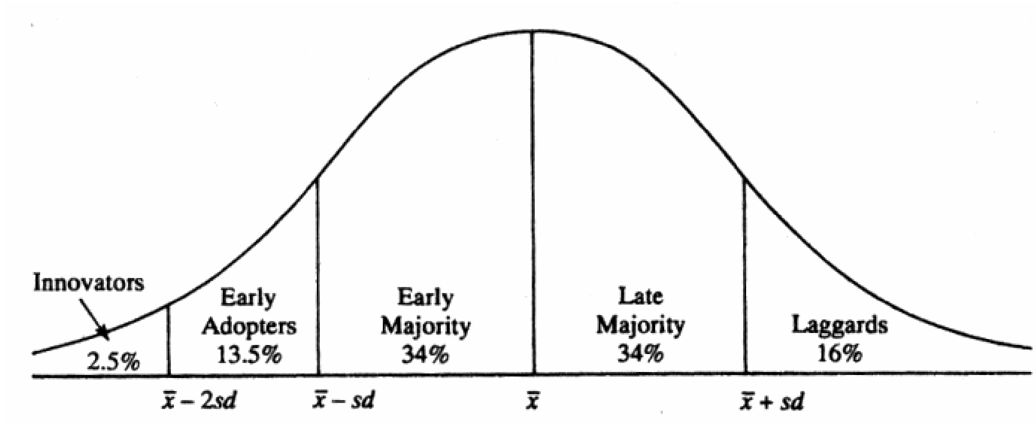


Figure 24. Frequency of new adoptions.

Note. From "The Adoption of Spreadsheet Software: Testing Innovation Diffusion in the Context of End-User Computing," by J. Brancheau and J. Wetherbe, 1990, *Information Systems Research, A Journal of the Institute of Management Sciences,1*(2), p.118. Copyright 1990 by J. Brancheau and J. Wetherbe.

Rogers' (2003) model includes two basic concepts, adoption and diffusion. The first concept, adoption, refers to the onset of usage of a specified technology, idea, or innovation by an individual or group of individuals. The second concept, diffusion, refers to a comprehensive "snapshot" of all individual adopters within a particular subsystem or population at any given time. This aggregate portrait identifies the chronology of individuals who adopt a technology within statistically defined time periods which are then placed in order of adoption (first, second, third, etc.). To follow this line of reasoning for this particular study, the researcher created two phases of measurement: a respondent-based measurement of adoption, and a population-based description of diffusion.

Creation of the Five Rogerian Categories of Adoption

To measure individual *adoption*, respondents were subdivided into the five

Rogerian categories of Innovators, Early Adopters, Early Majority, Late Majority, and Laggards (Rogers, 2003), using the variable *years of use* to make the category designations (see Appendix A, Items 31 to 36, column C, section IV of the survey questionnaire). This placement was based on the specific DM technology application that had been used for the greatest number of years. This procedure is defensible, and seems preferable to taking an average, since one does not need to use all technologies to be classified as an innovator or adopter.

After the variable *years of use* was created and the category placement was accomplished, a frequency distribution revealed a very intriguing but lamentable tendency on the part of respondents. While estimating the *years of use* for different technologies, respondents often rounded their numerical figures up or down to multiples of five. The frequency distribution of the *years of use* variable presented in Table 29 clearly shows the frequency spikes caused by this rounding or reporting bias.

Table 29.

Years of Digital Music Technology Use

Years	Frequency	%	Valid %	Cumulative %
0	6	2.5	3.2	3.2
1	2	.8	1.1	4.2
2	6	2.5	3.2	7.4
3	9	3.8	4.8	12.2
4	2	.8	1.1	13.2
5	15	6.3	7.9	21.2
6	7	2.9	3.7	24.9
7	9	3.8	4.8	29.6
8	12	5	6.3	36.0
9	1	.4	.5	36.5
10	24	10.1	12.7	49.2
11	3	1.3	1.6	50.8
12	7	2.9	3.7	54.5
13	5	2.1	2.6	57.1
14	5	2.1	2.6	59.8
15	22	9.2	11.6	71.4
16	8	3.4	4.2	75.7
17	1	.4	.5	76.2
18	4	1.7	2.1	78.3
19	2	.8	1.1	79.4
20	14	5.9	7.4	86.8
21	1	.4	.5	87.3
22	1	.4	.5	87.8
23	2	.8	1.1	88.9
24	1	.4	.5	89.4
25	15	6.3	7.9	97.4
26	1	.4	.5	97.9
27	1	.4	.5	98.4
30	2	.8	1.1	99.5
32	1	.4	.5	100
Total	189	79.4	100	
Missing	49	20.6		
Total	238	100		

In all cases, the frequencies for multiples of five were a minimum of twice the number for adjacent categories and were often substantially higher (e.g., the modal category of *10 years* had 24 responses, representing 12.7% of the 189 valid responses). The category of *9 years* (before) and *11 years* (after) had one response and three responses, respectively. The same type of reporting bias is evident for the categories of 5, 15, 20, and 25 years, as can be clearly seen in the distribution in Table 29. This reporting bias translates into measurement bias for the variable *years of use*. However, since at this point in the analysis, the purpose is aggregate description of the Rogers' variable, careful handling of the grouping can minimize the negative effects of this bias.

In order to achieve the approximate percentages Rogers (2003) specified for the bell-shaped distribution (Innovators, 2.5%; Early Adopters, 13.5%; Early Majority, 34%; Late Majority, 34%; and Laggards, 16%), the cumulative frequency distribution on the previous page (Table 29) was used to establish the cutting points for the categories and resulted in the following frequency distribution.

Table 30.

Percentages in the Sample Population for the Rogerian Categories

Rogerian categories	Years	Predicted %	Actual %
Innovators	26-32	2.5%	2.6%
Early adopters	21-25	13.5%	10.6%
Early majority	13-20	34.0%	32.3%
Late majority	6-12	34.0%	33.3%
Laggards	0-5	16.0%	21.2%

Table 30 identifies the five Rogerian categories, the percentage in each adopter group (as predicted by Rogers), and the actual percentages of the 189 survey respondents from the sample population who provided valid data for this variable. Since achieving an exact match of percentages was impossible due to the actual cumulative percent numbers for the present data, the researcher chose the category cutting points to correspond as closely as possible to Rogers' percentages, falling within only one to two percentage points of those specified by the Rogerian model. Figure 25 below provides a graphic illustration of how the categorization of the sample data conformed to Rogers' bell-shaped, five-category model of technology adoption.

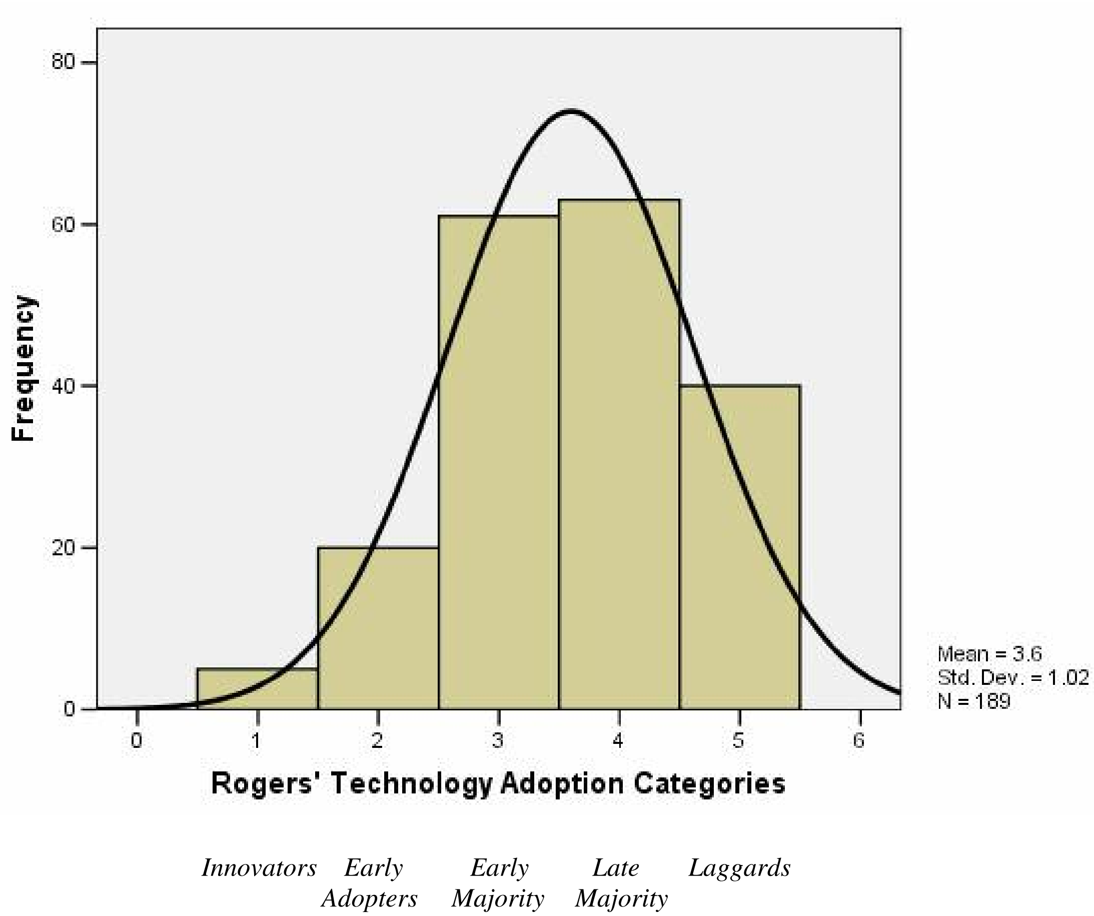


Figure 25. Sample data compared to Rogers' bell-shaped model.

Figure 25 shows a reasonable correspondence between the categorization of sample respondents (into the five Rogerian categories) and Rogers' bell-shaped model. After the five Rogerian categories were established, the relationship of *Rogers' ATV* (a variable introduced in chapter 3 which placed respondents into the five Rogerian categories) and various types of technology use was explored.

The Relationship of Rogerian Categories to the ITUS

First, a one-way ANOVA was conducted to test the relationship of the *Rogerian Adoption Typology Value* variable (*Rogers' ATV)* to the use of generic digital technology. Table 31 depicts the mean scores for the *ITUS*, within Rogerian categories.

Table 31.

Mean ITUS Scores by Rogerian Adopter Categories

Adopter Categories	*n*	Group *M*	*SD*
Innovators	5	5.8	4.38
Early Adopters	18	9.5	5.02
Early Majority	50	10.7	5.04
Late Majority	55	9.1	4.57
Laggards	34	8.6	4.36
Total	162	9.5	4.78

Table 31 shows mean scores on the *ITUS* ranging from 5.8 to 10.7, with higher usage reported by the middle groups. These *mean* differences, however, showed no significance with a one-way ANOVA test ($F = 2.0$, $p = .097$). Therefore, regarding the usage of generic instructional technology among piano pedagogues, no significant differences emerged for any of the five adopter categories in Rogers' (2003) model. This suggests that Rogerian adopter categories for digital music technology are not associated with greater use of generic technologies (e.g., databases, presentation software, etc.) as measured by the *ITUS*.

The Relationship of Rogerian Categories to the DMTUS-I

Table 32 shows a similar comparison, but explores the relationship between the Rogerian categories and the usage of digital music technologies. As previously mentioned, the *DMTUS-I* offered respondents specific and somewhat sophisticated scenarios for applying DM technologies to piano pedagogy.

Table 32.

Mean DMTUS-I scores by Rogerian Adopter Categories

Adopter Categories	*n*	Group *M*	*SD*
Innovators	5	15.6	19.83
Early Adopters	20	24.8	14.20
Early Majority	61	23.7	13.14
Late Majority	63	19.2	12.13
Laggards	40	9.9	11.57
Total	189	19.2	13.74

Table 32 illustrates the mean scores for the *DMTUS-I*, presented within the Rogerian categories of adoption (ranging from 9.9 to 23.7 on the 60-point *DMTUS-I*). These differences showed statistical significance at the .001 level with a one-way ANOVA test ($F = 8.25$, $p = .000$). Adopter groups in the middle range of the scale again reported higher usage rates. In this instance, however, the differences were greater and statistically significant. The data in Table 32 indicated that categories two and three, the Early Adopters (24.8) and Early Majority (23.7) reported the largest usage, respectively.

It is particularly noteworthy that the score for Innovators (15.6) was almost 10 points lower than the Early Adopters and only slightly greater than the group with the lowest usage score (Laggards with 9.9).

The Relationship of Rogerian Categories to the DMTUS-II

The final usage comparison for the Rogerian categories involves the *DMTUS-II*, which measures usage levels across broad categories of digital music technology. Table 33 presents the average use of digital music technology (*DMTUS-II*) within the five categories of the Rogerian model of adoption and diffusion.

Table 33.

Mean DMTUS-II scores by Rogerian Adopter Categories

Adopter Categories	*n*	Group *M*	*SD*
Innovators	5	7.8	5.93
Early Adopters	16	12.7	4.99
Early Majority	50	12.1	5.28
Late Majority	58	9.7	5.00
Laggards	34	7.1	4.89
Total	163	10.1	5.42

Table 33 presents mean scores for the *DMTUS-II*, ranging from 7.1 to 12.7 on the 24-point *DMTUS-II*, also presented within Rogerian categories of adoption. These differences showed significance at the .001 level with a one-way ANOVA test ($F = 8.25$, $p = .000$). Again, the middle adopter groups reported the highest usage rates, demonstrating a similar pattern to previously reported analysis of the *DMTUS-I* variable in Table 32. Table 33 indicates that the highest usage for the *DMTUS-II* occurred in categories two and three, the Early Adopters (12.7) and Early Majority (12.1), respectively. As seen in the last usage set, the score for Innovators (7.8) was surprisingly low and not much greater than that of the Laggards, who reported the lowest usage score (7.1).

The results of this battery of one-way ANOVA tests indicate that significant relationships existed between the five Rogerian categories of technological adoption and the rates of usage of digital music technology (*DMTUS-I* and *DMTUS-II*). However, the data analysis also noted no significant relationship between the Rogerian categories and levels of usage for generic instructional technology (*ITUS*).

A Contrast of Rogerian Attitudes with Technology Use

With the completion of the distribution of usage levels presented from the context of the Rogerian adopter categories, an analysis of respondent attitudes toward technology use proceeds, as measured by the *DMTAS*. Earlier findings in this chapter demonstrated that the subjection of the *DMTAS* to a one-way ANOVA test pointed to the observation that Innovators received the highest average attitudinal score on the scale (M = 43.5). Test results reported that the Innovators attained the greatest level of positive attitudes toward DM technology usage, followed by a steady decline in mean scores across the remaining groups. As predicted by Rogers' (2003) model, the Laggards received the lowest or most negative attitudinal score (M = 33.7). These differences were significant at the .001 level (F = 5.07, p = .001).

These attitudinal data resulted in a different pattern than the one previously noted regarding technology usage. Previous discussions of the *DMTUS* noted Laggards as reporting the lowest DM usage scores, followed by Innovators and the adopter groups from the middle of the adoption and diffusion timeline. The current results regarding attitude indicate that the Innovators demonstrated the highest or most positive attitudes toward DM technology on the scale. However, while Innovators as a group reported the longest use of technology, they also displayed relatively low levels of current usage. In order to understand the reasons for this unexpected discrepancy between Innovator attitudes and usage levels, a visual model was created to contrast Rogerian categories with respect to both technology use and attitudes.

Figure 26 displays the mean *DMTAS* scores in comparison to the means for the two DM technology scales, *DMTUS-I* and *DMTUS-II*. This line graph reveals a completely different pattern of Rogerian group attitude scores than found within the previous digital technology usage scores. The top line in Figure 26 represents the average *DMTAS* scores for the five Rogerian groups; the middle line shows the average *DMTUS-I* scores (representing more specialized DM technology applications); and the bottom line reports the groups' average *DMTUS-II* scores (representing more established and broader DM technology applications). Actual scores for the five groups are displayed below the line graph.

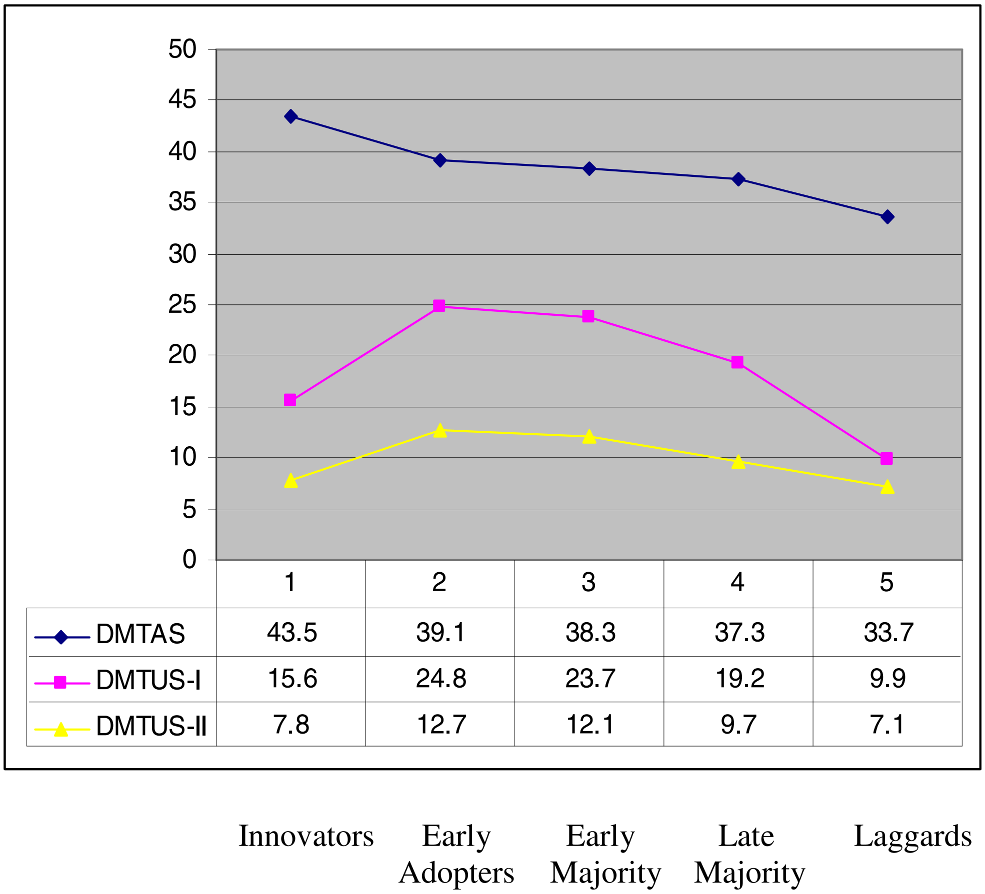


Figure 26. Rogers' adopter categories by DM attitudes and usage.

