Factors Affecting Faculty Adoption and Sustained Use of Instructional Technology in Traditional Classrooms

Comprehensive Qualifying Exam
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Heidi Grunwald
Doctoral Student
University of Michigan
Center for the Study of Higher and Postsecondary Education
610 E. University 2101 SEB
734.615.3349

Fall 2002 CQE Chair: Dr. Richard Alfred
Fall 2002 CQE Reader: Dr. Stephen DesJardins
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Introduction

Unlike even five years ago, today’s college students come to college equipped with cell phones, personal data assistants (PDAs), laptops, MP3 players, digital cameras and personal web-pages. The terms ‘Generation D’ and ‘Millennium Gap’ describe the difference between the students entering college today and those entering before the year 2000. These students have spent their lives surrounded by robust, virtual reality games and unlike those who were raised with passive broadcast media such as radio and television, they expect interaction and expect to see faculty integrating technology into their college classrooms (Duderstadt, 1998). Many college students' computer knowledge transcend that of their professors (Tapscott, 1997) and they arrive on campuses ready to engage information in new ways, only to be taught by faculty who are reluctant to alter their "chalk and talk" pedagogy.

Critics conclude that in order to survive as institutions, universities and colleges must incorporate technology into instruction (Albright, 1999; Duderstadt, 1998; Rogers, 2000). Blustain, Goldstein & Lozier (2001) note the array of forces --new delivery technologies, changes in demographics, the emergence of the corporate university, and the complex global economy-- that are creating a new competitive landscape for higher education. O'Donoghue, Singh, & Dorward (2001) add that if the traditional university is to survive in this new environment, it will have to match the multimedia sophistication and global educational networking of its competitors. Results from the 11th National Survey of Computing and Information Technology in American Higher Education, found that the single most important information technology issue for institutions over the next two-three years to aid in this survival, was ‘assisting faculty efforts to integrate information technology into instruction’ (Greene, 2001, p. 4). While the results show some differences by institutional type and control, the overall pattern is consistent across all sectors.

Institutions appear to be engaged in a teaching reform whereby the learning process is student centered. A rationale frequently cited in the literature for the diffusion of instructional technology is
that it can be used to engage students in new ways, taking the faculty role from “sage on the stage” to “guide on the side” (King, 1993). Albright (1999) outlined a set of learner-centered outcomes facilitated by instructional technology: promote inquiry, creativity and enable revision and improvement, provide greatly expanded access to information, enable students to obtain, literally, up-to-the minute information, expand course discussion beyond the classroom, and enable participation by experts and resources anywhere in the world, customize learning experiences, promote real-world learning, and promote learning of scholarly research tools to facilitate course outreach. Greene & Gilbert (1995) posit that instructional technology can move student learning from: reception to engagement, classroom to real-world, text to multiple representations, coverage to master, isolation to interconnectedness, product to process, and mechanics to understanding. Furthermore, recent surveys of faculty at higher education institutions rate instructional technology essential to instruction as very important or critically important (Beggs, 2000; Grove & Zemel, 2000; Spotts & Bowman, 1995).

The national call for faculty adoption of technology in the classroom has spurred traditional campuses to examine whether and to what extent faculty are using instructional technology. Faculty and others are calling for more empirical research on the successes and failures of instructional technology with research methodologies that acknowledge the complexities of the endeavor. For this to be possible, faculty must be using instructional technology in their classrooms. A study done by Market Data Retrieval (http://www.schooldata.com/pr18.html, 1999), reported that only one-third of new teachers reported that their college experiences left them “very well prepared” or “well prepared” to integrate technology into classroom instruction.

National technology competencies for students are being discussed by the U.S. Department of Education (Thomas & Knezek, 1999) and school districts throughout the country believe technology literacy is a critical factor in preparing students to succeed in the 21st century (Prime, 1998). Furthermore, the CEO forum, a think tank comprised of twenty businessmen and education leaders based in Washington, D.C. is recommending to the National Council for Accreditation of Teacher
Education (NCATE) that computer technology become a mandatory component of Teacher Education licensure by 2002. How does this affect higher education? Faculty members are the role models for prospective K-12 teachers and can have a significant impact on teachers’ use of instructional technology in their future classroom (Parker, 1997). This affects a larger community than Schools of Education because secondary teachers come from all disciplines. As of Fall1998, forty percent of the country’s colleges and universities had some sort of computer literacy requirement (Green, 1999).

This paper does not attempt to assess the validity of the research evaluating the impact of instructional technology on student learning, nor to make the argument that instructional technology will match the teaching strategies and learning outcomes set forth by all faculty. Enough evidence exists that instructional technology has tremendous potential benefits for faculty who carefully design and integrate it into their classroom. Therefore, for the purposes of this comprehensive qualifying exam, it is assumed that faculty adoption and sustained use of instructional technology is the desired outcome for colleges and universities. With that said, this topic has policy implications, (as shown by the PITAC 2001 report and the 11th National Survey of Information Technology and Computing in American Higher Education), for all stakeholders preparing students to live and work in the complex global information economy.

The immediate challenge for higher education institutions is to understand the factors that influence faculty adoption and sustained use of instructional technology. This understanding will better equip institutions to establish support structures enabling faculty to adopt and use instructional technology. An extant body of empirical research illustrates positive impacts on student learning outcomes when instructional technology is employed (Albright, 1999; Biao & Sivin-Kachala, 1996; Birman, 1997; Dwyer, 1994).

To understand the process through which faculty choose to adopt and use instructional technology, I have completed a critical analysis of the question: What factors affect faculty adoption and sustained use of instructional technology? The definition of instructional technology has changed
often and appeared in many different forms, both media specific and omnibus in nature (Saettler, 1990). Saettler (1968) reminds us that any definition of instructional technology must be subject to the concept held by the definer and involves consideration of time and media. For this review, instructional technology is defined as the use of devices and materials, in particular: email, spreadsheets, simulation software, the world wide web, statistical computing, presentation software, multimedia software (defined as computer-mediated integration of text, audio, or video, (Albright, 1999)), course-hosting software, or computer conferencing and bulletin boards, to achieve instructional objectives (Spotts & Bowman, 1995).

Massy & Wilger (1998) point out that faculty adoption of instructional technology occurs in three dimensions: the first, faculty adoption of instructional technology for personal productivity aids, allowing faculty and students to perform tasks faster and more efficiently; the second, ‘enrichment add-ins’, such as web pages, list-servs, video and multimedia presentations which do not change the basic mode of instruction; and finally, a paradigm shift where faculty reconfigure their teaching and learning activities to take full advantage of the technology. Doing so would result in a blend of the human and the technology, each doing what they do best, with new and improved learning objectives in mind. It is a difficult task to define instructional technology, but it is even more difficult to determine exactly what and with what intensity constitutes adoption and sustained use of instructional technology. Hall (1978) reminds us that defining the exact innovation and describing the intended level of use is imperative in measuring such a process. For the purposes of this review, I examined all literature that mentioned adoption and use of at least one of these present day technologies available to faculty. I did not include the instructional technology required to teach courses that are taught completely online (i.e. distance learning). Thus, this study focuses on faculty who adopt and use instructional technology in traditional classrooms.

I have treated instructional technology adoption and sustained use as a process whereby faculty decide whether to adopt instructional technology and then, depending upon a number of factors,
decide to use instructional technology and emerge on a continuum involving varying degrees; from no use at all to sustained use. The implications are different for each construct. Because it is impossible to have use or sustained use without an initial attempt to adopt, I treat these two events as co-related factors. I employed a commonly used construct in the innovation acceptance literature to define sustained use as current usage or faculty intentions to continue such use in the future.

To facilitate my review of factors affecting faculty adoption and sustained use of instructional technology, I synthesized and critically analyzed research and theory from two large cross-disciplinary bodies of literature that I identified *a priori*, that I believed contributed to understanding this process. These bodies of literature included innovation adoption (diffusion) theory and specific adoption of instructional technology and sustained use (utilization/acceptance) of instructional technology. I also examined all alternative models outside these two bodies of literature that relate to adoption and/or sustained use of instructional technology.

This exam is broken down into six sections. The first section includes the historical roots of instructional technology, particularly how does the push for integrating instructional technology into the classroom compare and contrast with the histories of previous educational innovations such as film, radio and television?

The second section includes a critical analysis of the innovation adoption theories, their historical roots and their relevance to higher education. Many of the models in this extant body of literature that describes adoption of instructional technology are based on Rogers’ (1995) innovation diffusion theories. Because this was the most commonly cited model, I used his theories as the basis to inform the construct “adoption of instructional technology”. The innovation diffusion theories are vast, encompassing both individual and organizational units of analyses. At the present time, the decision for faculty to adopt instructional technology remains a personal one and the literature indicates that teaching is typically a private enterprise for most faculty (Blau, 1973). Tornatsky et al. (1983) posited that using organizations as the unit of analysis is difficult because only rarely are entire organizations
involved. Ultimately, adoption is completed at the individual level and individuals will be at varying stages of the adoption process (Rogers, 1995). Therefore, I have focused this review exclusively on models of innovation diffusion that have the individual as the unit of analysis. To conclude the second section, I reviewed alternative models to adoption outside of the innovation diffusion literature.

The third section includes a critical analysis of the recent theories on information technology acceptance and utilization. I have done a comprehensive literature search on sustained use to identify all related constructs and examined how they are used in models describing sustained use of instructional technology. Sustained use appears in the literature through related constructs (technology acceptance and utilization) in the Management Information Systems (MIS) literature.

Two well-known models of technology use both developed in the MIS field, Technology Acceptance Model (TAM) and the Task-Technology Fit model (TTF), are specific adaptations of the more general Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB). As such, these theories will be used to describe the process of sustained use in the proposed conceptual framework for faculty adoption and sustained use of instructional technology. I will offer a detailed analysis of their historical roots in behavioral psychology, their role in describing the phenomenon of instructional technology use and their relevance to higher education.

The fourth section includes a discussion of the reviewed literature and a proposed conceptual framework for faculty adoption and sustained use of instructional technology. The fifth section explores implications for future research from the proposed conceptual framework and the sixth section is the conclusion.

As a general outline, I composed an overarching research question and several sub-questions that helped guide me through the process.

*Overarching Research Question:* What factors affect faculty adoption and sustained use of instructional technology in traditional classrooms?

*Sub-questions:*
1. What are the historical and current forces that make the adoption and sustained use of instructional technology compelling and of interest to all stakeholders?

2. What are the key factors identified by the innovation adoption and adoption of instructional technology literature that help explain faculty’s initial attempt to adopt?