Figure 26 clearly reveals that a different contour and pattern exists for the *DMTAS* scores across Rogerian categories than exists for their usage level of DM technology. Regarding the usage of both broader and more specialized applications of DM technologies (the *DMTUS-II* and *DMTUS-I*, respectively), users in the middle of the time continuum (Early Adopters, Early Majority, Late Majority) displayed the highest scores for both scales. Innovators followed with fairly low average usage scores and finally Laggards, displaying the lowest usage scores.

The DM technology attitudinal patterns, as measured by the *DMTAS*, showed a marked difference relative to usage habits. As might be expected, Innovators attained the highest positivity scores (M = 43.5), with the other adopter categories showing progressively declining scores on the adoption and diffusion timeline (as measured from the time of earliest adoption to the latest). Laggards displayed the lowest attitudinal scores of the five adopter categories (*M* = 33.7). Tested with a one-way ANOVA, these differences showed significance at the .001 level ($F = 5.07$, $p = .001$). However, proper interpretation of the mean differences between Rogerian groups on the *DMTAS* (from 33.7 to 43.5) depends on a recognition that the total scale range of this attitudinal scale is from 10 to 50, thereby indicating strongly positive attitudes on the part of most respondents.

A Test of the Rogerian S-curve Model

The final portion of the analysis for Research Objective 5 consisted of a comparison between the technological diffusion of the sample population and the S-curve graph (see Figure 27).

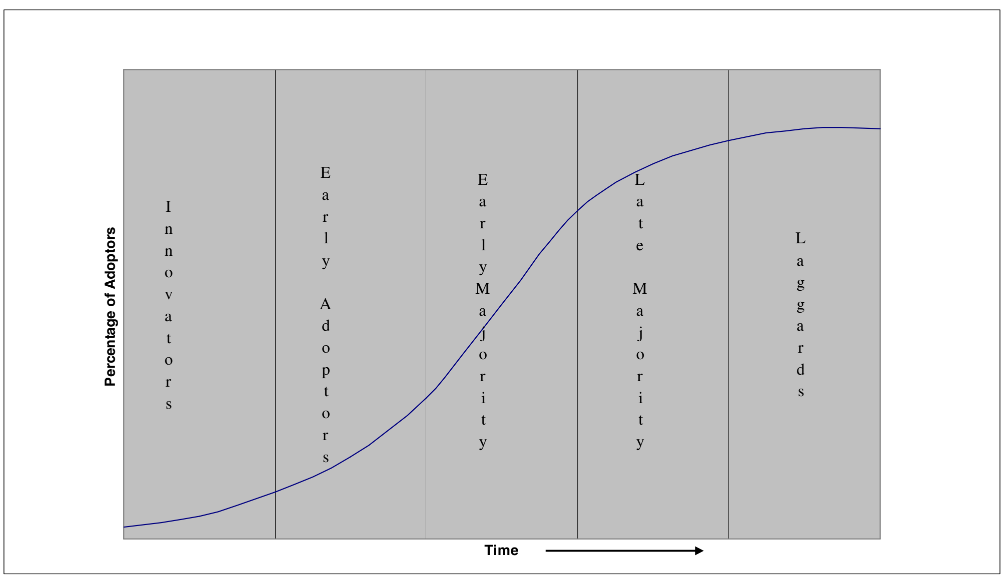


Figure 27. S-curve adoption for technology innovations.

Note. Adapted from *Diffusion of Innovation, 5th ed.* by E. M. Rogers, 2003, New York: Free Press, Copyright 2003 by E. M. Rogers and the Free Press.

The Rogerian S-curve representation illustrates a time-related curve suggested by Rogers (2003) as the most appropriate means of graphing the diffusion of a technology across a specified population. The linear characteristics of the typical S-curve show a pattern of mild and gently graduated adoption during the Innovator and Early Adopter stages, followed by an accelerated ascent throughout the Early Majority stage. The diffusion line gradually levels off during the final two stages of Late Majority and Laggards towards a flat line representing a point of relatively full saturation or diffusion.

Rogers (2003) further claimed that the S-curve offered a suitable alternative to the bell curve model for graphing adopter categories from the perspective of aggregate adoption (diffusion). Proponents of the model assert that the S-curve better enabled users to understand the progression of events with respect to a particular population or social system. Rogers' model further suggests that the S-curve provides a reliable and universal standard of comparison across differing analysis results among adoption and diffusion studies (Mahajan & Peterson, 1985).

In Figure 28, the graph represents a timeline of the population respondents' longest time period of reported use for any technology or their *years of use.* The year of earliest use reported by any of the sample respondents with regard to any of the research technologies was calculated to be 1974. This year served as the starting point for the horizontal axis in Figure 28 and continued until 2006. The sample respondents reported *years of use* for this entire range of years, with the exception of years 28, 29, and 31. Figure 28 provides the resulting line graph.

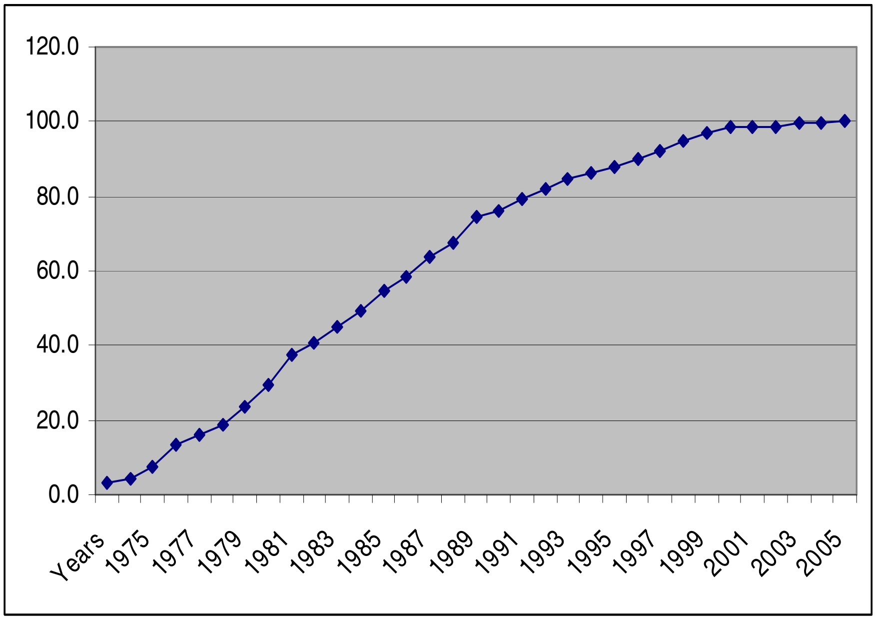


Figure 28. Year of DM technology adoption.

Figure 28 clearly shows that while the current data indicate a similar pattern of increased usage over the specified period of time, there are differences between the graph of the present study data and the typical Rogerian S-curve. Figure 28 lacks the three descriptive stages of the S-curve mentioned earlier: (a) mild and gently graduated adoption during the Innovator and Early Adopter stages, (b) accelerated ascent during the Early Majority stage, and (c) a tapering off in the final two stages of Late Majority and Laggards.

The cumulative frequency polygon in Figure 28 only corresponds to the third stage of the Rogerian model, where the diffusion rate began to level out or taper off. The initial two stages of Rogers' model failed to materialize from the points of adoption in Figure 28 for the current population. In contrast to the S-curve prediction, the current research data resulted in a roughly linear relationship for the first 16 years (exactly half of the 32-year span), followed by a second but somewhat gentler linear relationship for the next 10 years. Only during the final 6 years of the current diffusion cycle does the graph follow the parameters of the Rogerian model (see Figure 28).

A Summary of the Findings Related to Objective 5

The initial analysis of the sample respondents involved the categorization and distribution of the respondents according to the five-part Rogerian adopter matrix (Rogers, 2003). The first graphic representation distributed the population's adoption information along the bell curve model according to close approximations of the percentages specified for each group. The resulting distribution compared favorably to Rogers' (2003) bell-curve model, allowing for feasible comparisons between the five Rogerian groups and the categories identified with the present sample (according to the implications and characterizations of these groups as suggested by Rogers' model).

Integrating the population's responses into Rogers' (2003) adopter categories failed to produce any significant statistical differences regarding their usage of generic technology, as measured by the *ITUS*. However, significant differences emerged between adopter groups related to their use of digital music technology (the *DMTUS-I* and *DMTUS-II*). Laggards displayed the lowest levels of usage, followed by Innovators, an unexpected result. Although the Innovators were first in the adoption and use of the technologies in question, they nevertheless reported lower levels of current usage than those respondents in the categories of Early Adopter, Early Majority, and even Late Majority. The average usage for the two *DMTUS* appeared theoretically consistent with Rogers' characterizations of the five Rogerian groups (2003).

The pattern of diffusion for the entire sample population generated a roughly linear increase over the 32-year period of adoption reported by faculty respondents. This pattern was subsequently compared to the visual diagram of the roughly three-part S-curve model suggested by Rogers (2003). The graphic representation of the data appeared to correspond only to the third stage graphic presentation of the S-curve model. Therefore, while there were some similarities between the actual study data and the S-curve model, notable differences emerged between the pattern of technology and diffusion observed in the present study data and that suggested by Rogers. The sample data suggested that a more directly linear model may be appropriate as an alternative to the S-curve model.

Summary of Chapter 4

This chapter presented basic demographic information about the respondents in the form of faculty profile variables, followed by a presentation of the univariate highlights of both the key independent and dependent variables. Each of the five research objectives was then explored in detail. Since this chapter presented the specific findings for each research objective in detail and a summary of the same results occurs in chapter 5 to supply a context for discussion, they will not be summarized in detail at this point. However, the following highlights appear worthy of review.

Statistical highlights include the following observations. Surveys were returned by 238 respondents (of 695 possible respondents) for a return rate of 34%. Females represented over half of the sample population (60.1%). Regarding age, 90 respondents (38.3%) identified themselves as under 45 years of age, 74 (31.5%) fell between the ages of 45 and 54, and 71 (29.8%) were 55 or older. The average time period for teaching at the university level was 17.9 years. Regarding their professional duties, 90.3% of the respondents taught applied piano, 74.4% taught undergraduate piano pedagogy-related courses, 69.2% instructed class piano, 32.5% engaged in preparatory school teaching, 29.5% offered graduate piano pedagogy related courses, and 81% taught a piano pedagogy-related course within the last five years.

Pertaining to professional involvement in the field, 68.4 % of the population indicated membership in between one and four conference organizations, with the largest group (59.4%) claiming membership in MTNA. The majority of respondents attended conferences frequently: 54.9% attended annually, 14.7% every 2 years, 16.5% every 3 to 5 years, and 13.9% from 6 years to never. Many respondents (42.2%) attended a minimum of one digital music workshop per conference attended, but 32.5% attended no digital music technology workshops when attending conferences.

Four summative scales were created to measure key dependent variables for this research: (a) the *ITUS* (Instructional Technology Usage Scale), measuring the use of generic digital instructional technology; (b) the *DMTUS-I* (Digital Music Technology Usage Scale I); and (c) the *DMTUS-II* (Digital Music Technology Usage Scale II), both of which measured the use of digital music instructional technology; and (d) the *DMTAS* (Digital Music Technology Attitude Scale), which ascertained respondent attitudes toward actual and hypothetical usage of digital music instructional technology. Distributions of these four new summative scales revealed high usage rates of both generic and digital music technologies, as well as generally positive attitudes on the part of faculty pedagogues *toward* digital music instructional technologies.

Respondents demonstrated a higher use of digital music technology than anticipated, both for private professional use and also for teaching these technologies as a class subject. Approximately 77% reported using digital keyboards, synthesizers, or digital pianos in a class piano setting, 69.3% reported using MIDI equipment to record student performance for playback analysis/archives, and 78.1% reported using electronic music technology to support student playing (scales, musicianship, etc.). The rate of DM technology usage was extensive enough to give the respondent group a higher average usage score for the *DMTUS-II* (M = 9.8), measuring digital music use than for the *ITUS* (M = 9.2), measuring the use of generic digital instructional technologies.

No significant gender effects emerged regarding the use of both forms of digital instructional technology for the purposes of piano pedagogy, but one-way ANOVA tests revealed younger faculty members as significantly more likely to use generic digital instructional technologies, as measured by the *ITUS* (F = 3.54, p = .008), as well as digital music technology use, as measured by the *DMTUS-I* (F = 2.9, p = .023). However, age differences affected the rate of technology less than expected. The magnitude of age effects was modest at best and no age effect was observed for the *DMTUS-II*. Significant correlations occurred between the usage of digital music technology and organizational memberships (r = .164, p = .014), conference attendance (r = .157, p = .017), and digital music workshop attendance (r = .492, p = .000).

Several tests were conducted to test the relationships of (primarily) dependent variables with each other. Respondent attitudes toward digital music technology, as measured by the *DMTAS* and as tested by Pearson's correlation tests, resulted in positive and significant relationships to usage of the *ITUS* (r = .369, p = .000), to the digital music scales of the *DMTUS-I* (r = .573, p = .000), and the *DMTUS-II* (r = .664, p = .000). Generic digital technology use (the *ITUS*) showed positive and significant correlations to both summative scales measuring the use of digital music instructional technology (for *ITUS* and *DMTUS-I*, r = .501, p = .000, and for the correlation between *ITUS* and

DMTUS-II, $r = .595$, $p = .000$). Linear regression tests also confirmed these positive and significant relationships.

Finally, in order to test Rogers' (2003) model of the adoption and diffusion of technology, the sample population was sorted into the five Rogerian categories of Innovators, 2.5%; Early Adopters, 13.5%; Early Majority, 13.5%; Late Majority, 34%; and Laggards, 16%. Using "years of use" for digital technology as the basis for sorting, the following percentages placed the sample population into the appropriate five Rogerian categories: Innovators (2.6%), Early Adopters (10.6%), Early Majority (32.3%), Late Majority (33.3%), and Laggards (21.2 %). These percentages corresponded as closely as possible to the percentages suggested by Rogers (2003).

A comparative analysis for respondents in the five Rogerian adopter categories followed, with respect to their use of digital instructional technology and their attitudes regarding digital music technology. For each of the four summative scales, the following differences were noted: (a) for the *ITUS*, no significant relationship emerged; (b) for the *DMTUS-I* that focused on more specific and sophisticated applications of digital music technology, a one-way ANOVA revealed statistical differences at the .001 level ($F = 8.25$, $p = .000$); (c) for the *DMTUS-II*, which focused on more popular and established applications of digital music technology, a one-way ANOVA also showed statistical differences at the .001 level ($F = 6.38$, $p = .000$); and (d) for the *DMTAS*, a one-way ANOVA again showed statistical differences between groups at the .001 level ($F = 6.38$, $p = .000$).

The pattern of DM technology usage and attitudes was shown to differ for the five Rogerian groups. Regarding DM technology usage, users in the middle of the time continuum (Early Adopters, Early Majority, Late Majority) displayed the highest scores for both scales, followed by Innovators, who had fairly low average scores, with Laggards displaying the lowest scores. Regarding attitudes toward DM technology, as measured by the *DMTAS*, the pattern was markedly different. Innovators had the highest scores in terms of positivity, but scores on the timeline of adoption (from the time of earliest adoption to the latest) then steadily declined to the Laggards, who again displayed the lowest scores. When tested with a one-way ANOVA, these differences were significant at the .001 level ($F = 5.07$, $p = .001$).

A comparison of the data to the Rogerian S-curve model was undertaken and a cumulative percent frequency polygon of the study data revealed that while an increase in technology usage occurred over the 32 years spanned by the respondents in the sample population, only one of the three specific stages predicted by the Rogerian model materialized. The S-curve plot three stages delineated a mild and gently graduated adoption curve during the Innovator and Early Adopter stages, followed by an accelerated ascent during the Early Majority stage, with a final leveling of the curve in the final two stages of Late Majority and Laggards. For the actual data plot of this current research, only the third stage of leveling was clearly visible. Therefore, the S-curve model suggests the possibility of limited usefulness or perhaps limited applicability, but for only particular scenarios of technology diffusion.

Chapter 5 summarizes these findings in light of their implications for the adoption and diffusion of digital music technologies. It also discusses implications regarding the effective use and successful implementation of these technologies for piano pedagogy programs.

Chapter 5

Summary, Conclusions, and Recommendations

The purpose of this study was to assess the current level of diffusion and adoption of specific digitally based instructional and music technologies by piano pedagogues in American graduate and undergraduate pedagogy programs. Data for the study were obtained through a 37-item questionnaire sent to 695 music faculty members listed under the heading of "Piano Pedagogy as An Area of Teaching Interest" in the current *Directory of Music Faculties in Colleges and Universities, United State and Canada, 2005-2006*, published by the College Music Society (CMS). The questionnaire was available to respondents by either paper survey or online access at www.surveymonky.com.

The final valid survey population of questionnaire respondents consisted of 238 individuals (81% of whom identified themselves as teaching or having taught a piano pedagogy-related course in the last five years) yielding a return rate of 34%. This response was judged to be an adequate sample for the research.

The survey instrument provided the information for the data analysis in four sections: (a) "Section I. Background Information," (b) "Section II. Scenarios for Using Music Technology in Class," (c) "Section III. Attitudes toward Technology in Music," and (d) "Section IV. Inventory for Use of Generic Instructional and Music Technology Items." Each section of the survey questionnaire was designed to answer one or more questions posed by the five research objectives stated below. Section I consisted of eight questions or items seeking demographic information of a personal and professional nature to establish a descriptive profile of the faculty population. These items served as independent variables for the statistical analysis. Items 1 and 2 measured respondents' gender and age. Items 3 through 8 profiled the population as to professional demographic information, including types of classes taught, conference membership attendance, and digital music technology workshop training.

Four summative scales created from the survey data measured usage levels of digital technology and related attitudes: the *ITUS* or Instructional Technology Usage Scale, the *DMTUS-I* or Digital Music Technology Usage Scale I, the *DMTUS-II* or Digital Music Technology Usage Scale II, and the *DMTAS* or Digital Music Technology Attitude Scale. These four usage scales represented the primary dependent variables in this study, although the responses to individual survey items or sets of individual items sometimes required analysis and discussion. Measurement of the reported years of use for various digital music technologies addressed the fifth and final research objective regarding the Rogerian model of adoption and diffusion (Rogers, 2003).

In order to test the research model presented in chapter 3, the following research objectives were established:

1. Identify profiles of piano pedagogy faculty who use, and do not use, certain *generic digital instructional* technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject;
2. Identify profiles of piano pedagogy faculty who use, and do not use, specific *digital music* technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject;
3. Identify the specific attitudes of the overall sample, and of demographic and pedagogical subgroups of respondents, related to implementation or non-

implementation of generic digital instructional or digital music technologies;

4. Examine the relationship between faculty instructional technology adoption and usage and digital music technology adoption and usage; and
5. Compare the patterns of generic digital instructional and digital music technology usage with the five-part adopter categories of the Rogerian typology concerning the adoption of innovations.

Several of these objectives involved comparisons of dependent variables to the faculty profile variables, measuring both sociodemographic and professional characteristics of faculty respondents. This chapter begins with a presentation and description of the profile variables, followed by a description of technology usage variables and a subsequent presentation of the key bivariate findings relating to the specified research objectives. The final section includes an assessment of the Rogerian model of the adoption and diffusion of technology.

Discussion of Faculty Profile Variables

The faculty profile variables served as explanatory variables in the research model and revealed the following information. An analysis of the respondent population indicated a reasonable representation of piano pedagogues nationally (60.3% females and 39.7% males). Johnson's (2002) study of undergraduate pedagogy core content corroborated this finding and concluded that the typical piano pedagogy teacher was female. The survey population consisted of more respondents in older age categories than in younger age brackets. The average time teaching within the profession was 17.1 years. The combination of the age variable and the time-in-profession response corroborated the observation that a majority of the respondents were mature and experienced faculty members. This combination led to the conclusion that a solid majority of these pedagogues had ample time to choose whether they would adopt or reject the use of generic instructional or digital music technologies.

The data from Item 5 revealed that the sample population was qualified to answer the questions posed in the questionnaire, with 81% of the respondents having taught a graduate or undergraduate piano pedagogy-related course during the last five years. Data indicated that 68.4% of the population identified membership in one or more professional organizations, with MTNA listed as the population's preferred choice (59.4%). Over 30% of the population reported no professional memberships whatsoever. Data measuring frequency of conference attendance (Item 7) indicated that 86.1% of the pedagogues attended professional conferences at least once every five years, with 54.9% attending annually. The 86.1% who attended conferences is a larger figure than the 69% of those respondents who identified membership with one or more organizations. These data suggest that a number of faculty members chose not to identify themselves with various conference memberships yet still attended some conference activities.

Item 8, which measured attendance at digital music workshops, demonstrated a greater statistical relationship to the dependent variables than any other faculty profile variable, with 42.2% of the population attending at least one technology-related conference session. The fact that 32.5% of the population chose to avoid participation in digital music technology workshops while attending conferences was not surprising. One possible explanation for this lack of digital music workshop attendance is that some of these individuals previously mastered these technologies (whether at workshops or by other venues) and no longer felt the need for technical guidance regarding any pedagogical application. Another possibility, however, is that at least some of these individuals possessed little or no interest in learning about digital music technology for the purposes of piano pedagogy. Rogers' model of adoption and diffusion generally provides for this type of rejection or nonuse, particularly related to the five adopter characteristics from Rogers' (2003) theory of diffusion where Laggards tend to avoid new technologies or technological applications for any number of reasons.

The reasons for choosing these particular variables as key descriptors of the faculty respondents are fairly basic and straightforward. First, gender and age are typical sociodemographic variables used in most research studies of social behavior, and previous adoption and usage of technology studies ascribed particular relevance to both of these characteristics (Holloway, 1996; Mahajan & Peterson, 1985; Rogers, 2003; Todd, 1992). Regarding gender, previous stereotypes often ascribed leadership in engineering and technical fields to males (Katz, 1963; Rogers & Shoemaker, F., 1971). From the perspective of age, younger age cohorts are often viewed as having greater interest in and exposure to newer technologies (Baker, 2003; Rogers, 2003).

If this study confirmed these assumptions or predictions, the results might be an indication that women and older professionals need greater support and resources to encourage their use of these technologies. If the previously mentioned gender and age predictions proved unsubstantiated, the results would suggest that these assumptions were either fallacious or that over the years, women and older cohorts achieved professional parity in the area of educational technology usage. In actuality, the data indicated that gender had little significant effect on any type of technology usage for this population of piano pedagogues. This lack of gender effect has been seen in other relatively recent studies regarding the mastery and usage of a wide variety of educational technologies (Carter, 1998). Age, however, was found (as predicted) to be inversely related, with younger faculty showing moderate but significantly higher usage of both generic and digital music instructional technology. However, this age effect exerted less influence than expected.

The professionally related profile variables used in the present analysis were *organizational memberships, conference attendance,* and *DM workshop attendance* per conference. Judged to be useful indicators of professional development or involvement in the field, these three variables exhibited positive relationships to the use of both categories of digital technology. In most cases, the data confirmed these predictions, with the variable *DM workshop attendance* showing the greatest correlation to digital technology usage of the three professionally related profile variables.

The importance of these three variables, particularly *DM workshop attendance*, can be seen in two somewhat similar studies related to attitudes and technology usage within educational contexts. Carter's (1998) study, which assessed the status of diffusion and adoption of computer-based technology in an Appalachian College Professional Association, emphasized the need for training as an important catalyst for implementing educational technology mastery and usage. Carter's research also suggested that collegiate instructional technology departments were often unable to supply the faculty training needed to master and apply digital technology to their teaching. It was implied that professional organizations might have to supply the needed training. In a study related to digital music technology attitudes and use by independent piano teachers, Young (1995) found that 83% of the study's respondents listed professional organizations and their attendant workshops as the primary means by which they learned about technology in teaching. These are the same professional organizations attended by their colleagues at the college and university level. It would appear that the value of technology training by professional organizations remains an important venue for attaining technology mastery, positively affecting DM technology use in a variety of pedagogical arenas. The data from the current study appear to support this premise.

Discussion of Findings for Technology Use

The high level of usage reported by piano pedagogues for various types of generic and digital music technology represented some of the more interesting findings from this research. The following presentation offers a brief summary of the relatively high level of usage of generic and digital music technologies.

Generic Technology

Individual items on the ITUS.

Most of the findings for the six categories of technology exhibited a fairly high level of use with respect to professional purposes, from the use of the Internet (97.2%) to web page creation (35.8%). A majority of respondents utilized four of the six generic digital instructional technologies. In contrast, a majority of respondents indicated that they did not teach five of the six technologies to their students.

The population of faculty pedagogues reported substantially lower usage rates for teaching these generic technologies as class subjects than for personal and professional use. Though this lower usage was predicted, these findings nevertheless reported useful information, as they indicated a phase of technological diffusion whereby at least some faculty respondents fully implemented some generic technologies in the course of their teaching. As such, these figures appeared to represent those who believe in the value of these technologies for general learning and for application to piano pedagogy training. Though used as a curriculum item at far lower levels than for personal or professional use, teaching these technologies to students brings the diffusion cycle “full circle”; technologies and their applications taught as a class subject transcend the personal methodology of an individual faculty pedagogue, however effective, by sharing it with successive generations of piano teachers (Sarason, 1990).

Findings for the ITUS.

The *ITUS* is a summative measure of the overall usage of generic digital instructional technologies. As a group, the sample respondents displayed high usage rates of the six specific generic technologies for pedagogical use. Complete nonuse of these generic technologies rarely occurred (only two respondents, 1.1%, received a score of zero on the *ITUS*). This distribution of the *ITUS*, used in conjunction with the results of the individual item analysis which preceded it, suggests that this population of piano pedagogues were regular users of generic digital technology. However, the data also indicated that they are more likely to use these technologies for background tasks or personal productivity than as a class subject. Though Carter’s (1998) previously mentioned study followed a different research model and researched a wider variety of technology types than this present study, the Carter survey generally found that the faculty members within the larger sample population of the Appalachian educational consortium widely used many of the same generic computer technologies. As with the current study, use was far more likely to be for background activities related to personal and preparatory use than as a classroom curriculum subject.

Digital Music Technology

Individual items on the DMTUS-II.

The description and discussion of the usage rates for digital music technologies necessitated a greater level of complexity than seen with the *ITUS,* since there are two sets of survey items dealing with digital music technologies through two corresponding summative scales. This complexity, however, was advantageous for analysis, allowing for the comparison of respondent usage regarding different applications of digital technology, whether broad based and established or more focused and specialized.

Table 34.

DMTUS-II Technologies for Professional Use, Class Prep, or Facilitation

Item	*n*	Regular Use %	Some Use %	Any Use %	No Use %
31 Computer-based instruction	212	21.2	36.8	58.0	42.0
32 Music notation software	210	38.6	31.4	70.0	30.0
33 MIDI sequencing	211	22.7	23.2	46.0	54.0
34 MIDI keyboards: class piano	209	77.0	10.5	87.6	12.4
35 MIDI keyboards: applied lessons	209	13.9	31.1	45.0	55.0
36 MIDI keyboards: use in performance ensembles	207	11.1	33.3	44.4	55.6
Total %		30.8	27.7	58.5	41.5

Regarding key generalizations, Table 34 reveals that a sizeable proportion of the sample population used most of the digital music technologies listed in the *DMTUS-II* to varying degrees. The fact that these technological applications represented a broader based and more established set of pedagogical scenarios seems evident from the high usage rates, particularly in the “any use” column which showed 44.4% to 87.6% of respondents made some use of these technologies.

Table 35 documents the usage rates for the same digital music technologies presented in Table 34, but from the perspective of a class subject.

Table 35.

Percent Use of DMTUS-II Technologies for Teaching as a Class Subject

Item	*n*	Regular Use %	Some Use %	Any Use %	No Use %
31 Computer-based instruction	201	16.9	35.3	52.2	47.8
32 Music notation software	201	19.9	22.9	42.8	57.2
33 MIDI sequencing	200	17.0	23.0	40.0	60.0
34 MIDI keyboards: class piano	199	64.8	15.1	79.9	20.1
35 MIDI keyboards: applied lessons	197	11.2	29.4	40.6	59.4
36 MIDI keyboards: use in performance ensembles	195	10.3	29.2	39.5	60.5
Total %		23.4	25.8	49.2	50.8

The researcher predicted the usage rates would be substantially lower for DM technology use as a class subject than for those reported for professional use, class preparation, or class facilitation. Table 35 reveals that while usage rates were indeed lower for use of these DM technologies as a class subject, the data indicated differences of only 5 to 6 percentage points when compared to the respondents' usage of the same technologies for personal or professional use and class preparation or class facilitation. This finding was unexpected. This percentage difference is illustrated by comparing Item 33 in Table 34 where 22.7% of survey respondents reported using MIDI sequencing for personal or professional activities with Table 35 where 17% of the faculty reported teaching MIDI sequencing as a class subject, a usage difference of only 5.7%. The data in both tables confirmed this pattern in all columns of usage: "regular use," "some use," and "any use." The notable exception to this pattern resulted from scores related to the use of music notation software, where 70.0% of the sample population reported "any use" for personal professional purposes (Table 34), compared to only 42.8% use for teaching as a class subject in Table 35 (a far greater usage difference).

These findings suggest that the majority of these technologies not only benefited students by aiding faculty in better class preparation and delivery, but by presenting these technologies' potential applications as the content. The use of music notation software was the notable exception, where almost twice as many pedagogues used the technology for personal or professional use than as a class subject. However, to provide perspective regarding use of this technology in collegiate music settings, it should be noted that many music departments offer music notation training through other instructional venues such as theory classes and digital music technology classes for all music majors. In departments with these alternative venues, teaching the mechanical skills of notation software would result in redundancy and be a waste of valuable class time. However, teaching pedagogical applications for notation software in either applied lesson or class piano situations could be of immense benefit to future piano teachers.

The data therefore support the generalization that while usage rates of digital music technology are somewhat lower on an item-by-item basis compared with usage rates of generic digital instructional technology (also referred to a *generic technology*), the great majority of the pedagogues who use digital music technology for personal or professional use also taught these technologies to their students. It should also be recognized that 40% of the sample population taught almost all of these digital music technologies to their students as a curricular subject, and almost 80% of the respondents did the same for teaching MIDI keyboards for class piano use.

Individual items on the DMTUS-I.

Section II of the survey (Items 9 through 14) provided the other set of questions which asked respondents to rate their usage of digital music technology. A clear majority of faculty piano pedagogues reported using four of six specified digital music technology applications, with over 40% reporting at least some use of the other two technology scenarios. Given the relative technical or specialized nature of some of these pedagogical applications when compared with those from the *DMTUS-II*, this rate of usage was unexpected and noteworthy. This finding indicated that the more advanced DM technology users either successfully disseminated these uses to their colleagues through conference workshops or that many respondent faculty members devoted substantial personal research time to the mastery and application of these digital music technologies.

A greater percentage of pedagogues reported using the specified technology applications in a single class setting. The failure to use these technologies in other settings might stem from departmental equipment deficits, lack of release time to integrate these applications into various curricula, or burdensome set-up requirements in other teaching venues. From a different perspective, it might also originate from a lack of interest in DM technological applications for the other teaching venues. Regardless, it is noteworthy that over 30% of the pedagogues reported using three of the six technologies in multiple settings. These findings indicate that a sizeable portion of the sample population made some use of the more advanced pedagogical applications of DM technology, both in single and multiple teaching settings.

The DMTUS-I and DMTUS-II.

The *DMTUS-I* measured the use of more specialized DM applications while the *DMTUS-II* focused on more common, general, and established DM technology uses. A heavy concentration of scores was seen at the lower usage end of the *DMTUS-I*, along with a gradual decline of responses toward the higher usage end of the scale. The location of the mean (18.1) occurs in the lower third of the range of possible scores, which is consistent with the concentration of scores at the lower end of the scale. The data indicated a steady decline in the number of individuals who made greater use of technologies within the scale.

The data showed that a larger percentage of respondents reported greater usage levels on the *DMTUS-II* than occurred in the *DMTUS-I* analysis. Two thirds (66.7%) of the sample fell within the first half of the scale, from 0 (zero) to 12. However, one third (33.3%) fell into the upper half with scores of 13 to 24, thereby corroborating the observation that numerous pedagogues extensively used DM technology.

One intriguing result of the analysis was the remarkable similarity between the *DMTUS-II* score distribution and that of the *ITUS* (generic technology usage scores). The usage level for the *DMTUS-II* not only equaled but surpassed the generic technology usage level, since the usage level for the *DMTUS-II* was 33.3% at the high end of the scale, surpassing the 28.1% usage level for the *ITUS* at the same level. The fact that the respondents indicated a greater percentage of generic technology use over DM instructional technology use for private professional activities made this finding both puzzling and worthy of further investigation.

Comparison of usage for ITUS and DMTUS.

To better understand why piano pedagogues possessed higher usage scores on the *DMTUS-II* than on the *ITUS*, Table 36 renders a comparison of the six-item averages between the *ITUS* and *DMTUS-II*. As previously explained, each technology use scale incorporated both usage columns (columns A and B) from the questionnaire, with column A measuring technology usage for private professional activities and column B measuring the same technology when taught as a class subject. Some interesting differences emerged from a detailed comparative analysis of these scales, yielding insights into the differential use of these technologies by faculty piano pedagogues.

Table 36.

Column Percent Comparisons for ITUS and DMTUS-II

Scale or Subscale Identification	Regular Use %	Some Use %	Any Use %	No Use %
Professional Use, Class Prep				
ITUS-A, Six-Column Mean	40.4	21.8	62.2	37.8
DMTUS-II, Six-Column Mean	30.8	27.7	58.5	41.5
Taught as a Class Subject				
ITUS-B, Six-Column Mean	14.8	20.3	35.1	64.9
DMTUS-II, Six-Column Mean	23.4	25.8	49.2	50.8
Overall Column Averages				
ITUS	27.6	21.1	48.7	51.4
DMTUS-II	27.1	26.8	53.9	46.2

Table 36 provides evidence that respondents used generic technologies (the *ITUS*) at a higher rate for "professional use and class preparation," but digital music technologies (the *DMTUS-II*) at higher rates when "taught as a class subject." For example, the average percentage for "regular use" for the *ITUS-A* subscale was 40.4, compared to 30.8 for the *DMTUS-II.* However, this pattern was reversed when these technologies were "taught as a class subject," where the average percentage for the *DMTUS-II* was 23.4, compared to a 14.8 for the *ITUS-B.* Table 36 also shows that the percentage for "some use" was higher in all categories for the *DMTUS-II.*

To generalize the findings in Table 36, respondents used generic technologies for private professional use at a higher rate, but they reported a higher usage rate for teaching digital music technologies to their students, thereby contributing to their higher overall summative scale scores on the *DMTUS-II*. This finding failed to appear from the earlier analysis of scale averages and distributions of the *ITUS* and *DMTUS-II*. However, it emerged through the detailed analysis of the percentage of use reported for the individual items used in each scale and through the observation of the overall patterns created between the subscales (e.g., subscale A's tabulation of technology usage for "professional use" and subscale B's technology usage for "taught as a class subject").

To conclude the analysis and summarization of the *ITUS*, *DMTUS-I* and *DMTUS-II*, the following generalizations are noteworthy. The first generalization stems from the fact that while the relatively high usage rate for generic instructional technology (such as use of web browsing, databases, desktop publishing, etc.) was expected for the *ITUS*, the usage rate for digital music technology (for both *DMTUS-I* and *DMTUS-II*) was higher than originally anticipated by this researcher. This opens the door to speculation regarding the profession-wide status of equipment availability for digital music technology application by piano pedagogues in a variety of educational venues.