3. What are the key factors identified by the sustained use (technology acceptance and utilization) literature that describe faculty’s sustained use of instructional technology? How are these factors the same or different from those in adoption and innovation?

4. What are the key factors identified by alternative models that relate to both adoption and sustained use that help predict adoption and sustained use of instructional technology? How do these factors help fill gaps in the earlier identified literature? What are the strengths and weaknesses of these theories?

5. What factors would be included in an integrated conceptual framework to describe faculty adoption and sustained use of instructional technology in traditional classrooms?

6. What are the implications for future research from the framework?

Section I: Historical Origins of Instructional Technology and its Relevance to Higher Education

Definition of Instructional Technology

There have been and will be many definitions of instructional technology. Saettler, (1968) defined instructional technology in two different ways: the first, the physical science concept of instructional technology which included ‘the application of physical science and engineering technology, such as motion picture projectors, tape recorders, television, and teaching machines for group presentations of instructional materials’ (p.2) and the second, set in a behavioral science paradigm, ‘instructional technology is viewed as the approach to the problems of learning and instruction’ (p.5).

In 1970, in a report by The Commission on Instructional Technology to the President and Congress of the United States, instructional technology was defined as ‘a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives,
based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction.’ (p.19). And in 1972, David Engler, a scholar who studied the meanings of instructional technology echoed Saettler’s definition with instructional technology as 1. hardware—television, motion pictures, audiotapes, and discs, textbooks, blackboards, and so on and 2. the process by which we apply the research findings of the behavioral sciences to the problems of instruction. Similar to Saettler’s definition, Engler’s first definition is limited by the date and technologies that he named. The second definition is a more general definition and is complementary to that of Saettler’s behavioral science paradigm.

In 1973, Armsey & Dahl defined instructional technology as made up of ‘the things of learning, the devices and materials which are used in the processes of learning and teaching’ (p. vii). In an attempt to capture the relevant pieces of the historical definitions and to include a modern day context so that this comprehensive review was manageable, I defined instructional technology as the use of devices and materials, in particular: email, spreadsheets, simulation software, the world wide web, statistical computing, presentation software, multimedia software (defined as computer-mediated integration of text, audio, or video, (Albright, 1999)), course-hosting software, or computer conferencing and bulletin boards, to aid instruction of students.

Why is instructional technology important and why is it relevant for higher education today? Tickton, (1971), summarized the report by the Commission on Instructional Technology written in 1970 that stated the purpose of instructional technology was ‘to make education more productive and more individual, to give instruction a more scientific base and to make instruction more powerful, learning more immediate, and access more equal’ (p. 32). Today, in the year 2002, no scholar would argue that the purpose of instructional technology is anything different than what was outlined by the Commission in 1972. The modern day technologies, both hardware and software, have made education more productive, individual, powerful and immediate. Furthermore, although not addressed in this review, instructional technologies associated with distance education and those involved are attempting
to address equal access of higher education. Scholars who have studied the history of instructional technology and the rise of the personal computer and the world-wide-web, believe strongly that instructional technology can and will enhance teaching and student learning (Allbright, 1999; Greene & Gilbert, 1995; King, 1993).

**Brief History of Instructional Technology from 1900 to present**

Although the earliest instructional technologists were probably the Elder Sophists in Athens (ca. 500-410 B.C.), this timeline of the history of instructional technology focuses on the major educational innovations and their diffusion throughout the United States from 1900 to present. Included is a historical analysis of the lessons learned from these educational innovations and how these lessons inform what we do with instructional technology in the future in higher education.

Instructional technologies that were considered innovations in the past include educational film, radio, television, and the computer. The beginnings of educational film appeared in 1902 when Charles Urban of London made some of the first educational films: films with slow motion, microscopic and undersea views. In 1904, the Marey Institute in Paris produced films of the flight of insects and the locomotion of animals in water and the first ever outstanding educational filming occurred on Paul J. Rainey’s 1911 hunting expedition and was titled the *African Hunt Pictures* (Saettler, 1990).

By 1910, there was a catalogue titled Catalogue of Educational Motion Pictures, that contained 330 pages and listed 1,065 film titles, classified under 30 different topics that could be rented by schools. Thomas Edison was one of the first to produce film for classroom showing in the United States. In 1911 he filmed a series of historical films on the American Revolution. His enthusiasm for film took off in 1913 when he was quoted as saying ‘Books will soon be obsolete in the schools. Scholars will soon be instructed through the eye. It is possible to teach every branch of human knowledge with the motion picture. Our school system will be completely changed in ten years.’ (Saettler, 1990, p. 98). Soon there were many commercial ventures into educational film. An Eastman Kodak Company named Eastman Teaching Pictures, Inc. formed in 1928 and in the 1930's black
window shades, silver screens and the 16mm projector lent an aura of innovation to classrooms. The
depression of the thirties, the deaths of George Eastman and the ETP president brought an abrupt halt
to Eastman Teaching Pictures. In 1944, the company gave the University of Chicago its entire stock of
negatives (Cuban, 1986; Saettler, 1990).