Based upon the data from the current sample population, this finding suggests that as a group, American college and university piano pedagogues may be approaching market saturation or final diffusion for some of these technologies from the perspective of equipment availability, as anticipated by Rogers' (2003) adoption and diffusion model. This does not, however, necessarily imply a saturation of usage regarding the pedagogical applications of such equipment; new applications of previously existing technology are continually being conceived (Berz, 1994).

The second generalization suggests that all three distributions showed a substantial usage rate for all designated technologies. The *DMTUS-I*, however, produced a higher number of nonusers, since it represented a set of more specialized and sophisticated pedagogical applications (see Section II, Appendix A). Nevertheless, even acknowledging the possible usage deterrent connected with learning more specialized and complex levels of technology applications (*DMTUS-I*), a sizeable percentage of the sample population used several of these advanced applications in their teaching.

Third, the usage rate was surprisingly high for both *DMTUS*. This higher average usage rate was particularly evident for the *DMTUS-II*, which exceeded even generic digital instructional technology usage scale, as measured by the *ITUS* (i.e., $M = 9.2$ for the *ITUS*, $M = 9.8$ for the *DMTUS-II*). Furthermore, the percentage of respondents at the top half of each scale (having scores of 13 to 24) was 28.1% for the *ITUS*, but 33.3% for the *DMTUS-II*. This researcher finds this evidence interesting, since it suggests that many pedagogues are not simply "dabbling" in selected technologies, but are actually embracing and utilizing several of the digital music technologies for private and professional activities and for curricular implementation.

Finally, though limited in number, a few piano pedagogues attained scores at or near the top of the *DMTUS-I* and *DMTUS-II*, which is only possible if a respondent reported use of most or all of the six specified DM technologies on a regular basis. By defining "heavy users" as those receiving usage scores in the top 25% of each theoretical subscale for the *DMTUS-I*, 12 heavy users received scores of 46 or higher on the 60-point scale, representing 5.2% of the sample. For the *DMTUS-II*, 17 heavy users received scores of 19 or higher on the 24-point scale or 9.2% of the sample. During the development of these two DM technology use scales, the researcher speculated as to whether any respondents would score at or near the highest regions of the two *DMTUS*. The fact that a small number of respondents succeeded at this sophisticated level of implementation, further indicated the small but positive extent to which the profession adopted these digital technologies and applications.

At this point, it is worth noting the differences in respondent attitudes and DM usage choices from this current population with those of a previous study concerning the attitudes and technology usage choices of a select number of independent piano teachers (Young, 1990). Though the methodology and research design were organized quite differently, Young's study queried independent teachers as to their choices of some DM technology categories and the reasons for those choices. Where applicable, the differences offered interesting contrasts in motivation between the piano pedagogues of this study and those of the independent teachers of Young's population.

The current study revealed that of the six DM technology categories presented in the *DMTUS-II*, the technology with the highest frequency of regular use (77 %) was MIDI keyboards for class piano use (see Table 34). However, only 13.9 % of these respondents used keyboards for applied lessons, often citing a number of reasons to not use MIDI keyboards in private lessons, including the need to preserve the culture of the piano from all intrusions by electronic instruments (see Appendix D). The use of keyboard technology for ensemble performance and teaching Items 35 and 36 as a class subject was even lower (see Table 35). In the Young (1990) study, the use of keyboard technology applied primarily to private lessons.

While the direct motivations for teaching with MIDI keyboards at the collegiate level were not directly queried by the current study's questionnaire, the open-ended question from Item 37 offered pedagogues an opportunity to respond to technology use in whatever manner they deemed appropriate. The responses often indicated varying levels of concern that the acoustic piano was in danger of being replaced by an electronic variation. Other comments suggested that pursuing the use of keyboards in an applied lesson environment would be a waste of time or would reduce a student's level of musicality.

In contrast, the reasons for using this technology in the applied lesson venues by the independent piano teacher's of Young's (1990) study included (a) the reinforcement of concepts taught on the acoustic piano (62%), (b) the utilization of sounds for popular music (43%), and (c) the instruction of students regarding performance on electronic instruments (36%). In a Likert scale section of Young's study which surveyed the respondents' opinions about teaching with keyboard technology, only 6% of the population agreed with the statement that the acoustic piano will be replaced by MIDI keyboards. However, 84% of these teachers believed that use of keyboard technology in lessons could prevent dropouts and 98% indicated that MIDI keyboards increased interest in weekly lessons.

It is noteworthy that the fifteen year old Young (1990) study offered a perspective that has not yet adequately influenced college piano pedagogy programs. Since the majority of current piano pedagogy students will actually teach in independent studios rather than collegiate pedagogy programs, there appears to be a gap in the training of future piano teachers. While current pedagogy faculty do use MIDI keyboard technologies, they may not use enough of these specific teaching applications (as exhibited by the *DMTUS-I and II* keyboard scenarios) that could enhance and improve the quality and viability of applied lessons on the independent studio level.

Testing of Bivariate Hypotheses

Research Objectives 1 through 3

Due to the similarity between some research objectives and for ease of presentation, the statistical review and discussion for Research Objectives 1, 2, and 3 appear jointly in this section. This approach seemed reasonable since the independent variables (i.e., the *faculty profile variables*) are the same for the initial two objectives and a more detailed approach to these objectives already occurred in chapter 4. Research Objective 3 investigated respondent attitudes toward DM technology, which also used the *faculty profile variables* as predictor variables.

Research Objective 1 identified faculty profiles regarding the use and nonuse of certain generic digital instructional technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject. Research Objective 2 identified the profiles of piano pedagogy faculty who used and did not use specific digital music technologies for professional productivity, class preparation, or class facilitation, or for use as a class subject. Research Objective 3 identified the specific attitudes of the total sample and of various respondent subgroups, related to the usage of generic or digital music technologies. Table 37 presents a summary list of the statistical findings for all three research objectives.

Table 37.

Summary of Statistically Significant Findings by Faculty Profile

Profile of Faculty / Tech Scales	*ITUS*	*DMTUS-I*	*DMTUS-II*	*DMTAS*
Gender	*t* = NS	*t* = NS	*t* = NS	*t* = NS
Age	*F* = 3.54** *r* = -.25***	*F* = 2.9* *r* = -.16**	*F* = NS *r* = -.13*	*F* = NS *r* = NS
Organizational Memberships	*r* = NS	*r* = .145*	*r* = .164*	*r* = NS
Conference Attendance	*F* = 2.93* *r* = .225*** *b* = .794**	*F* = NS *r* = .124* *b* = NS	*F* = NS *r* = .157* *b* = .628*	*F* = NS r = NS *b* = NS
DM Workshop Attendance	*F* = 4.94*** *r* = .334*** *b* = 1.46***	*F* = NS *r* = .492*** *b* = 6.4***	*F* = NS *r* = .472*** *b* = 2.4***	*F* = NS *r* = .496*** *b* = 3.2***
ITUS	-	-	-	*r* = .369*** *b* = .264***
DMTUS-I	-	-	-	*r* = .573*** *b* = 1.17***
DMTUS-II	- -	- -	- -	*r* = .664*** *b* = .552***

Note. Significance Designations: * .05 level; ** .01 level; *** .001 level; NS = not significant; - = NA

Effects of gender.

Beginning with *gender* as an independent variable, no statistical differences were discovered for *gender* related to most of the usage or attitudinal variables. However, one small difference emerged from the analysis. Males reported significantly greater usage for Item 30, “webpage creation,” than females at the .05 level (not shown in Table 37, $t = 2.42$, $p = .016$). An examination of a cross tabulation table revealed that males were approximately 50% more likely to use this technology either occasionally or regularly. In no other respect was *gender* a significant predictor of technology usage.

While this information may appear to be an unimportant finding, it actually serves to help debunk a common myth concerning *gender* and technology. Our present culture is not far removed from a period when the American culture often assumed that men dominated the intellectual areas of math, engineering and digital technology (Connors, 2000). Therefore, it is noteworthy that almost no *gender* differences emerged from the current study regarding the mastery and use of generic digital instructional or digital music technologies within the piano pedagogy profession. While more women than men are piano pedagogues at the collegiate level, the data suggests that both genders share an equal likelihood of mastering successfully all digital instructional technologies.

Effects of age.

Regarding the faculty profile variable of *age,* a few significant relationships emerged related to the technology usage variables, but none with respect to attitudes (*DMTAS*). Table 37 shows that significant statistical relationships emerged related to the *age* variable and the *ITUS*, as well as to the *DMTUS-I* and *DMTUS-II* variables. For both generic digital instructional and digital music technologies, younger faculty members made significantly greater use of both categories of digital technology than their older counterparts.

The application of a one-way ANOVA and a Pearson's *r* test for the *ITUS* variable and that of *age* revealed statistically significant relationships. The most measurable *age* effect (in terms of test coefficients and statistical significance) occurred between *age* and generic technology, where scores on the *ITUS* ranged from a high of 10.2 for younger faculty (ages 25 to 34) to a low of 4.8 for older faculty ages 65 or over (where $F = 3.54$, $p > .01$). However, this was only a moderate relationship at best, as suggested by the weak-to-moderate magnitude of the Pearson's r coefficient. The *age* effect for the digital music technology variables (*DMTUS-I* and *DMTUS-II*) were statistically significant, but at an even lower level of correlation. Regarding the *DMTAS* variable, the analysis process uncovered no significant *age* effect.

In summary, while predictable and significant *age* effects emerged from the analysis, none of them proved as strong as the researcher expected. While anecdotal evidence from daily life indicates that younger people make far greater use of digital technologies than older individuals, analysis results from this study led this researcher to the conclusion that this difference is somewhat less pronounced, at least within this portion of the professional pedagogy community.

Perhaps even more striking was the observation that no *age* effect emerged in relation to the *DMTAS*, suggesting that older faculty showed no greater resistance to the newer digital music technologies than younger faculty. Therefore, where there were slightly lower technology usage rates among older faculty members, they appeared to be related to factors other than attitudinal issues, possibly factors such as lack of relevant formal training while in graduate school, current time constraints, or the psychological deterrent of approaching retirement. Furthermore, since the *age* effect was minor and the overall sample population exhibited a relatively high rate of technology usage, it appears that many older faculty members utilized both generic and DM technology frequently and fairly extensively within their pedagogical routines.

Effects of organizational memberships.

The data revealed a mixed pattern of influence regarding *organizational* *memberships* and digital technology use. Table 37 indicates that those who belonged to one or more professional organizations demonstrated no greater likelihood of using generic technology (*ITUS*) but were significantly more likely to use digital music instructional technology (*DMTUS*). While the magnitude of these effects was not strong, significant relationships were observed between *organizational memberships* and both *DMTUS-I* ($r = .145$, $p < .05$) and *DMTUS-II* ($r = .164$, $p < .05$). The relationship between *organizational memberships* and the *DMTAS* variable revealed no significant statistical differences. Therefore, faculty respondents who belonged to single or multiple professional organizations showed a slightly greater likelihood to use DM instructional technologies, but not generic ones. Neither did they express significantly different attitudes toward DM technology use within the profession.

Effects of conference attendance.

The frequency variable *conference attendance* served as a slightly better predictor or indicator of instructional technology usage than *organizational memberships.* Though somewhat moderate in effect, statistically significant relationships materialized between faculty pedagogues who attended conferences more frequently and both categories of technology use (generic and digital music). The strongest observed effects for this variable occurred between *conference attendance* and the *ITUS*. The results of three different tests corroborated the finding of a significant relationship between these variables. A one-way ANOVA test showed higher use of technology (*ITUS*) with both frequency of attendance categories, indicating that respondents who attended conferences with greater frequency received higher average generic technology usage scores ($F = 2.93$, $p = .014$). A Pearson's correlation revealed a moderately positive but significant relationship (r = .225, p = .001) and a linear regression produced a positive slope which was also significant (b = .794, p = .002). All three tests profiled more frequent conference attendees as reporting somewhat greater use of generic digital instructional technology.

The next strongest relationship occurred between the frequency of conference attendance and the *DMTUS-II* variable, measuring the usage of more established and less specific applications of digital music technology. Two of the three tests resulted in statistical significance, with a Pearson's one-way correlation test indicating a positive correlation (r = .157, p = .017) and a bivariate regression test demonstrating a positive linear relationship (b = .628, p = .034). When testing conference attendance in relation to the *DMTUS-I* variable (measuring more specialized digital music applications), only one of the three tests (a Pearson's correlation, r = .124, p = .030) resulted in statistical significance.

The following generalizations represent the conclusions drawn from the previous statistical analysis concerning the relationship between the frequency of conference attendance and the use of digital technology for piano pedagogy (as measured by the three technology use scales and the one attitude scale). First, the frequency variable of *conference attendance* was positively related to the use of digital technology for pedagogy, particularly the use of generic technology (*ITUS*). Second, the *conference attendance* variable also demonstrated a somewhat positive relationship to both measures of *DM technology use* (*DMTUS-I* and *DMTUS-II*). Third, the analysis of the *conference attendance* variable demonstrated no statistical significance related to attitudes about DM instructional technology (*DMTAS*).

This set of statistically significant yet moderately weak relationships may result from a heightened interest in professional development by frequent conference attendees. The heightened interest displayed by conference attenders regarding professional development offers a possible explanation as to the statistically significant yet moderately weak set of relationships between digital technology usage and the frequency of conference attendance. The desire to stay abreast of such recent developments offers one plausible reason for a slightly increased use of digital technology by frequent attenders.

Effects of DM workshop attendance.

The final profile variable, *DM workshop attendance,* was the most powerful predictor variable of the profile variables as related to digital technology usage. Nine out of the 12 tests conducted (three tests for each of four dependent variables) resulted in moderately strong and significant effects on DM technology usage. Comparison treatments between the *DM workshops attended* variable and the *generic technology use* scale variable (*ITUS*) produced a significant relationship through the following tests: a one-way ANOVA ($F = 4.94$, $p < .001$), a Pearson's one-way correlation test ($r = .334$, $p < .001$), and a bivariate linear regression test ($b = 1.46$, $p < .001$). These three tests provided evidence of strong relationships between these variables at the .001 level.

These test findings suggest some intriguing speculative explanations. The association between *DM workshop attendance* and the *generic technology use* variables was unexpected. The most plausible explanation for this finding suggests that those who expressed interest in digital music technology training also tended to express a similar interest in acquiring knowledge and skills for the pedagogical applications of generic digital instructional technology.

The attendance level of technology related workshops also appeared to be a strong predictor of usage for both DM technology scales (*DMTUS I* and *II*). Testing these relationships with Pearson's correlations and linear regressions (related to digital music workshop attendance and DM technology usage) confirmed statistical significance, coupled with strong coefficients. These test results provided evidence for a positive and measurable relationship between the number of digital music workshops attended and the usage rate of DM instructional technology for pedagogical purposes. A Pearson's correlation test and a bivariate linear regression also detected a significant relationship between the number of digital music workshops attended by the respondents and their attitudes *toward* digital technology, as scored on the *DMTAS*. This was the first and only case where a faculty profile variable related significantly to faculty attitudes with respect to digital music technology (Pearson's correlation and linear regression tests confirmed a positive linear relationship, $r = .496$, $p < .001$; $b = 3.2$, $p < .000$), with coefficients at a slightly stronger magnitude than previous comparisons between *DM workshop attendance* and the *DMTUS-I* and *DMTUS-II*.

For the scatterplot and linear regression results, the slope was positive and significant ($b = 2.4$, $p = .000$), with a fairly strong standardized slope ($b = .472$). These findings indicate a moderately strong and positive relationship between the frequency of DM workshop attendance and DM technology usage. These findings substantiated the premise that the profile variable of *DM workshop attendance* was the strongest predictor thus far of digital music technology usage, generic digital technology usage, and faculty attitudes toward digital music technology. These findings were not surprising, since it seems apparent that those who attended digital music sessions and workshops with greater frequency would also tend to express strongly positive attitudes concerning DM technology use for piano pedagogy activities.

Profile variables summary.

In summary, several profile variables revealed significant relationships (though the differences were small) to these usage and attitudinal variables. The weakest predictor of usage or attitudes was *gender*, only possessing a highly specialized influence in the area of web page creation (where men displayed slight but significantly greater usage). Gender was not found to be a significant factor in any other area.

The next weakest predictor was *organizational memberships,* displaying positive but weak correlations with both *DMTUS* variables and no significant relationships to either generic technology use or to faculty attitudes toward digital music technology. Faculty member *age* was a moderately effective predictor, displaying significant relationships with all technology usage variables, but not with attitudes toward DM technology usage. Younger faculty members demonstrated somewhat greater technology usage levels, but this was more apparent for the use of generic instructional technology than for DM technology, where the relationships were significant but weak. Finally, though the analysis of *conference attendance* showed significantly positive relationships toward all measures of technology usage, the strongest relationships occurred between *DM workshop attendance* and the usage scales.

For Research Objective 3, the *DMTAS* variable was used as a predictor variable of both generic and digital music technology use. The testing procedures found the *DMTAS* to be significantly related to the *ITUS* (r = .369, p < .001; b = .264, p < .001), but even more strongly related to the *DMTUS-I* of specialized digital music technology usage (r = .573, p < .001; b = 1.17, p < .001). The strongest relationship, however, was between

DMTAS and the *DMTUS-II*, which measured use of the six designated digital music technologies within relatively general categories of application. This relationship produced positive coefficients ($r = .664$, $p = .000$; $b = .552$, $p = .000$).

The data indicated that the self-reported attitudes of the majority of the respondent population acknowledged positive predispositions toward the use of at least some forms of digital music instructional technology. The data also suggested that moderately positive attitudes provided an insufficient motivation to lead to high usage rates for most respondents. The data also indicated that members of the sample population generally failed to embrace the highest usage rates until their individual attitude scores reached the top portion of the attitudinal scale.

Generally speaking, the data indicated a person does not need to be a critic, fiercely opposing the use of digital music technology, to be a nonuser or low-end user of these digital technologies. Based on the data, as well as from the perspective of informed experience and personal conjecture, the nonuse of digital music technology seems to originate from rather obvious conditions such as a lack of preparation time to integrate digital technologies into one's curriculum, a lack of needed training to begin the process of usage, the lack of funds for proper equipment, or simply an attitude of ambivalence or of lukewarm positivity.

Objective 4: The Relationship of Generic and Digital Technology Use

Research Objective 4 examined the relationships between generic digital instructional technology usage and digital music technology usage. As a general conclusion regarding Research Objective 4, faculty respondents who reported use of some of the more established digital music technologies from the second digital music technology usage scale (*DMTUS-II*) also ranked among the highest users of the more specialized and sophisticated pedagogical applications found in the first digital music technology usage scale (*DMTUS-I*). Conversely, those who made little use of the more established and generalized applications of these digital technologies also made sparse use of *DMTUS-I* technology applications.

Table 38 displays the results from a series of Pearson's *r* correlations and bivariate linear regression tests relative to the *ITUS,* the *DMTUS-I*, and the *DMTUS-II*.

Table 38.

Correlation and Regression Coefficients of ITUS and DMTUS-I & -II

Dependent Variables	*n*	*r*	sig.	*b*	sig.
DMTUS-I	181	.501	.000	1.49	.000
DMTUS-II	172	.595	.000	.698	.000

The data indicate a strong and positive correlation between usage of generic instructional technology (*ITUS*) and usage of digital music technology (both digital music scales *DMTUS-I* and *DMTUS-II*). The correlation coefficients are significant and positive for this variable set, as are the slopes of the bivariate linear regressions. The data supports the premise that those who make the greatest use of generic instructional technologies also make the greatest use of digital music instructional technologies for piano pedagogy. As with previous data sets, the data appears to indicate a nonspecific orientation toward technology use with respect to the nature of the technology; piano pedagogues in this population tended to use whatever technology (generic and not specifically music related) enhanced their teaching style and curriculum.

The strength of the test coefficients and the clear nature of these relationships offer interesting observations concerning the relationship between the two digital scale types. For example, the *ITUS*, measuring generic technology use, is conceptually and operationally distinct from either of the DM usage scales. No technology overlaps exist between the *ITUS* and either of the *DMTUS*. Finally, the data refute any conclusive reason as to why pedagogues who score high in the usage of one area of technology type (e.g., generic technology) should necessarily score high in the other area (e.g., digital music technology). A study regarding the adoption and use of computer-based technology in the Appalachian College Association also found no distinct reasons for the usage of one technology choice over another (Carter, 1998). However, one of the conclusions from this study also noted that those who mastered one specific generalized technology tended to learn others within the same category of usage, in this case, educational computer technology.

While the data fail to corroborate this speculation, one previously mentioned possibility or explanation for this phenomenon is time constraints, preventing many professionals from gaining proficiency in more than one technology or area of technology (Rogers, 2003). Time scarcity might require choices that exclude the mastery of one technology over another (Cuban, 2001). Another line of speculation approaches the ambiguity from the opposite perspective. It appears that those pedagogues who spare time and energy to learn one venue of technology and subsequently teach it to their students seem to find the time and resources necessary to learn other applicable technology venues as well (Rogers, 2003). However, time commitments always involve choices and this line of reasoning fails to consider what other professional or personal activities must be ignored to attain a mastery of digital technologies. An additional factor affecting usage is the availability or lack of digital hardware and software within a given music department (Fullan and Stiegelbauer, 1991; Renfrow, 1991a). Further study into this line of speculation could prove fruitful.

The final observations from Table 38 relate to the test results of any association between the *DMTUS-I* and *DMTUS-II* variables. These treatments yielded a Pearson's correlation coefficient of .753 (p = .000) and a linear regression best-fitting slope of .302 (p = .000). With strong and positive coefficients, the data support the observation that those faculty pedagogues who scored high on the *DMTUS-I* (consisting of relatively specialized digital music applications) also scored high on the *DMTUS-II* (composed of more general and established technologies usage scenarios). The high correlation (r = .753, p = .000) and linear slope (b = .552, p = .000) of this data set indicate two things: (a) there is a very strong relationship between the two digital music usage scales, and (b) the scales are not identical and therefore do not directly measure the same things. Restated, while some of the technologies mentioned between the two scales overlap, the *applications* of these technologies differ from scale to scale, with no identical items and no identical constructs.

Research Objective 5: Assessing the Rogerian Model

The fifth and final research objective compares the patterns of instructional and digital music technology usage from the current data with the five-part adopter categories in the Rogers' (2003) typology. Concerning the adoption and diffusion of innovations, Rogers (2003) suggested that while an individual's personal attitudes and behaviors greatly impact his or her eventual use (or nonuse) of digital music technology, the final decision is not solely a matter of individual choice. An individual's attitudes and behaviors fit within a larger societal ethos of social influence, institutional or structural opportunities, and normative constraint. In a Rogerian type study of the *Attitudes and Perceptions of University Faculty toward Technology Based Distance Learning*, Walsh (1993) noted that peer influence was the single greatest source of information regarding new technologies for distance learning and that peer influence was a major factor in the decision making process regarding implementation or rejection of this teaching venue.

Placed in the context of this current study, whether or not an individual member of a social system (in this case, the community of college and university piano pedagogues) adopts or rejects a digital music technology is also due to the following influences: the availability of the particular technology; the pedagogue's institutional infrastructure; a knowledge of the technology, its uses, and its liabilities (as gained through individual research, institutional support, or conference workshops); and the influence, modeling, and persuasion of technology pioneers such as Rogers' (2003) Innovators and Early Adopters (Curry, 1992).

Creation of the Rogerian categories.

Since the research community widely recognizes Rogers as the definitive voice regarding the process and interpretation of innovation diffusion, one key goal of this research was the use of the present study data to assess the applicability of Rogers' model as it pertains to the adoption and diffusion of digital music technology within the community of college and university piano pedagogues (Carter, 1998; Dalton, 1989; Holloway, 1996; Mahajan and Peterson, 1985). As previously described, the study protocol sorted the sample population into the five Rogerian categories of adoption and diffusion, using the approximate percentages found in Rogers' original model (Innovators, 2.5%; Early Adopters, 13.5%; Early Majority, 13.5%; Late Majority, 34%; and Laggards, 16%).

The data closely corresponded to the percentage specifications of the Rogerian categories and the standard bell curve representation. The creation of the Rogerian categories and the comparison of these categories to Rogers' (2003) model (including their projected percentages in the population) prepared the way for further analysis and assessment of Rogers' theory concerning the nature of the adoption categories from this model and the characteristics of respondents in these five groups (Rogers and Shoemaker, 1971).

Use of generic technology.

A one-way ANOVA test examined the relationship between the *Rogers' ATV* variable and the generic technology usage scale (*ITUS*); however, the analysis discovered no statistically significant relationship. This is not surprising since the categorization of Rogers' (2003) adopter groups for this study relies on an individual's years of DM technology use, not the length of use for generic technologies. Early users for one type of technology are not necessarily early adopters or users of another type. However, because of the association previously seen between the use of generic and digital music technologies, the exploration of this potential empirical relationship appears reasonable.

Use of digital music technology.

For both of the digital music scales, significant relationships emerged between Rogerian groups and technology use. For the more focused *DMTUS-I*, mean usage scores on a 60-point scale ranged from 9.9 for the Laggards to 24.8 for the Early Adopters. As discussed in chapter 4, one very interesting and unexpected finding revealed that the Innovators scored relatively low (15.6) on the mean usage scale, ranking lower than all categories except for the Laggards. According to the Rogerian model, Laggards ranked lowest in innovation used and were the last category to adopt or reject an innovation within their societal group.

For the *DMTUS-II* which focused on more general and established applications of DM technology, mean usage scores on a 24-point scale ranged from 7.1 for the Laggards to 12.7 for the Early Adopters. As with the mean scores of the *DMTUS-I*, the Innovators scored significantly lower (7.8) than all other adopter categories except for Laggards. This pattern mirrors that found for the *DMTUS-I* variable, and raises some interesting theoretical possibilities.

Assessment of Rogerian group characteristics.

According to Rogers' (2003) descriptions of Innovators, their strongest attributes include a venturesome nature and an obsession for anything new. They rank as the "risk-takers" within the five categories of adoption. As such, these individuals often lack the respect associated with the more conservative Early Adopters. As one who has known a number of these innovative individuals, this researcher has noted that the mastery of a particular technology appears more important to these individuals than finding the appropriate applications for the innovation.

Based upon Rogers' (2003) descriptions of each adopter category's characteristics and the researcher's own informal experience with the adoption habits of a large number of music faculty, the researcher offers the following speculation as to the unexpected usage disparity and a plausible explanation for the low DM technology usage by

Innovators when compared to the other categories. As Rogers (2003) suggested, Innovators are “dabblers” whose personalities and dispositions best suit them to experimentation with new ideas, equipment, and immediate applications. They are the trailblazers who may not always care if they maximize the potential of any one technology over an extended time period; they often adopt it, master it, and move on to something new. For Innovators, it appears that the process or journey towards mastery of a new innovation is more important than the less exciting prospect of using a technology for pedagogical applications over time (Best et al., 1995).

The fact that those categorized as Innovators in this study fell into the same position (next to last) on both digital music technology usage scales gives some credence to this possibility. Though using these technologies the longest period of time, the only group with a lower usage rate was the Laggards. According to Rogers’ (2003) model, the Laggards adopter category consists of those who resist adoption over the longest period of time or who reject the use of a specified technology completely.

Early Adopters, on the other hand, tend to be more integrated into the social system than Innovators. They are greatly respected by their peers, serving as role models within their social system with regard to the implementation of new ideas or technologies (Rogers, 2003). Acutely aware of their position within their societal group, Early Adopters recognize that retention of their leadership position depends on making the right suggestions and choices to their constituents ((Best, et al., 1995). As a result, they choose a more cautious approach to adoption, being less inclined to adopt a specific technology without having to seriously consider the practical applications for its use (Rogers, 1962).

The data for the two *DMTUS* appear to corroborate aspects of the characteristics regarding Early Adopters. Early Adopters ranked highest of the five adopter categories related to their technology usage rate. The data confirmed this observation for both the *DMTUS-I* and *DMTUS-II*. Though Early Adopters ranked second only to the Innovators with respect to the number of years an individual technology was used, they apparently demonstrated different approaches to the technology. Rather than being motivated by the exploration process regarding new technologies, Early Adopters in the current population appear more interested in discovering viable applications for a new technology, followed by the extended practical use of that technology for as long as it remains a productive tool. This fits the characteristics of the Early Adopter in Rogers' (1963, 2003). Consistent with this characterization, the current data show Early Adopters to not only be among the longest term users of such technology, but to continue actively their use of the designated technology and application, displaying the highest levels of current usage within the sample population.

As measured by both digital music technology scales, the Early Majority group closely followed the Early Adopters category in their usage ranking. The Early Majority respondents also displayed high levels of usage, possibly (though not necessarily) possessing a longer time period for experimentation and proficiency development than the Late Majority group. Based on the higher current usage levels, Early Majority respondents also reflected a solid commitment to productivity, possessing more than sufficient experience with technology usage in the field. Though these speculations are untested in a direct statistical sense, they are consistent with the usage levels seen in the data and the factor of the passage of time and are also consistent with Rogers' (2003) model. These possible explanations appear particularly relevant to establishing the usefulness of Rogers' bell curve template for designating theoretical adopter categories.

The technology usage rates seen in the present study as pertaining to the different Rogerian categories appear to lend credence to Rogers' (2003) categorization. The application of the Rogerian model more accurately applies to relatively "mature" technologies, those with diffusion histories of 20 years or more. The technologies for this study have sufficient marketing timelines to develop a fairly accurate diffusion history, as postulated in Rogers (2003) cycle of diffusion. The technology histories for all of the music technologies in the study allow for the emergence of a fairly accurate historical distribution of adoption categories. A sufficient number of those with the longest reported periods of use (e.g., Innovators and Early Adopters) are still actively teaching, allowing them to also be included in the current study.

Therefore it is reasonable to conclude the following: (a) Rogerian adoption categories were appropriately applied to the present sample, (b) significant relationships emerged between the five Rogerian ATV categories and the rates of usage for digital music technology (*DMTUS-I* and *DMTUS-II*), and (c) no significant relationship was found between Rogerian adoption categories and the differential use of generic technology.

Attitudes toward digital music technology.

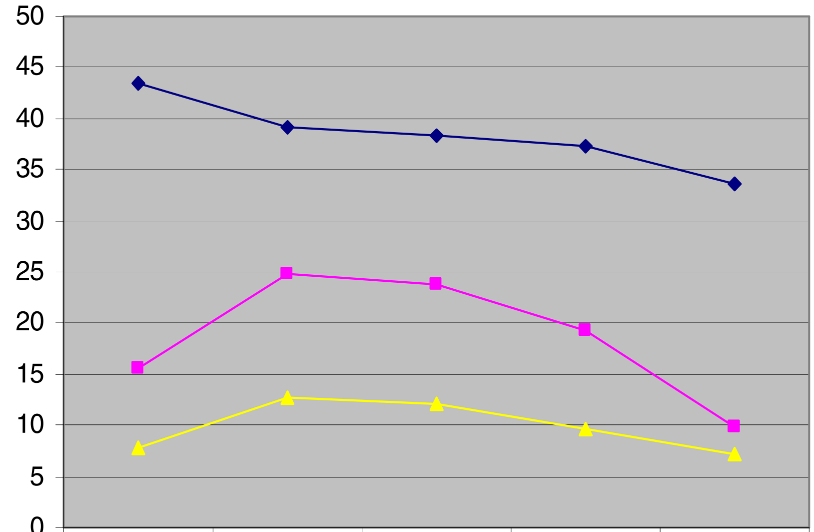
Respondents in Rogerian categories have now been described in terms of their differential use of technology, but discussion of their respective attitudes toward DM technology necessitates the measurement of the categorical adopter placement with the *DMTAS*. As a first step in this analysis, the *DMTAS* was subjected to a one-way ANOVA test. Results indicated that Innovators had the highest average score on the *DMTAS* of all groups (M = 43.5), representing the greatest positivity of attitudes toward digital music technology usage, and mean scores then steadily decreased across groups to the Laggards (M = 33.7). These differences were significant at the .001 level (F = 5.07, p = .001).

Furthermore, these results represented a different pattern than the one previously noted for technology usage. For the *DMTUS* previously discussed, Laggards reported the lowest digital music usage scores, followed by Innovators, and then by the technology adopter groups in the middle of the timeline. In this case, Innovators, who have used the technology the longest, but who also display relatively low levels of current usage, have the highest or most positive attitudes toward DM technology.

Figure 31 displays the mean *DMTAS* scores vis-à-vis the means on the two digital music technology scales, *DMTUS-I* and *DMTUS-II*. This line graph reveals a completely different pattern for the Rogerian groups' attitude scores than was true for their digital technology usage scores. The top line in Figure 31 represents average *DMTAS* scores for the five Rogerian groups; the middle line represents their average *DMTUS-I* scores (representing newer, more specialized DM technologies); and the bottom line represents their average *DMTUS-II* scores (representing more established DM technologies). Actual scores for the five groups are displayed below the line graph.

Figure 31 clearly reveals that a different contour and pattern exists for the *DMTAS* scores across Rogerian categories than exists for their level of usage of DM technology. For the usage of both established and specialized DM technologies (the *DMTUS-II* and *DMTUS-I*, respectively), users in the middle of the time continuum (Early Adopters, Early Majority, Late Majority) displayed the highest scores for both scales, followed by

Innovators, who had fairly low average scores, with Laggards on the bottom displaying the lowest scores.



	1	2	3	4	5
DMTAS	43.5	39.1	38.3	37.3	33.7
DMTUS-I	15.6	24.8	23.7	19.2	9.9
DMTUS-II	7.8	12.7	12.1	9.7	7.1
	Innovators	Early Adopters	Early Majority	Late Majority	Laggards

Figure 29. Rogers' adopter categories by DM attitudes and usage.

Regarding attitudes toward DM technology, as measured by the *DMTAS*, the pattern was markedly different. Innovators attained the highest scores in terms of positivity. The scores on the timeline of adoption (from the time of earliest adoption to the latest) steadily declined thereafter to the level of Laggards, who again displayed the lowest scores.

Diffusion of Digital Music Technology

The Rogers' (2003) model offered two different statistical representations of the results for adoption and diffusion studies. From the perspective of measuring the distribution levels for the adopter categories that are central to Rogers' (2003) theory, the use of the standard bell curve represented the categorization of individual adopters, based on the amount of time each individual implemented a specific technology from a designated starting point. From the perspective of aggregate adoption known as *diffusion*, a second statistical representation known as the S-curve served to illustrate this concept.

An evaluation of Rogers' (2003) S-curve model suggests three theoretical stages of diffusion in terms of time and the cumulative rate of adoption: (a) a pattern of mild and gently graduated adoption during the Innovator and Early Adopter stages, (b) accelerated ascent during the Early Majority stage, and (c) a tapering or leveling off near the point of technology saturation in the final two stages of Late Majority and Laggards. The S-curve model was then compared to the distribution of study data.

Figure 32 portrays the diffusion process for the current sample population. Beginning with 1974, the earliest year of reported use by any sample respondent, Figure 32 presents the data from the present sample population in terms of years of use or adoption. The figure graphically illustrates the diffusion of digital music technology for the sample population by graphing the cumulative percent of usage for each year represented through 2006. Responses for this sample (usage reported in *years of use*) occurred in every year in this range except for years 28, 29, and 31 (that is, 1975, 1977, and 1978, respectively).

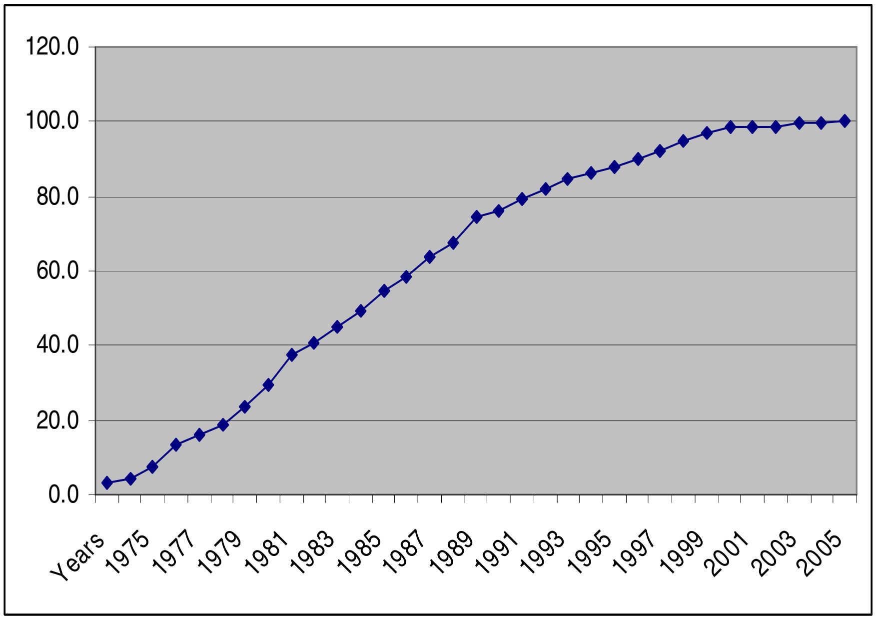


Figure 30. A test of the Rogerian S-curve using the study data.