Because of cost, limited access and unreliable projectors, teachers seldom used the films.
Empirical results in the form of experimental designs produced results stating that films motivated
students to learn. Ironically, as the research findings were being disseminated, the commercial
educational film enterprise was in a crisis. No corporation could be established that produced
acceptable educational films that could also show a profit, the use of film in the classroom virtually
disappeared. Other reasons for film’s failure to catch on remained: teacher’s lack of skills with
equipment, costs of film and equipment, upkeep, inaccessibility to equipment and films, and finding
and fitting the right film to the class (Cuban, 1986). Film continued to be used in the classroom but
never replaced textbooks and blackboards and never became a major innovation in the educational K-
12 classroom.

Early college and university film production began in 1910. In 1921, Yale University published
the Chronicle’s of American Photoplays, and in 1932, the University of Minnesota established a General
College Program that included a Visual Education Service that organized, collected and classified and
produced educational films. In the postwar era, colleges and universities continued to produce film,
particularly at the University of Chicago with donations by Encyclopedia Britannica and the Carnegie
Foundation for the Advancement of Teaching (Saettler, 1990). Educational film provided an impetus
for instructional technology, but never experienced widespread use in the classroom.

The educational innovation that followed was the use of radio as an educational tool. Radio
broadcasting in schools began in the mid-1920’s and the growth of educational radio occurred primarily
from 1925-1935 (Cuban, 1986; Saettler, 1990). During this period, formal courses in radio education
were established at colleges and universities and the U.S. Office of Education organized a radio section to meet the growing needs of the use of radio for educational purposes (Saettler, 1990).

Benjamin Darrow, founder and first director of the Ohio School of the Air, wrote frequently about the magic of radio. In his book, *Radio: The Assistant Teacher*, he proclaimed the aim of educational radio was to bring the world to the classroom. Much like Thomas Edison’s enthusiasm for educational film, Darrow was a tireless promoter of radio in the classroom. In 1945, W. Levenson, Darrow’s successor, wrote ‘the time may come when a portable radio receiver will be as common in the classroom as is the blackboard (Cuban, 1986, p. 19).

The case-study of the Ohio School of Air was the largest of its kind. In 1928, B.H. Darrow received funding from the Payne Fund and negotiated free broadcasting from a station in Cincinnati. After a long and arduous road through curriculum design, the Ohio School of Air emerged with a weekly air schedule that included stories for young, intermediate and upper grades, current events, history, dramatization for literature classes, geography, and lessons in music. From 1929-1931, the Ohio School of Air was considered a success story, but in 1931, the Ohio legislature reduced its funding and in 1937 the legislative funds disappeared. Despite its closure, the Ohio School of Air provided a model, and much like educational film, an impetus for similar educational innovations. It had demonstrated that radio could be an effective type of instructional technology and they had managed to produce a wealth of research concerning radio instruction (Cuban, 1986).

Wisconsin, Kansas, Michigan, and Minnesota’s institutions of higher education set up their own stations and established ‘schools of the air’, however many of these attempts were unsuccessful because the faculty did not realize that radio technique was not easy to master and not the same as giving a lecture (Saettler, 1990).

In 1927 a Preliminary Committee on Educational Broadcasting was set up to 1. clarify objectives 2. exchange relevant information between states and 3. fortify and ensure the progress of instructional radio. In 1929, an Advisory Committee on Education by Radio was formed and
recommended that the Office of Education devote a section to educational radio with funds financed through the Office of Education. Radio took another hit, however, when Herbert Hoover did not support the proposals that were advanced by the Advisory Committee. The history of educational broadcasting continued on this path for the next twenty years, until in the 1940’s it had all but vanished (Saettler, 1990). In 1943 a national survey found that radio was wide-spread in homes but why it remained a stepchild of education included such reasons as: corporate control over the airways, equipment availability and length of broadcasts, no radio receiving equipment, school schedule difficulties, lack of information, poor radio reception, and uninterested teachers. By the 1980’s publications and research relating to instructional radio had vanished. There were no course offerings by radio, commercial radio networks had closed their doors to educational broadcasting and the national level committees within the U.S. Office of Education had disappeared.

The newest educational innovation was fast becoming instructional television (Saettler, 1990; Cuban, 1986). The proponents of instructional television learned very quickly from decades of educational radio that the main obstacle to wide expansion was going to be securing television stations explicitly for educational purposes. In 1949, the FCC presented a group of assignments providing for 2,245 stations in 1,400 communities but no reservation of any channels exclusively for educational purposes. One lonely FCC commissioner dissented suggesting the FCC reserve channels for educational television.

This lonely Commissioner, Frieda Hennock, organized a meeting at her home in 1950 that proved to be a landmark in educational broadcasting because it marked the beginning of the Joint Committee on Educational Television. The JCTE was later authorized to make a presentation to the FCC on behalf of the Association of Land-grant Colleges, the Association of State University Presidents, the National Association of State Universities, and the National Council of Chief State School Officers. The FCC hearing took place in November 1950 wit sixty-one people including educators, public officials, university presidents, deans, professors, state and city superintendents and
others interested in education giving testimonies. Finally, in April of 1952, the FCC reserved 242 television stations for educational use and the first educational television stations began to open in 1953.

KUHT, a station jointly operated by the University of Houston and the Houston Board of Education became the first noncommercial station. KTHE, from the University of Southern California, went on the air in 1953 and by the mid 1950’s sixteen channels had been activated. Early days of educational broadcasting faced staff shortages, small budgets and programming only during the week. During the time that educational broadcasting was taking a foot-hold, instructional television emerged. The difference between educational broadcasting and instructional television was that educational television referred to any type of programming that was presented for a serious purpose, whether to teach someone or to develop a broad cultural understanding. Instructional television referred to open or closed circuit video programs designed to teach a specific subject matter as part of a formal course of study to students either at home or at school.

NBC’s Continental Classroom included televised courses offered for credit by various higher education institutions. The St. Louis schools, in a partnership with the Fund for the Advancement of Education, offered courses exclusively over television. Students received instruction in groups of up to 150 for ninth-grade grammar and English composition. In Pittsburgh, PA grade school and high school students viewed telecasts from a group of outstanding teachers (Saettler, 1990). Many experiments began to follow at the K-12 level.

Passage of the National Defense Education Act in 1958 put more money into classroom television. In 1962, President Kennedy secured $32 million from Congress for educational television. By 1971 over $100 million had been spent from public and private sectors. The greatest single benefactor to instructional television was the Ford Foundation, spending $300 million during the national instructional television movement. During the early 1970’s a media use study was conducted (Saettler 1990). Dirr & Pedone found that 72% of teachers had instructional television available to
them, but only 59% used it at all and only 46% used at least one series regularly. There were no studies cited on the use of instructional television in higher education except for the large distance learning initiative that was funded by the Ford Foundation to help Adult Learners return to school. Although the instructional television movement didn’t last long (1950-1970), it did become the impetus for the Public Broadcasting Act of 1967, which established the Public Broadcasting Service (PBS) and National Public Radio (NPR).

Reasons cited by Cuban (1986) for the downward spiral of instructional television include: inadequate or obsolete equipment, limited availability of the signal, awkward scheduling, and amateurish programming. The advent of satellite and more advanced telecommunication media brought instructional television back on the screen in the 1990’s for distance education programs in colleges and universities, however, the advent and pace of computer technologies has put instructional television on the backburner. Cuban (1986) and Saettler (1990) posit that it is possible instructional television will fall into general disuse.

Computers emerged on the educational scene with CAI (computer aided instruction) in the 1960’s. Large-scale IBM computers were used to develop drill and practice and tutorial type instructional ware. Universities projects included the University of Texas, Florida State University, University of Wisconsin, Harvard, University of California at Santa Barbara, Dartmouth, MIT and the University of Pittsburgh. The software programs were to present increasingly difficult material and provide reinforcement for correct responses. Despite the fast rise and decline of CAI, in 1971, the National Science Foundation gave a $10 million grant to two private companies to develop a national CAI system. By the 1970’s it was clear that CAI had not succeeded and had all but vanished. Reasons cited for CAI’s failure included BASIC’s complex, non-intuitive language, the lack of quality software, lack of teacher skills with the technology, and cost. In 1977, the advent of the microcomputer simplified CAI, but the shift from behaviorist to cognitive psychology and learning strategy theories shifted the emphasis in the classroom from acquiring discrete bodies of knowledge to problem-solving
and critical thinking skills (Saettler, 1990). By the end the 1980’s simple CAI was all but extinct, but increasingly complicated learning software of a new type was beginning to emerge on the educational scene.

From the late 1970’s to the early 1990’s the number of personal computers at home and in classrooms grew exponentially until present where there is one on almost every desktop in every school, college and university. In higher education, the personal computer helped faculty to increase productivity and reduce operating costs. Faculty members were soon able to prepare their own class materials, course syllabi, conference papers, grant proposals, manuscripts, and other documents. Midway through the 1990’s, the computer made a revolutionary shift from being a ‘desktop tool’ to a ‘communications gateway’ to colleagues and content (Green & Gilbert, 1995). The advent of the world-wide-web changed the nature of the way computers were used in education forever. The ways in which faculty were able to use it to improve teaching and learning had just begun to emerge.

Past history has shown that before one technology can be fully exploited for its maximum gains, another technology appears. As a new technology appears, it is often superimposed on the educational system implying that the existing problems can be cured by this new technology or that what exists now is inadequate. The result has been low faculty buy-in and marginal benefits to the students. The history of instructional technology documents how difficult it is to affect the adoption and use of the new technologies (Cuban, 1968; Saettler, 1990). Some of the prevailing explanations refer to insufficient funds, lack of adequate time, poor teacher preparation and persistent resistance to change by the teachers. Although all of these factors may still be relevant today, this review of the literature aims to identify the factors that affect faculty adoption and sustained use of instructional technology in traditional classrooms and the models that exist to describe the process.
Section II: Literature Review of Innovation Diffusion/Adoption Theories

Instructional technology has always been labeled an educational innovation (Cuban, 1986; Rogers, 1995; Saettler, 1990) and research on the topic has been closely connected to the study of innovation diffusion. The seminal theory of innovation diffusion originated from mass communication research in the early 1970’s. Rogers and Shoemaker (1971) developed a model that is cited more often than any other in the innovation diffusion research and is considered the most complete assessment of innovation adoption. This theory lays the foundation for the majority of the studies on adoption of instructional technology that follow, particularly in higher education (Mahajan, 1985; Mitra, LaFrance & McCullough 2001; Surry & Farquhar, 2002). Rogers, (1962, 1983, 1995) refined the model that he and Shoemaker originally conceived and created a comprehensive review in his 1995 book *Innovation Diffusion*. For the remainder of this review I will refer only to Rogers (1995), giving a detailed review his theory before I begin to analyze and critique the research.