Figure 32 above outlines a pattern of increased usage over time that is somewhat similar to Rogers' (2003) model. However, a comparison of the graphic representation of the current study data with Rogers' S-curve model shows major differences (see Figure 5). Although the third stage (a linear tapering or leveling off phase) compares favorably with the Rogers' model, the initial two stages (a mild approach followed by a steep ascent) failed to materialize adequately. The graph of the current study data rather suggests a roughly linear relationship for the first 16 years, which is exactly half of the study's diffusion span of 32 years. The next 10 years continued with a slightly more gradual linear relationship (i.e., with a very gentle slope), followed by the expected tapering or level off for the final 6 years. Therefore, based on the current study, the S-curve model demonstrated a somewhat limited usefulness or applicability.

The model's lack of viability for this study may stem from the basic premise that the Rogers' (2003) model has universal applicability for all diffusion and adoption scenarios. While Rogers (2003) reviewed many studies pertaining to a variety of technologies and innovations for which the S-curve model was found to be a useful construct, other researchers have suggested that not all technology is adopted into a population at the same rate. For example, in a recently released book on technology and globalization, *The World is Flat*, Friedman (2005) suggested that while many technologies are slow to achieve acceptability within the general public, the global adoption of Internet technology took place at an incredible rate, against all predicted expectations through a number of diverse factors. Among them were the particular market histories of Netscape's browser and Microsoft Windows 95, as well as a strong market demand fueled by people's ability to immediately see the huge potential in the technology. These factors led to a pattern of adoption that did not follow this pattern of "cultural lag," but resulted in an adoption rate that was much faster and more widespread than anyone's expectations.

Regarding the rate and pattern of adoption for the technologies included in the present study, it is possible that dispersion and marketing factors of some of these digital music technologies (e.g., electronic keyboards, music notation software) also resulted in unique patterns of adoption and diffusion for similar reasons. On the other hand, the method of gathering data and operationalizing Rogers' (2003) concepts in the present study may have produced an anomalous pattern that failed to fit the S-curve model. Rogers developed his S-curve model after painstaking review of adoption rates for particular technologies (such as hybrid corn). Regarding the present study, several similar technologies were grouped together to increase the population of those who might fall into different Rogerian categories. As a result, the linear pattern observed in Figure 32 might actually be a composite picture of a series of S-curves formed by the adoption of the six listed technologies. If true, the multiple S-curve patterns, each with a different starting date for the availability of the technology, might have the effect of smoothing out or modulating the pronounced S-figure contained in Rogers' model.

The nature of the self-reported data also suggests a possible reason for the present study's deviation from the standard S-curve. Most of the analysis data for Rogers' (2003) S-curve diagrams originated with government or business sources, including thousands of cases based upon documentary evidence such as records, receipts, and reports. As a general rule, such aggregate data collected by large institutions during the course of their day-to-day business is highly reliable. In the present study, not only was the sample size fairly limited when compared to these industrial studies, but respondents probably provided some data on the basis of social desirability and by faulty or hasty recollection.

One observation from this current study tends to substantiate this possibility. The frequency spikes discussed in chapter 4 regarding the "years of adoption" that tended to group into multiples of five (i.e., years 5, 10, 15, 20, etc.) serve as evidence that significant measurement error, or at least measurement "approximation," occurred on the part of many respondents. All of these factors could have contributed to a biased categorization of faculty respondents into Rogerian categories.

In spite of the possibility of strategic design and protocol errors, quickly dismissing the study findings pertaining to the Rogerian model objective might be ill-advised, without at least considering the logical and most obvious alternative. As Friedman (2005) and others have suggested, real life situations occasionally occur where traditional or normative models of technology adoption do not hold. Perhaps the "linear growth and rounded taper" graph seen in the present study data accurately portrays diffusion history for the adoption of digital music technology. If so, these results might indicate that sometimes factors develop that prohibit the different categorical adoption rates suggested by the S-curve model, but which encourage more gradual but steady adoption of some technologies.

One of these alternative factors affecting adoption and diffusion rates might be scheduling conflicts between an institution's school calendar and the annual convention cycles of many professional organizations. These various permutations of two differing activity schedules could directly impact the ascent rate of personal adoption and usage regarding a particular technology's diffusion curve. Other causal factors possibly affecting adoption rates include the various academic models of decision-making within many educational institutions (e.g., democratically run committees structures for decision making as opposed to the hierarchical decision-making structures found in many organizations), departmental budget constraints, and burdensome academic schedules, any or all possibly causing a potential Innovator or Early Adopter to postpone experimentation and professional development for an unspecified, but often lengthy period of time.

In summation, the current study data failed to completely satisfy the theoretical conditions pertaining to the Rogerian S-curve timeline for an expected diffusion history. Most notably, the rapid ascent in the middle of the theoretical S-curve model failed to emerge on the graphic plot of the present data. The data from this current study showed a steady and generally linear increase rather than conforming to an S-curve configuration.

Only the latter stage of the graph followed the predicted leveling of cumulative adoption found in the theoretical S-curve model from Rogers' diffusion model (2003).

Qualitative Data: Respondent Comments

The final question of the survey was the only qualitative item on the descriptive survey. The author chose to place its contents in chapter 5, since chapter 4 presented the descriptive data of the questionnaire. The qualitative data best fit with the conclusions and discussion section of this chapter. Item 37 asked respondents to add any comments regarding personal attitudes toward any or all of the items found on the survey. After these general instructions, respondents were prompted with this sentence, "I am particularly interested in the comments of those who are uncertain of, disapprove of, or reject the use of any digital technology relating to this survey, as it impacts the practice and curriculum of piano pedagogy." While not testing any of the research objectives directly, the 94 comments obtained from this item (representing 40% of the sample population) provided useful insights into the attitudes of those in the profession regarding the use of digital music technology, as well as sometimes regarding other findings and speculations provided in this research. Some of the comments also corroborated Rogers' (2003) descriptions of the five adopter categories in the adoption and diffusion model. The complete set of comments, as transcribed in order of case number, is found in Appendix D. None of the comments listed below or in Appendix D identify individual respondents.

Item 37 yielded fascinating insights into individual respondent attitudes regarding digital music technology, as well as providing some explanation as to each individual teacher's usage or nonusage of technology. As expected, a handful of comments were fairly extreme in their characterizations, particularly for those respondents who manifested dispositions of total technology acceptance or complete technology rejection. However, few of the comments indicated that respondents either totally embraced the comprehensive use of technology for pedagogical purposes or totally rejected it. Comments most often partially affirmed the use of technology, followed by one or more relatively negative qualifying statements. The following quotations represent a small sample of the 94 responses to Item 37, as found in the survey questionnaire (see Appendix A). The following quotation section allows the respondents to speak for themselves, with a minimum of editorial commentary.

Here are some comments that seemed to fit the extremes of the continuum, both on the positive and negative side of the issue. The first comment came from a technology proponent who appeared to fit some of the characteristics of Rogers' (2003) Innovator category, enthusiastically confirming,

> I love anything to do with technology, as it enhances my INTEREST as much as my knowledge. *Blackboard* has greatly helped communication between me and my GA's, as well as between teacher/students.

From the perspective of digital technology rejection, the following comment was short and succinct, stating, "I don't use music technology in my teaching piano pedagogy. Sorry." For whatever reason, this respondent definitely fits the adoption category of Laggard, a term that should not be construed as derogatory, but simply as Rogers' (2003) label for those who have failed to adopt or have strongly resisted the use of a particularly technology.

Far more of the open-ended responses for Item 37 showed mixed reactions regarding the use of technology, both to its use and efficacy. The following respondent reported:

> Technology is here to stay! It seems to be useful with class piano and pedagogy on a limited basis with younger children. I believe piano teaching is an art. The overwhelming visual stimulation that young children are subjected to does little to improve problem-solving or in-depth listening skills. It seems as though we are forced to embrace all technology as the real lifeline, what is really about one on one, in-depth relationships between student and teachers that breeds a high artistic level of performance.
> Of course, you're hearing this from an old person! So scratch it!

Several respondents to this item indicated a great concern over the use of digital keyboards as replacements for the acoustic piano. Even though the technology usage scales and application scenarios presented several types of digital technology, the inappropriate use of keyboards regarding pedagogical applications and performance appeared to remain the major focus of their apprehension toward digital technology use. The following respondent stated,

> I have no objection to the use of DT. However, it cannot & should not be a substitute for the 300-year old tradition of using acoustic keyboards with all of their complexity, extraordinary sounds and touch, the subtleties of which can never be duplicated by DT.

Another respondent declared,

> As teaching aids I value the use of the types of technology you asked about. But I am still resistant to digital instruments replacing acoustic ones for performance because I think it somehow disconnects the player from the sound.

Some individuals took a more neutral attitude towards digital technology use in pedagogy, indicating,

> I maintain that technology remains a powerful and intelligent tool with many efficacious applications in both performance and pedagogy. In itself, technology remains neutral and is, therefore, not a prerequisite for

good pedagogy. It remains possible to be an effective music teacher with little or no use of technology. My question, though, is why would anyone want to do that?

A few teachers recited their personal or professional use (or lack thereof), followed by the reasons for their choices, both voluntary and involuntary. One respondent summarized his or her difficulties regarding learning and using these technologies for professional and class use, and linked them to scarcity of resources and lack of accessible training, reciting,

> While I think technology is interesting, and can make instruction relevant to what/how students are learning in other arenas, I find it difficult to incorporate technology (outside of keyboard proficiency classes) for the following reasons: 1) no time/no funds. Our keyboard lab is still running 2003 Finale. I get to teach piano pedagogy as part of my load once every four years – the impetus to update is not continuous. 2) small community. We have two music stores – neither teaches nor advocates technology. Neither store, of which both sell major keyboard manufacturers, have ever invited me to a technology workshop. 3) no time within the pedagogy class. Good teachers need to have quality values to get beyond the bells and whistles. Investing curriculum time to technology does not yield any quality – just another "activity" to do without any regard to technology. Good luck!

This final quote presents an attitude that seems to transcend personal bias and preference concerning the means and format by which pedagogy teachers conduct their classes. This respondent concluded,

> I believe that teachers must use every means available to teach students in a manner that is meaningful to them. While the use of technology may not be important or relevant to us as teachers, it is the "only way" for modern students. Teaching music/piano with the tools technology provides means reaching the next generation of musicians. It also means keeping our art alive and a meaningful part of current culture.

While many other comments offer additional perspectives and personal detail to the survey findings, these were provided only as a selection of the types of comments that were given; all comments can be found in Appendix D.

In all cases, the open-ended responses to Item 37 produced a wide variety of narratives of various lengths. Each was distinctive, but the general direction of these remarks fell into one of the following characterizations. A few respondents embraced and overwhelmingly adopted the majority of these digital generic and music technologies, using them with vigor. An equally few respondents totally and rather vehemently rejected all use of digital technologies as unneeded and unwarranted. The large majority of the respondents presented a mixed reaction to digital technology use, both from the perspective of appropriate use and its ramifications regarding the future of the profession. Several indicated the need for adequate funding for departmental acquisition of equipment while simultaneously stating the need for release time to master and integrate the various technologies into their class curriculums. It would be fair to conclude that the overall attitudes toward the use of digital technologies for pedagogy, while generally positive, are mixed and do not represent a unilateral position regarding this group of pedagogical tools.

Limitations of the Research

The present research was based on an attempted census (rather than a random sample) of 695 music faculty members who listed Piano Pedagogy as an area of teaching interest in the *Directory of Music Faculties in Colleges and Universities, United State and Canada, 2005-2006*, published by the College Music Society. The final sample population consisted of 238 respondents, of whom 81% identified themselves as currently involved in piano pedagogy. The response rate of the total professional population of piano faculty members was just over 34%. This was considered an acceptable sample rate or percentage for this type of study. However, while this constitutes a respectable sample for a social research project of this type, the self-selection of respondents and the nonparticipation rate of 66% of the total professional population introduced a substantial (though unavoidable) possibility of sample bias.

Among the concerns regarding self-report data is the possibility of bias on the part of the actual respondent population. This is particularly true of controversial topics such as the viability, validity, or appropriateness of using digital music technology in American college and university piano pedagogy programs. Throughout the process of any study, detecting the degree of error in any survey study challenges researchers with a difficult if not impossible task. Bias from self-reported data originates from a number of possible scenarios. Some respondents deliberately mislead researchers through biased self-presentation, social desirability bias, self-promotional reporting of estimated use or disuse, and deliberate or unintentional bias through the failure to answer significant questions or even whole sections of a survey. Since some of the participants chose not to answer various items, the valid number of respondents varied on different items of the questionnaire throughout this study. Future studies by this or any other researcher should always strive to procure the largest sample possible to achieve better return rate, thereby diminishing the degree of self-report or sample bias.

Another research limitation lies with the fact that the researcher chose the technologies and their groupings for the usage scales based upon his own judgment and experience. These decisions resulted from an extensive personal history of involvement within the professional culture during the time period when these technologies first became available. The researcher recognizes that alternative technologies, pedagogical applications, or presentation formats could have been chosen, thereby changing the parameters and results of the study.

Suggestions for Further Research

The current study attempted to assess the current level of digital music technology implementation (adoption) by graduate and undergraduate piano pedagogy faculty in American colleges and universities. To procure this broad-based "snapshot" of current digital technology usage within the pedagogy community, the majority of technology usage categories and applications found within the questionnaire were relatively general in nature. Reflection on this current study leads the researcher to recommend additional descriptive studies regarding technology usage and application but with a more detailed and specialized focus.

1. The researcher first recommends revisiting portions of this study with a design modified to make use of the considerably greater assets and records available through professional organizations and conferences. Since professional organizations usually possess more extensive longitudinal data (based on organizational records rather than respondent recollection) and much larger samples, these assets might provide more accurate descriptions of key information (e.g., the influence of specific organizational programming and its effect on members) with regard to technology adoption and diffusion.
2. Future studies could further subdivide the general categories of technology use and application of this current study into multiple items for more detailed research, thereby assessing a more detailed and complete picture of digital music technology usage among collegiate piano pedagogues.

3. Another avenue of research offers some researcher the opportunity to compare digital music technology use between independent studio instructors and piano faculty in institutions of higher learning. Future researchers might use the data from the current study as a baseline from which to compare the results of a survey directed at independent piano teachers or, though more time intensive in nature, a comparison of technology use between two simultaneously conducted surveys, one for each group.
4. With the exception of the open-ended question on Item 37 of the questionnaire, respondents had little opportunity to give reasons as to why they chose to use or not use specific technologies and applications. The use of a qualitative study format for future research could provide useful information regarding individual faculty member's motivations and fears regarding this technology. Such a study might begin with a descriptive survey to attain the needed statistical results concerning actual use, followed up by case studies through in-depth phone interviews or personal visits with members of the designated population. This type of information would be extremely enlightening as to how, and in what exact pedagogical contexts these technologies are used, how often they are used in specific pedagogical venues, and to assess ultimately the credibility of the present survey research and its findings. Such interviews might also offer the exciting possibility of discovering new technologies and their applications as a researcher encounters pioneering Innovators and Early Adopters (or "creative adapters"), thereby fueling further research and better usage by the pedagogy professionals.

5. Finally, research needs to be done regarding a very controversial topic that is often ignored within the profession, yet which impacts the very educational paradigm within college and university music departments. This topic refers to a needed moratorium regarding the current avoidance of 20th century and 21st century pop styles within the halls of musical academia. Many of the digital keyboard technologies found in class piano environments were originally developed as performance instruments for these often ignored musical styles. While the world has created an incredibly complex and successful entertainment culture based upon these newer musical instruments and styles, the vast majority of college and university music programs refuses to accept the styles as worthy of teaching and performance. A study could be initiated that investigates the acceptance or rejection of specific digital performance technologies from the perspective of acceptable repertoire and literature choices within colleges and universities. Modern technology and modern musical styles are inextricably linked. Such a study might have far-reaching implications for the curricular content of music departments and piano pedagogy programs throughout the nation.

This study sought to assess the status of digital music technology use within American piano pedagogy programs at the collegiate level. Over the last 25 years, the piano pedagogy profession apparently progressed in its attitude towards and usage of the digital equipment and pedagogical applications currently available to the music profession. Yet, as a whole, the profession still appears uncertain as to the efficacy and legitimacy of digital music technology within the current educational paradigm.

Some teachers enthusiastically embrace digital music technology while others regard it with skepticism and even disdain. For the majority of piano pedagogues who fall into the uncertain middle, the use of digital music technology continually progresses at varying rates of implementation, often with an underlying concern and possible trepidation as to its ultimate effect upon the future of piano performance. Like fire, digital music technology can be viewed as friend or foe. If the use of electronic keyboards is misconstrued as a substitute or replacement for the traditional acoustic piano, then it indeed becomes a menace to the rich and magnificent tradition of piano literature and performance. However, if it is viewed as a pedagogical aid to offer a variety of support mechanisms for ensemble playing and the development of basic musicianship skills, it becomes a valuable ally in pursuit of the goals that are universally acknowledged by most piano pedagogues.

In reality, a wide variety of digital music technologies is available to the piano pedagogue, a fact which does not fit the frequently held stereotype that digital music technologies are no more than artificial substitutes for acoustic instruments. Some function in the role of tutorial and interactive teachers, while others enable the more efficient and creative composition of music. Still others allow for alternative performance venues that are not appropriate for the acoustic piano, yet which require excellent pianistic technique to adequately accomplish the task. Some technologies can function as substitutes, offering practice aids and ensemble opportunities not available to most pianists through traditional venues. Digital music technology also claims a performance role in musical styles not suitable for the acoustic piano, particularly for popular styles requiring different timbres for solo, ensemble, and accompaniment support.