This section of the review will include a brief historical background of diffusion research, a comprehensive overview of Rogers’ model, an interpretation of how that model best applies to faculty adoption and use of instructional technology and a critical look at the model’s strengths and weaknesses. I also review the empirical studies that have been conducted using his model as a framework, review alternative models and identify gaps in the research.

*History of Innovation Diffusion Research*

Although the history of diffusion research originated in Europe and dates back to the turn of the 20th century, the emergence of diffusion research as a collective field occurred in the early 1960’s. Anthropologists picked up on the European diffusion tradition in the 1920’s and became the earliest field to explore diffusion of innovations. By the 1960’s, sociologists, educators, public health officials, communication scholars, marketing and management scholars, geographers and econometricians were all involved in innovation diffusion theory. Rogers’ original intentions were to make diffusion of innovation research a *research tradition* and to break down barriers between the scholars working across
disciplines on the topic. He reported that by the mid 1960’s, a trend toward a more cross-disciplinary viewpoint in the tradition existed and that scholars across disciplines were aware of the parallel methodologies. Unified models started to emerge and Rogers in a meta-analysis, constructed a comprehensive model of the diffusion process.

Today, most all behavioral science disciplines have some interest in the diffusion of innovations. In 1994 there were over 3,800 diffusion publications and the body of literature spans nearly two-dozen academic disciplines (Mahajan & Peterson, 1985). Today, diffusion research is incorporated into textbooks in such fields as social psychology, communication, public relations, advertising, marketing, rural sociology, anthropology, and education. Furthermore, both practitioners and theoreticians consider innovation diffusion as a unique and useful field of social science knowledge.

It is important to note here that there are three distinct types of empirical research related to innovation diffusion theory. The first is process research, which focuses on the stages in the innovation diffusion process and it is longitudinal in nature. This type of research appears in the early literature and is qualitative in nature. As the computing power increased throughout the 1970’s and 1980’s, research efforts turned to the second type, variance-research, which focuses on predicting the factors that affect adoption and is cross-sectional in nature. The third type of diffusion research predicts the rate of adoption. This field of research includes mathematical functions such as the cumulative normal, Gompertz or logistic distribution to model the cumulative number of adopters over time. These models facilitate theoretical explanations of the diffusion process and can lend the ability to forecast diffusion given certain characteristics (Mahajan & Peterson, 1985). The mathematical diffusion models are limited by: discrete binary outcomes, fixed number of potential adopters, fixed geographical boundaries of the diffusion and the innovation itself cannot change over time. These limitations make these models less ideal for diffusion research conducted in the Social Science where almost none of these assumptions hold true and thus these models are not explored further.
Rogers’ Model of Innovation Diffusion

According to Rogers (1995), ‘Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system.’ (p.5). Communication is a process where subjects share information with each other in order to reach a mutual understanding (Rogers, 1995). In Rogers’ model, diffusion is a special type of communication, in which the messages that are shared are about the new idea or the innovation.

An innovation is defined as ‘an idea, practice or object that is perceived as new by an individual or other unit of adoption.’ (Rogers, 1995, p. 11). It is the perceived newness of an idea for an individual that determines whether an innovation is an innovation, even if the individual is part of the late majority or laggards. Innovation diffusion scholars have focused on three main research questions: 1) how do early adopters differ from late adopters 2) how the characteristics of an innovation affect its rate of adoption and 3) why the S-shaped diffusion curve increases rapidly at approximately 10-25% adoption? Often times, it is difficult for the researcher to define the innovation. This paper will define the innovation as the cluster of instructional technologies available to faculty to use in the traditional classroom including: email, spreadsheets, simulation software, the world wide web, statistical computing, presentation software, multimedia software, course-hosting software, or computer conferencing and bulletin boards.

Rogers defined five characteristics of all innovations that he believed affect the innovation’s rate of adoption. The first is relative advantage, which is the degree to which an innovation is perceived to be better than what was being done beforehand. Relative advantage can be measured by economic means, social prestige and convenience. The innovation does not have to have an objective advantage, just a perceived advantage by the adopter. The claim was that the more an innovation had a perceived relative advantage, the more quickly it would be adopted. The second characteristic is compatibility, which is whether the innovation is perceived as being consistent with the present values, past experiences and needs of the potential adopter. The more a potential adopter perceives the innovation to be compatible
with the adopter’s values, experiences or needs, the more likely it will be adopted. The third
characteristic is the innovation’s complexity, which is the degree to which an innovation is perceived as
difficult to understand and use. The more difficult, the less likely potential adopters are to adopt. The
fourth innovation characteristic thought to affect rate of adoption is trialability, the degree with which
an innovation can be experimented. The more an innovation can be partitioned and experimented with
before full adoption must occur, the more likely the innovation will ultimately be adopted. The last
characteristic is observability, which is whether or not the results of adopting the innovation can be
observed. The more visible the results of an innovation are, the more likely it is to be adopted.

Rogers’ model discusses the communication channels that are present at the time that potential
adopters are considering whether to adopt. Social science research concludes that the transfer of ideas
or knowledge occurs most frequently and more effectively between individuals who are similar
(Lazarfeld & Merton, 1964). Reflection on this topic will show in the exploration of conceptual models
used to describe the process of faculty adoption of instructional technology.

To this point, I have discussed how innovation characteristics affect the rate of adoption and
the communication channels through which information and knowledge is passed. The third dimension
in the definition is time, which indicates that this process is longitudinal in nature and includes a
decision process at some point. In fact, Rogers posits that the innovation-decision process takes place
when an individual moves from first knowing about an innovation to forming attitudes about the
innovation to a decision to adopt or reject, to a decision to use the innovation.

Figure 1 shows the conceptual map for the innovation-decision process that a potential adopter
passes through. It includes five stages: knowledge, persuasion, decision, implementation, and
confirmation.

***Insert Figure 1 Here***

The knowledge stage occurs when the potential adopter first learns of the innovation and the
potential effects it may have on his/her life and/or work. Furthermore, the knowledge stage includes
exploratory information gathering. Two competing hypotheses exist regarding the information
gathering stage. The first, posited by Coleman and others (1966), is that the initial information gathering
occurs through communication channels with peers that are not actively sought after. The competing
hypothesis is that the information gathering stage is an active stage and that individuals are predisposed
to certain behaviors that are likely to expose them to ideas that are in agreement with their existing
interests, needs and attitudes. This tendency is called ‘selective exposure’ (Hassinger, 1959). There is
also disagreement among scholars about whether the need for an innovation must exist before
knowledge and awareness. Some scholars suggest that the need can precede awareness or awareness can
precede the need.

Several types of knowledge are acquired within the knowledge stage. First, awareness
knowledge is information that the innovation exists and awareness knowledge motivates an individual
to seek out information on how the innovation works. When the amount of how-to-knowledge is less
than that required for a successful trial period, the adoption of an innovation is often rejected. In the
case of instructional technology, this is where, without adequate training and technical support, most
faculty get frustrated or overwhelmed and decide not to adopt. The third type of knowledge is called
principles-knowledge and includes the underlying principles of how and why the innovation work.
Most of the communication channels emphasize the awareness and how-to knowledge (Rogers, 1995).

The persuasion stage the adopter passes through occurs when an individual begins to form
favorable or unfavorable attitudes towards the innovation. This is primarily an affective stage in
contrast to the knowledge stage, which is predominantly cognitive in nature. As with selective exposure,
the persuasion stage includes selective perception, or the idea that an individual will form attitudes that
are in agreement with existing attitudes and values. In order to effectively assess the innovation,
individuals need to be able to think hypothetically and counter-factually; what will happen if I do? What
will happen if I don’t? Forming attitudes is affected by the five perceived characteristics of the
innovation. The more relative advantage, compatability, trialability, observability and less complexity an
innovation has, the more favorable attitudes a potential adopter is likely to have. The hypothesis is that persuasion will lead to overt behavioral change, although empirical research shows that attitudes do not always predict behavior (Rogers, 1973; Ajzen & Fishbein, 1980).

The persuasion stage helps to shape the decision phase where the potential adopter decides to adopt or reject the innovation. In the case of instructional technology, most faculty will not adopt without a small-scale trial of the technology. Research indicates individuals who are able to try out the innovation with a limited number of problems, and where there is at least some relative advantage to what was already being done, are more likely to adopt (Rogers, 1962; 1973; 1995). In the model in Figure 1, adoption can later lead to continued adoption (use) or discontinuance (abandonment). Rejection can lead to continued rejection or later adoption and potential sustained use.

The implementation stage occurs when the adopter puts the innovation to use. This is the actual physical use of the innovation, but it also includes an additional information-gathering period (Mason, 1962). At the individual level, the implementation phase is over when use of the innovation becomes a regular part of the adopter’s life/work.

The confirmation stage occurs when an individual assesses the impact and seeks reinforcement for the decision that has already been made. At the confirmation stage, the individual hopes to permanently establish the innovation’s compatibility with existing values.

Another stage that is not formally a part of the model, but allows for adaptation of the innovation in a local context, is what Rogers (1995) termed reinvention, the process of change that the innovation goes through as adopters adapt the innovation to suit their needs. The whole innovation-decision process is the time it takes a potential adopter to go from the knowledge stage through the decision stage, which will differ across individuals.

An individual is said to be innovative if he/she is relatively early in adopting new ideas relative to other members in a social system. Rogers (1995) hypothesized that the individual rate of adoption could be modeled whereby individuals fall into categories under the normal curve. The adopter
categories include 1) innovators 2) early adopters 3) early majority 4) late majority and 5) laggards. He posited that innovators were active information seekers about new ideas and were better able to cope with higher levels of uncertainty than other categories. When the cumulative adoption time path of a diffusion process is plotted, the resulting distribution is an S-shaped curve. Innovators are the lower tail of the S and the point at which the curve reaches an asymptote at the top is the point at which the laggards have finally adopted and the diffusion is complete (Rogers, 1995; Mahajan & Peterson, 1985). Although the diffusion pattern for most innovations can be modeled with the Sigmoid curve, the exact form, the slope and the asymptote may differ. Some innovations diffuse rapidly, (for example cell phones) while others, (for example instructional technology) diffuse at a much slower rate. The final dimension of the diffusion definition is the social system through which the innovation passes. The social system is defined as a set of interrelated units that are engaged in tasks that have a common goal. In the case of this review, this would be faculty within a department, within a school, within a college or university.