Finally, to meet the needs of those pedagogues who fear digital music technology and its repercussions regarding the professional status quo, it is the responsibility of the pedagogy profession to develop and disseminate nonthreatening applications and venues for these technologies. For those who argue that technology limits the pursuit of more important pianistic pursuits, the profession should show its members the added benefits of these technologies, which can stand beside the traditional pedagogical practices without overwhelming them. For those who see the teaching of piano as a narrowly defined practice and profession, they need only look to the great pianists of the past, who understood the intimate interdependent relationships between new technologies, digital or otherwise, and the creation, teaching, and performance of exceptional music.

This researcher believes it is time to return to a truly Renaissance attitude, where musicians are empowered to explore a variety of technologies and teaching approaches without concern for the politics of paradigm or unwarranted traditional bias. All serious musicians, whether students, teachers, composers, or performers, should be encouraged to be open minded and even adventurous in their exploration of new pedagogical approaches and technologies. The final goal is, as always, the production of great music and its transcending influence upon both the performer and the audience.

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Appendix A

Questionnaire

Piano Pedagogy Technology Skills Inventory

Name: ________________________________ (Optional)

Section I. Background Information

1. Please indicate your gender:
   Male Female

2. What is your age bracket?

Under 25	35-44	55-64
25-34	45-54	65 or over

3. How many years have you taught in colleges or universities? _____ years (please write in number)

4. Please indicate below the types of piano teaching you currently do? (Check All That Apply)
   Class or Group Piano   Individual Applied Lessons   Preparatory School Teaching
   Undergraduate Piano Pedagogy Courses   Graduate Piano Pedagogy Courses

5. Do you teach or have you taught at least one undergraduate or graduate piano pedagogy-related course in the last five years?
   YES NO

6. Do you belong to a professional organization that encourages the use of digital music technology by offering general sessions and workshops in music technology? YES NO

   If YES, please list the professional organization(s) in this category to which you belong?
   ____
   ____
   ____

7. How often do you attend professional organization conferences?

annually	every 6-7 years
biannually	seldom
every 3-5 years	never

8. If and when you participate in conferences of your professional organization, how many digital music technology-related sessions or workshops do you generally attend per conference?

none	two	four
one	three	five or more

Section II. Scenarios for Using Music Technology in Class

Please indicate how often you have used the following music technology applications in a variety of settings, such as in the classroom, in an applied lesson, or as a methodology you are teaching to pedagogy students. Please indicate your frequency of use for each item on a scale from 0 to 10 where:

0 = no use of the technology in any setting

1 - 2 = some use in a single class setting (e.g., applied lessons only)

3 - 5 = frequent use in a single class setting

6 - 8 = some use in multiple settings (e.g., applied piano lessons, group piano lessons, & pedagogy classes)

9 - 10 = frequent use in multiple settings

For each item, write a number from 0-10 to represent your frequency of use, as described above.

	Usage Rating 0 (low) – 10 (high)
9. Used any MIDI keyboards, digital keyboard work-stations, external sequencers, MIDI players, or combination of these items to digitally record a student performance for playback analysis or archives	_____
10. Used any electronic music technology (keyboard, MIDI player, computer program, auto rhythm, disk accompaniments, etc.) to support student playing activities (e.g., scales, repertoire, individual duet practice, sight reading, improvisation, or recitals)	_____
11. Accompanied a student's solo or duet music with an orchestral or electronic sound(s) from a keyboard instead of a piano	_____
12. Directed students to practice or improvise a right-hand melody with a CD, sequenced piano, or computer-based or hardware-based accompaniment	_____
13. Developed or assigned pedagogy students to develop a written strategy for integrating computer-based music software, keyboard automation, MIDI player support, etc., into applied or group K-12 student piano lessons	_____
14. Used Finale or other music notation program to prepare, facilitate, or enhance an applied lesson, group lesson, or pedagogy–related class for piano	_____

Section III. Attitudes toward Technology in Music

To what extent does each of the following statements characterize your attitude(s) towards the use of educational technology in the music classroom? Using the categories below, indicate the extent to which you agree or disagree with each statement. Circle your answer.

SA = Strongly Agree A = Agree U = Undecided D = Disagree SD = Strongly Disagree

15.	Music technology should be used to improve learning throughout the piano pedagogy curriculum.	SA	A	U	D	SD
16.	I believe piano pedagogy teachers do NOT need to use computer or keyboard technology for the effective teaching of piano pedagogy.	SA	A	U	D	SD
17.	I do NOT believe the quality of piano pedagogy education is enhanced by the use of computer-based music technology.	SA	A	U	D	SD
18.	I believe the quality of piano pedagogy education is improved by the use of MIDI-based keyboard technology.	SA	A	U	D	SD
19.	I do NOT believe that MIDI-based digital pianos, keyboards, and synthesizers have potential as performance instruments.	SA	A	U	D	SD
20.	I would like to improve my skills in the use of music technology.	SA	A	U	D	SD
21.	Music technology should be used by piano pedagogy teachers more than it is now.	SA	A	U	D	SD
22.	Music technology is of little value in the piano pedagogy classroom because its use is too difficult or time-consuming.	SA	A	U	D	SD
23.	I would like to use music technology more in my teaching and learning.	SA	A	U	D	SD
24.	Music technology has NOT significantly altered the content and presentation of my piano pedagogy curriculum.	SA	A	U	D	SD

Section IV. Inventory for Use of Generic Instructional and Music Technology Items

In the following section (see next page), you will be asked to indicate how much you use certain technologies for various professional and academic pursuits. The inventory asks you about both generic instructional technology and music-related technologies. <u>To better understand each category label, please read the following column descriptions before continuing.</u>

Column A: **<u>Professional Use, Class Preparation, or Class Facilitation:</u>** Professional activities outside of teaching, such as publishing, research, music composition, etc.; class/lecture planning; or the facilitation of in-class presentation.

Column B: **<u>Taught as Class Subject:</u>** An intentional part of the course curriculum as knowledge you want your students to learn, a skill you want them to acquire, or a methodology for their use as teachers.

Column C: **<u>Years Used:</u>** The approximate number of years you have used this technology in any capacity.

Column D: **<u>Your Need for Technical Training:</u>** Your perceived need for training to learn or improve your use of a technological item or skill.

Section IV. Inventory for Use of Generic Instructional and Music Technology Items (continued)

Columns A & B	Column D
1 = Do Not Use	L = Low Training Need
2 = Occasional Use	M = Moderate Training Need
3 = Regular Use	H = High Training Need
N/A = No Access	N/A = Not Applicable

Please read the column descriptions on the preceding page before continuing. In Columns A and B, please write a 1, 2, 3, or "N/A" (see descriptions above) on each line to indicate how much you use each technology listed. In Column C, write in a numerical answer. In Column D, circle your answer.

	Instructional & Music Technology Activity	**A**	**B**	**C**	**D**
	Please rate the following instructional or digital music technology items:	*Professional Use, Class Prep, or Facilitation* (1, 2, 3, NA)	*Taught as Class Subject* (1, 2, 3, NA)	*Years Used (write in number)*	*Your Need for Technical Training (circle)*
25.	Created documents with desktop publishing software	____	____	____	L M H N/A
26.	Created database for music activities, e.g., a CD or music library	____	____	____	L M H N/A
27.	Created presentations for lectures using *PowerPoint*-type software	____	____	____	L M H N/A
28.	Used *Blackboard* or other classroom management software	____	____	____	L M H N/A
29.	Browsed the Internet/World Wide Web for information	____	____	____	L M H N/A
30.	Created a professional or studio Internet web page	____	____	____	L M H N/A
31.	Used computer-based music instruction in a class or private lesson	____	____	____	L M H N/A
32.	Used music notation software (e.g., *Finale*) for composing, arranging, or in-class tool	____	____	____	L M H N/A
33.	Used MIDI sequencing soft-ware or hardware for lesson or class prep or in a class setting	____	____	____	L M H N/A
34.	Used digital keyboards, synthesizers, or digital pianos in a class piano setting	____	____	____	L M H N/A
35.	Used digital keyboards or other digital/MIDI support in a private piano lesson	____	____	____	L M H N/A
36.	Used MIDI keyboards in a student performance ensemble	____	____	____	L M H N/A

37. Please add any comments for me to consider regarding your personal attitudes towards any or all of the items found on this survey instrument. *I am particularly interested in the comments of those who are uncertain of, disapprove of, or reject the use of any digital technology relating to this survey, as it impacts the practice and curriculum of piano pedagogy*. Feel free to add more information on a separate sheet.

____

____

____

Appendix B

Institutional Review Board Letter of Exemption

The University of Oklahoma

OFFICE FOR HUMAN RESEARCH PARTICIPANT PROTECTION

May 9, 2005

Mr. Leonard Thomas Stampfli Jr.
Music
CMC 138
CAMPUS MAIL

RE: Exempt from IRB Review
IRB Number: FY2005-357
Title: Status of Digital Music Technology Implementation by Graduate and Undergraduate Piano Pedagogy Faculty in American Colleges and Universities

Dear Mr. Stampfli Jr.:

The Institutional Review Board considers that this research is exempt in accordance with the Code of Federal Regulations, Title 45, Part 46, Sub-part 101 (b), Category:

2. Research using cognitive, diagnostic, aptitude, and educational achievement tests, or surveys, interviews, or observations of public behavior, unless human subjects are identifiable, and disclosure of responses could put them at risk of liability, or damage to their reputations or financial standing.

as revised November 13, 2001. Further review of this study by the IRB is not required unless the protocol changes with regards to the use of human subjects. In that case, the study must be resubmitted immediately to the Board. Please inform the IRB when this research is completed.

If you have any questions related to this research or the IRB, you may telephone the IRB staff at 405.325.8110 or visit our web site out irb@ou.edu.

Cordially,

Lynn Devenport, Ph.D.
Vice Chair
Institutional Review Board – Norman Campus (FWA #00003191)

FY2005-357

cc: Dr. Nancy Barry, Music

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Appendix C

Correspondence

Cover Letter to Pilot Participant

Tom Stampfli
315 East College Ave.
Greenville, IL 62246

January 12, 2006

Dear Participant:

I am presently involved in a study investigating the status of digital music-related technology implementation by piano pedagogy faculty in American colleges and universities. The results of this study will be the basis of a doctoral dissertation at the University of Oklahoma.

Your assistance in piloting this survey instrument would be invaluable. You'll find the questionnaire on the following web site (www.surveymonkey.com/asp?u-1000). If you are willing to assist me, please take the survey. I would appreciate it if you would include the following information in the *final comments* section of the survey:

1) The time it took you to complete the online survey

2) The identification and location of any grammatical or spelling errors you find in the instrument

3) The identification and location of any question, directive, or statement you consider to be unclear

4) Any suggestions for improving the formatting of the survey

5) Any other suggestions for improving the content or content presentation would also be appreciated.

For the purposes of this study, music-related technologies are defined as any digital or computer-based instructional technology (including MIDI-based innovations) that you might use for personal professional productivity, class preparation or facilitation, or as an actual class subject within the pedagogy course offerings at your academic institution.

The questionnaire should take about 15-20 minutes to complete. By completing the questionnaire, you are consenting to participate in this study. You may be assured of complete confidentiality. The responses will be used solely to improve the survey and no data entered will be used in the actual study. Please complete this electronic pilot questionnaire no later than January 24, 2006.

Thank you again for your help in refining this survey instrument. Your time and effort is most appreciated. If you are interested in receiving the results of this study, please e-mail me at tom.stampfli@greenville.edu.

Sincerely,

Tom Stampfli

Cover Letter to Survey Participant

Status of Digital Music Technology Implementation by Graduate Piano Pedagogy Faculty in American Colleges and Universities

Tom Stampfli
315 East College Ave.
Greenville, IL 62246

(date)

Dear Piano Pedagogy Instructor:

I am a graduate student under the direction of Professor Nancy H. Barry in the music department at the University of Oklahoma. I invite you to participate in a research study being conducted under the auspices of the University of Oklahoma-Norman campus. Entitled the *Status of Digital Music Technology Implementation by Graduate and Undergraduate Piano Pedagogy Faculty in American Colleges and Universities,* the purpose of this study is to assess the current level of diffusion and adoption of specific digitally-based educational and music technologies by piano pedagogues, based upon actual use as the measurement of adoption of a technology. The results of the study will be the basis of a doctoral dissertation at the University of Oklahoma.

Your participation will involve answering an online questionnaire that can be completed within 20 minutes or less. Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time. However, your assistance as an expert in the field of piano pedagogy would be invaluable. The results of the research study may be published, but your name will not be used. In fact, the published results will be presented in summary form only. All information you provide will remain strictly confidential.

Since there has not been a comprehensive national study on the status of digital music-related technology implementation by piano pedagogy faculty in American colleges and universities, the findings of the study should be beneficial to administrators, piano pedagogy instructors, and other music educators regarding better use of technology in pedagogy programs with no cost to you, other than the time it takes for the survey. *If you have little or no interest in music technology as it relates to piano pedagogy, your opinions concerning this topic are of particular interest to this researcher.*

The questionnaire can be found at https://www.surveymonkey.com.asp?u= 193321035401(1000). I believe you will find the on-line survey to be the most efficient and easy means of participating in the survey. If you prefer to work with a paper copy, please find the paper version and stamped return envelope in your cover letter packet. If you believe another person in your institution would more appropriately handle the questions, please forward the URL web site address for the questionnaire or the paper survey to that person. Please complete this electronic questionnaire or mail in the survey no later than February 28, 2006.

If you have any questions about this research project, please feel free to contact me at (618) 664-6562 or tom.stampfli@greenville.edu . You may also contact my faculty sponsor, Dr. Nancy Barry, at (405) 325-8110 or irb@ou.edu .

By clicking on the submit button found at the end of this online survey or returning a paper copy of the questionnaire in the envelope provided, you will be agreeing to participate in the above described project.

Thank you for your consideration.

Sincerely,
Tom Stampfli
Principal Researcher

Appendix D

Open Ended Responses from Item 37 of Questionnaire (See Appendix A)

I think use of technology has benefits, but I also think you can be effective without it. In our class piano lab, the main advantage with digital keyboards is that they have headphones and internal metronomes. Otherwise, they function just like a piano.

We have a Baldwin Piano Lab from 1974. The channeling and teacher-to-student piano features no longer work, but with speakers off and headsets on, I teach classes of up to 12 students. This is an electronic lab, but I don't think it's what is called a digital lab system.

I am not convinced that digital technology is a necessity, certainly not in my home studio where I have 3 acoustic pianos, 2 blackboards, and 12 desk chairs.

As a unit of a music education course, this technology is appropriate, but for serious private or mini-group piano instruction, a "real" piano is 100% more preferable.

I have no objection to the use of DT. However, it cannot and should not be a substitute for the 300-year old tradition of using acoustic keyboards with all of their complexity, extraordinary sounds and touch, the subtleties of which can <u>never</u> be duplicated by DT.

Great and important survey! I tried to do online version but my computer crashed, so resorted to paper. I personally am not particularly skilled in or drawn to technology, but believe the pedagogy students need to learn to use all items mentioned in your survey, as all are helpful teaching tools. I cover the very basics of technology in ped courses, as the MUED dept here offers an intensive 3-semester tech sequence that all PhD and most MM students take (MMs take 1 semester.)

A tool, not an end in itself.

I believe technology contains many opportunities for enhancing the learning experience. Someday I hope to get around to learning enough to use it more.

Piano pedagogy students usually need to learn the basics of teaching. Pedagogy classes could include a unit on technology, but it is not necessary on the undergraduate level because there is so much else to cover. Perhaps graduate pedagogy classes could devote more time to this subject. As for class piano teaching, I would use accompaniment CDs if I had them. They are too expensive for students or my department to buy.

Learning and implementing seems so time-intensive and therefore seems to stay on the "back burner."

I'm not hostile to technology as one might conclude! For me, it's a matter of time and priorities, which has most of my load distributed as an "artist-teacher" resource, both as a piano teacher and as a chamber music and vocal coach.

Keyboards greatly improve the ability to teach class piano. Ability to make this class "fun" with "special effects" is valuable but not necessary. For private lessons, I would always choose a real instrument.

My instruction is directed towards piano performance majors and principles. There are instructors with the school that teach all students the skills necessary for using technology in their career. My instructions have been towards the need of my performance majors and teaching on a one to one basis. I feel all students need to acquire skills in the vast area of technology.

Taking this survey reminded me to address these uses with my piano pedagogy class!

Students at my university are required to take *Finale*, MIDI technology-related courses outside of pedagogy area. A webmaster designs the web pages for the various areas of music study.

Technology is here to stay! It seems to be useful with class piano and pedagogy on a limited basis with younger children. I believe piano teaching is an art. The overwhelming visual stimulation that young children are subjected to does little to improve problem-solving or in-depth listening skills. It seems as though we are forced to embrace all technology as the real lifeline, what is really about one on one, in-depth relationships between student and teachers that breeds a high artistic level of performance. Of course, you're hearing this from an old person! So scratch it!

Technology can be looked at not only as a training tool, but also an investment in the business and PR side of teaching.

I feel that I am "learning as I go", having received no training in technology as a doctoral student in the 90s. The need is great.

I'm actually in the same position as you. I taught high school for five years and then taught as an adjunct for two while working on my DMA at USC (South Carolina) and this is my first year full-time (still finishing up that DMA). We don't have access to a lot of technology but we have a limited Tech Lab with *Finale* and a few other programs. Piano studies are still pretty traditional here. The tech education is provided in theory and music ed curriculums.

I use some music technology, some of the time. Restraints are: 1) budget restrictions, i.e., we don't own much, 2) class time restrictions, i.e., one semester pedagogy total, and 3) personal interests level of professor is low to moderate. There's only so much I can learn each year due to heavy teaching schedule.

I believe that every student should have lessons eventually on an acoustic piano. Electric keyboards are very valuable for class piano in which it allows for a variety of pedagogical tools to be used.

Most of my teaching is in applied piano, not in class piano settings in general. I'm fairly comfortable with the technology for class piano, I just haven't had much use for it.

I think technology is good, but it should not supplant other more traditional teaching. I use it in some classes, but I don't like to be forced to use it by my school or by accrediting agencies/state mandates!

I taught class piano at the college level 1 year. I have concentrated on private acoustic piano lessons in the year since. My Ph.D. is in interdisciplinary humanities, which took much class time for years. Your document is well conceived and presented, should work very successfully to your needs.

The various forms of technology I have used have improved remarkably in the last couple of decades. I don't currently use much technology other than word processing and e-mail. I would be more than willing to learn it if the college provided the equipment and I could find workshops and have the time to attend them.

I do not reject the many uses of technology. My own strengths are in the more traditional aspects of pedagogy, so I concentrate on that in my undergraduate pedagogy courses. So much to do, so little time to do it.

I do not use most technology in piano lessons for piano performance majors. I still believe the traditional piano basic skills are the most important to piano performers. However I use and encourage them for piano pedagogy students, and survey MIDI/*Finale* etc.... are essential to theory/ear training classes!!

I wish I had more time in my full-time teaching load to learn more about the integration of technology into my teaching. I am not opposed to its use, nor do I think the "latest" batch of technology should replace that magnificent specimen of technology, the concert piano. I think there can *unknown word*, in this day and age, probably should be a happy coexistence.

I don't use music technology in my teaching piano pedagogy. Sorry.

While I think technology is interesting, and to make instruction relevant to what/how students are learning in other arenas, I find it difficult to incorporate technology (outside of keyboard proficiency classes) for the following reasons: 1) no time/no funds. Our keyboard lab is still running 2003 *Finale*. I get to teach piano pedagogy as part of my load once every four years – the impetus to update is not continuous. 2) small community. We have two music stores – neither teaches or advocates technology. Neither store, of which both sell major keyboard manufacturers, have ever invited me to a technology workshop. 3) no time within the pedagogy class. Good teachers need to have quality values to get beyond the bells and whistles. Investing curriculum time to technology does not yield any quality – just another "activity" to do without any regard to technology. Good luck!

I do not utilize technology as much as I would like to. Our University offers only the one pedagogy class one semester a year. We are in the process of adding a pedagogy degree. It probably will be used more in this new offering. As of now, there is no time.

If you had asked about the use of technology in my home-based studio, my answers would have been different. I am an adjunct teacher not a doctor! We have two class periods in the intro piano ped class in which we examined technology for home-based studios. I'm in favor of using it!

It's the wave of the future. Students are very adept at using technology and we need to stay current for our students.

It goes without saying that we need to know how to use technology if in nothing else, our group piano classes. In a private setting, however, I fail to see much benefit. In a pedagogy course, it is imperative that we include technology as a part of the curriculum. I suspect, however, that in years to come it will be set aside. Yes, honestly, I think the tide will turn towards the old traditional approach.

The golden age of piano playing happened before the invention of a computer. Anything can be used wisely and unwisely.

I think it's usage is great, but I am getting older and feel less inclined to become acquainted with the new stuff. I look upon this as something for the younger generation.

I believe MIDI accompaniments should be more classically based, less based on pop styles, and have more artistic and expressive merit.

All above digital technology has been useful to my students as an adjunct to their classwork lessons, they use it regularly as a "language lab.”

If you instructed me and offered to me technology, I would use it.

I do not use technology to teach advanced piano students. If I were knowledgeable about music technology, I would share it with pedagogy students.

Since I don't teach pedagogy anymore, I don't feel I can help you there. In general, though I am not a big fan of all this technology, I have significant success with old-fashioned practice techniques and problem solving.

I am not a piano pedagogy professor. I'm a professor of piano performance or piano as a secondary instrument. My goal in my own life is less time on the computer and more on any real piano, an acoustic one. One big problem: I am expected to constantly add use of new technologies with no time or teachers given to me for learning it. My students all learn technology easily, but it does not come easily for me. Technology does not improve the quality of my teaching. The prices paid for the focus on technology: time to teach what music really is, in an acoustic instrument setting.

I find technology valuable as a support to concepts such as form, harmony, rhythm, phrasing, but I am not convinced of its use when strictly speaking of the training of a classical performance artist.

Confusing, confusing, confusing! I find Section 4 very confusing and the content very disgusting. The emperor Markus Aurelias counseled "simplicity is best." Please take his advice.

I need to do more in this area. I see its value. I am limited by an outdated Musitronic piano lab and insufficient IT help with the software and hardware we have. It is difficult for a small department to keep up with technology. We used the lab in music theory and keyboard skills classes.

I had a class in the use of *Blackboard*. I still have not used *Blackboard* for my classes (it takes too much time for me to set it up) and articles, etc. I love *PowerPoint* presentations. Again, it's very time consuming to prepare.

Tom, I'm on sabbatical this semester so I don't regularly check mail. Sorry this is late. My use of technology is largely through my collaboration with Paul (name omitted) in projects we are doing, in using him as a resource for my pedagogy students. I am more (unreadable word) support resource for my students than a great model. Their presentations are made using *PowerPoint*, they know the value of creating pieces with *Finale* or *Sibelius*. They learn how to use a digital lab, how to sequence accompaniments or orchestrations for students. That is unlikely to change too much for me as I continue to give 20 solo and chamber recitals, teach private lessons and chamber music, physiology and psychology of piano, as well as pedagogy.

It is true that using technology makes class preparation more difficult. For class piano instruction, I sometimes prefer to play along with my students to encourage musicality and phrasing. However, as I continue to teach more pedagogy (I'll begin teaching grad level pedagogy in the fall of 06), I will expand my own knowledge of technology so I can share it with my students. At recent conferences, I've noticed that some teachers are so interested in technology that it takes all of their time, and some forget about musicality and expression.

I have an interest in learning more. I find publishing software, *Finale*, and digital pianos in a group setting to be quite useful. I am sure there are many technologies that could be used for enhancement of learning of which I am unaware.

In general, I feel technology can be useful (and, of course, fun!) in teaching music. I use it mainly to keep students interested in learning musical concepts and ensemble playing. Since technology is a huge part of their daily lives at home and school I feel using...

Technology helps students feel music is relevant to life. Having said that, the teacher, without technology, should be able to convey the relevance of music to life as well as keep lessons interesting and stimulating. Most of us who are teaching presently did not grow up with technology in or as a part of our lessons, and we came out "OK" or even better for some. The master composer/musicians did not have the "benefit" of technology, and there is no evidence that we are producing excellence at that level as a result of having it. I do feel technology has a place perhaps more in the areas of creativity and theory education. I personally use it in my studio for both. Also I use programs on music composers and ear training and orchestrated compliments for method books pieces. When I use technology in a keyboard class I have to remember not to focus on the technology itself but the teaching of the music (mechanics).

I feel that technology is more distraction than teaching aid. Many times I resort to the "basics" when teaching (chalkboard, projector, basic digital keyboard features). Technology makes me nervous and it never seems to run smoothly for me.

Tom -- Use of technology has made the biggest impact on my teaching/supervision of doctoral students working on their DMA research papers (dissertations), and has revolutionized the way I can conduct my own research. Your survey seem to emphasize keyboards and software, but I find the online, immediate access to information of all kinds to be every bit as valuable to our field. Good luck on your survey and completing a dissertation!

I direct the MIDI keyboard entertainment ensemble and regularly perform with the student group. Synthesizers provide portability, perfect tuning, a myriad of timbres, easy possibilities for recording and sequencing, and are adaptable to every genre (i.e., rock, jazz, pop, country, classical, experimental).

Technology can be a good or bad thing. Teaching things like web page design or using notation software is often a complete waste of time. (Both of these things are best learned by Web design in music technology experts in those types of courses). Teaching things like how to incorporate technology into lesson plans or critiques of theory and aural skills software (sic). Also, I dislike the use of the word "quality" in describing technologies affect on piano teaching. Several of the best piano teachers in the country use no digital technology at all. Many of the worst do. The use of technology says more about the character of one studio in the quality of it.

Technology is changing so quickly, particularly recently, it is harder to keep up with all the changes. What one can do though is amazing, once one learns the new tool. I think it's imperative that we in the now "older" generation remain as current as is possible -- even will be behind, as I see students living and integrating the technology so easily into their lives. Some of them live by text-messaging. I don't at all.

(sic)I think technology is finding can be useful tool. Especially when used creatively it can enhance lessons in student excitement/enjoyment of lessons; however, I also think that it's completely expendable. Piano teachers functioned well without it for the last 100 years and I think we can continue to function well without it for the next 100 years. In my mind, it is an option, not a necessity.

I think the term "music technology" is too broad for many of the questions... certain aspects of music technology are more useful than others, making a straightforward answer to some questions difficult. For example, I would like to use music notation software (I do plan to use it a lot starting next fall); CD-ROM programs and certain web sites are great for teaching kids certain concepts in theory and history; likewise, recording technology such as ProTools is fantastic for many uses. But I can't think of any reason to use MIDI keyboards in any setting except as entertainment and in college class piano. They are not the same musical instruments as an acoustic piano, and should not be treated as an alternative. For class piano instruction, they are valuable simply because you can use headphones. Otherwise, I think they are inferior instruments for learning piano skills, and should not be promoted as an equally good instrument for pedagogical purposes.

Technology is fine for those who really can integrate it seamlessly into the piano lesson. On the other hand, it is not a MUST for a good piano teacher. I pick and choose bits and pieces of technology here and there to augment my teaching, but I don't feel the need to get on the bandwagon and use technology for everything I do.

We are a small school, with piano pedagogy taught irregularly, and a paucity of digital equipment at our disposal. At present I would consider using digital/computer equipment to enhance the private piano lesson, but not as a primary mode of instruction. By contrast, virtually all of our secondary piano needs are met this way, though there is much more that we can, and should do, given more resources.

Unfortunately, our piano pedagogy courses for undergraduates were canceled about six or seven years ago: before that, I taught them regularly, making some use of technology. My answers conform to my current use of technology professionally and in private lessons (only, at the moment) and the occasional chamber music coaching (perhaps because of my "Sounds of a Century" recital series of a few years ago-10 recitals, a one for each decade of the 20th century-I am known as the New Music Guy). I have never taught class piano, and have no interest in it (an area where such technologies are very useful, I believe). I also used to teach the New Music Ensemble, where we made much more frequent use of keyboards of the day (outdated today, of course: this would be 10 or more years ago).

Although I use technology in relation to composition, electronic music, and keyboard skills training, I do not use it in private instruction, since I don't believe that an intermediate or advanced student can benefit from it. The acoustic piano is far superior in its nuances, and quite different in the response of body movement and sound production. I have not ruled out research in measuring performance parameters such as timing, balance, voicing, etc. via MIDI pianos, but have not had time or opportunity to investigate this yet.

The web address you sent for the survey was too complicated! While I encourage the use of technology and use it every day, I spend much more time in pedagogy classes teaching method. I introduce students to technology available but don't demand they corporate it. Young people these days are advanced technologically. They can choose to use it when teaching or not.

The survey was a little difficult to understand (especially the last section), so I'm not sure I gave you what you are looking for... but wish you the best. Any hesitancy I have about the use of digital technology relates to the current "state-of-the-art" of available technology (is it appropriate to the current need?) rather than a bias against technology per se.

I have come into teaching at a very exciting time and some of my teachers are already using digital technology and are raving about the results. I need to get on board, and if I were not practicing so much, I'd be jumping into this. Our school is small and we are just developing "smart classrooms" with computer/projector/Internet capabilities in most classrooms for professors. I will definitely be using more PowerPoint presentations in the next couple of years. I am hoping that my college will help train has more on these wonderful resources. Thanks for putting this survey online. I have no idea where you're hard copy is *searching through my desk*.

In reference to PowerPoint presentations and creating a web page-I hope to accomplish both of these in the next year. Of my keyboard faculty, (name omitted) has been the most successful in using technology in very creative ways in his teaching. For example, students in his literature course were required to create a web page for a selected composer. A very valuable project.

I am a fan of technology, while the same time recognizing that it is an easy trap to fall into. I grow weary of the next "great thing" which is touted to solve all our problems, and then turns out to be just another complication. I use new technologies cautiously, and only those which I think I will be able to incorporate seamlessly and consistently into my teaching. Sometimes, I feel there is no substitute for good old-fashioned chalk, an eracer, paper, and pencil.

Can't wait to see the results. Thanks for your effort. All the best.

I hope your survey accumulates the data to show the music tech industry that THEY must aggressively court and train pedagogy and piano teachers. And that the costs of these instruments and applications MUST come down if they are to be viable options or "add-ons" for the average piano student.

I love using technology in my classes. My limitations often come from a lack of resources and time to adequately prepare. Thank you for allowing me to participate.

I believe that technology is a support issue. Piano training should ALWAYS be done on an acoustic instrument. The only exception would be for occasional use in giving the student a visual of voicing (key velocity) or of rhythm integrity.

Technology has the danger of training pianists and students solely to be technicians. Technology in that aspect has a positive uses, but I feel it ought not to be THE teacher of music. Music is artistry, and as such requires personal expression and nuance not found in any software or hardware: computer programs are mathematical, keyboards have prerecorded sounds. Teaching someone to play piano is one thing; teaching someone to move an audience is quite another.

I hope that I have not misunderstood column "D" in the above questions. I understood the directions to mean that you are asking what my own training needs are. Bus, it into things that I already use and know well, I do not need additional training. This, of course, is very different from what I perceive to be as the importance for training a student in these areas.

Keyboards, MIDI, and support software are great tools for group lessons, whether they be college students or young beginners. I am not sure you address this in your survey, per se, but I am wary of teachers who have adopted a "long-distance" teaching for some students. Through the use of the computer and video recorders, they are teaching students over a video feed. This allows them no one-on-one contact to adjust hand position, technique, etc. and takes away from the human contact of the lesson. Technology is great, but it cannot be a substitute for a live teacher who can correct, encourage, and inspire.

I love anything to do with technology, as it enhances my INTEREST as much as my knowledge.*Blackboard* has greatly helped communication between me and my GA's, as well as between teacher/students.

I am very supportive of the use of technology and would like to increase my knowledge and use. The current challenge is finding enough adequate training and practice to use it effectively and with ease in teaching settings.

While I believe that technology cannot replace time spent practicing at an acoustic instrument, it has much to offer in the way of enhancing student learning and participation. I welcome any new ideas for integration into the pedagogy curriculum.

With undergraduate students, they need SO much help in basic teaching issues that I'm not sure the time spent on technology can be supported. I do a survey of ways to use technology but that seems sufficient. Most students are rather technology savvy but need a LOT of help learning how to introduce a piece to a seven-year-old.

I would love to be able to do more with technology, and I've tried learning *Finale* and *Sibelius*, but the big issue for me is not having time to spend with the software (and with a tutor when I need one) to gain fluency. I do a lot with the e-mail, *word*, some *Excel*, etc., but not much with music software and have not learned *PowerPoint*. (I have trouble just burning CDs on my computer!)

I think the use of these things and the teaching of how to use them is valuable. I, myself, need some training and teaching in that area. It seems to take an incredible amount of time that I'd just don't have right now, but I would someday like to be more educated about using these things in the classroom and teaching them to students because so much of the music industry is headed in that direction.

As teaching aids I value the use of the types of technology you asked about. But I am still resistant to digital instruments replacing acoustic ones for performance because I think it somehow disconnects the player from the sound.

I have taught in situations that have not allowed me the time to explore the use of digital technology as much as I would like. But it is also an issue. I fully support the use of digital technology in the teaching environment

Music technology for teaching piano is expensive and quickly out of date. Not worth investing in for my college students.

I find that regular use of technology in the teaching studio is motivating for the students and enhances pedagogical efficiency. However, I do not believe that it is necessary to use technology to be a successful piano teacher. Staying on top of current technology can be cost prohibitive for piano teachers. Therefore, while I do include some technology-based instruction and assignments in my pedagogy class, I emphasize principles of good pedagogy, problem-solving ability, and development multiple modes of delivery rather than focusing on whatever technological trend happens could be at the four at any given time.

I like using digital technology to enhance offerings in classes and lessons, but more often than not improvise accompaniments to student scales and repertoire and assignments, which allows me to be more flexible and musical. In pedagogy classes, I try to teach my students how to improvise and use a piano as a tool that can organize, run, and pace a class. I do encourage students to practice using supplementary accompaniments, but less commonly.

I find technology very useful but with all the many responsibilities I already have at my university I find it impossible to truly span the time needed to understand and use these materials effectively. For the most part I'd tell younger students that the materials exist, they are the teaching materials of the present and future and they should go on to learn to use them.

I believe that teachers must use every means available to teach students in a manner that is meaningful to them. While the use of technology may not be important or relevant to us as teachers, it is the "only way" for modern students. Teaching music/piano with the tools technology provides means reaching the next generation of musicians. It also means keeping our art alive and a meaningful part of current culture.

Many of the state and local music teacher associations have graying membership. Highest percentages of members are those who did not learned to use computers and music technology as part of their college music study. College faculty typically have access to equipment and get the impetus to learn how to use music technology from their schools and from professional organizations such as MTNA and CMS.

I find opportunities for using music technology overwhelming for the amount of time I had to develop new materials for my lessons and courses. Trying to keep up with it is difficult, and I always feel "behind the curve.” I do not enjoy performances on the digital instruments we have, but I do enjoy their benefits in class piano instruction. Best wishes with your survey!

Congratulations, Tom! I maintain that technology remains a powerful and intelligent tool with many efficacious applications in both performance and pedagogy. In itself, technology remains neutral and is, therefore, not a prerequisite for good pedagogy. It remains possible to be an effective music teacher with little or no use of technology. My question, though, is why would anyone want to do that?

Technology is here to stay, and musicians live in the real world. Technology is certainly one of many tools that can be used to enhance the study of music, and the future teachers will be impacted even more so than veteran teachers. However, I do feel that students must still look at technology as a tool to help them become artists themselves. We cannot rely on machines to do our artistic work for us.

Here at U.T., we are fortunate to have (omit name) who is an expert in group pedagogy and technology. It allows me to concentrate on the issues of technique, Ton production, pedaling, repertoire, styles and interpretation. If I taught group piano, I would use technology constantly. As it is, I use videotaping a lot to help my students with both teaching and performing.

Looks like a very interesting study and I'll be anxious to read your results. I am currently working on preparing a study regarding the outcomes of technology use in the music profession, especially those related to group piano. So this will be an interesting resource for me. Thank you for your work and good luck.