In summary, Rogers’ innovation diffusion work includes four distinct yet interrelated theories. The first, the ‘innovation decision process’, includes five stages: knowledge, persuasion, decision, implementation and confirmation. The second, ‘individual innovativeness’, includes the four adopter categories: innovators, early adopters, mainstream adopters, laggards. The third, ‘rate of adoption’, states that the cumulative function of the rate of adoption of an innovation is an S-shaped curve. The fourth, ‘perceived innovation attributes’ posits that the potential adopters’ perceptions about an innovation’s compatibility, trialability, complexity, relative advantage and observability affect whether or not they decide to adopt the innovation.

Analysis and Critique of Rogers’ Innovation Diffusion Theories

Rogers’ diffusion model (1995) presented above is widely accepted and used often in innovation diffusion research. The model in Figure 1 allows diffusion scholars to utilize quantitative and qualitative research methods to explore the relationships between the stages. It is multidisciplinary in nature and
also allows researchers the ability to conduct longitudinal research to assess behavioral change. In doing so, scholars have the means to better understand the entire process by which individuals adopt an innovation. Lastly, the model can be tested with fairly uncomplicated statistical analyses.

One of the most pervasive critiques of innovation diffusion models is what scholars term the pro-innovation bias. Pro-innovation bias refers to the idea that adopting the innovation will be beneficial to all potential adopters. The diffusion research rarely incorporates an analysis of the potential long-term consequences of innovation adoption, mostly because it would require full adoption or a critical mass of adopters to determine such effects. The drawback to this is the assumption that adopting the innovation is the right choice. Furthermore, the pro-innovation biases are rarely stated within the research report. In this study, adopting the innovation, namely instructional technology, is assumed to be the desired outcome for faculty, because evidence has begun to amass that states the potential benefits of instructional technology on teaching and student learning.

The longitudinal nature of adoption is both an asset and a hindrance to Rogers’ model. Although the time factor allows researchers to use time-dependent statistical models, the actual recall required by innovators and early adopters can potentially bias the research results. Recall data requires the individual to think back in time. The quality of recall is variable depending on the innovation’s salience, the length of time that has elapsed since adoption, and the individual’s personal characteristics. Research shows that recall data are not completely accurate (Menzel, 1957; Coughenour, 1955).

Another problem with the longitudinal nature of adoption and sustained use is that an individual can be at one point in the adoption phase and may decide to adopt well outside the boundaries of the research study. Furthermore, the outcomes that are most commonly operationalized are adoption and use at one time point. There are few studies that actually examine a spectrum of levels of use across time periods (Tornatzky & Klein, 1982).

Another critique of the model is the assumed linearity of the stages and the problems determining causality. In the recent past, scholars have begun to use more sophisticated statistical
models that allow causal and longitudinal analyses simultaneously, namely structural equation modeling.

Beal and Rogers (1960), in a study of Iowa farmers, gathered evidence to suggest that there were at least four stages: knowledge, persuasion, decision and implementation to the innovation diffusion process. They did, however, find that some individuals skip stages suggesting that perhaps the model does not apply to all innovation diffusion or that the model in not linear in nature. Other scholars have found similar evidence that some innovation diffusion processes do not include all five stages (Coleman et. al, 1966; LaMar, 1966; Kohl, 1966).

A critique not of the model but of the literature that was reviewed was that few scholars actually critically analyze Rogers’ model. The model is cited and used as the basic conceptual framework without any critical review. Few, if any studies examined that cultural sensitivity of the model and the effect of gender on the model (Mitra et al., 2001). Another large gap in the literature was the lack of refinement studies, eg. the types of knowledge that are required within the knowledge stage.

Research Utilizing Rogers’ Innovation Diffusion Framework.

This section includes a review of the empirical literature where authors have explicitly cited Rogers’ (1995) framework or have used his terminology and inferred his theories. This comprehensive review includes works outside of higher education that are seminal in form, works that are from the K-12 sector on teacher adoption of instructional technology, and finally, works that are explicitly faculty adoption of instructional technology in a higher education context. Within each section, the review is sub-sectioned by the constructs from Rogers’ theory that the researcher examined i.e. innovation attributes, adopter categories, rate of adoption and the decision stages.

Research outside the field of education.

Fliegel & Kivlin (1966), in a seminal work on diffusion of farming innovations, wrote an insightful piece that outlined the research design challenges faced by diffusion scholars at that time. I included this study because it is informative to look at the ways the models have improved to match the
design challenges they outlined and the authors were rigorous in carrying out their sampling and research design efforts, therefore, their results can be interpreted with a certain degree of confidence.

One of the biggest challenges cited by Fliegel and Kivlin was the inability to take into account all of the similarities and differences among innovations that would make it possible to make generalizations from the known determinants of adoption of a given innovation to a second or third innovation. They identified the following challenges: 1. controlling for effects of personal, social, and situational factors known to have an impact on the adoption process, 2. determining attributes that might be relevant, 3. maximizing variance by including many innovations, 3. reliably measuring selected attributes, and 4. identifying the effects of attributes in the presence of other attributes.

In their study, the authors solved the first challenge by drawing a large enough sample to statistically control for personal, social and situational factors. To minimize the unmeasured confounders they scoured the extant literature to identify all factors that were cited as a potential factor in farming innovation diffusion and they maximized variation in the sample by including 33 separate farming innovations to be tracked. The fourth challenge of constructing and using reliable, valid measures of the innovation attributes, still exists in the literature today.

The list of potential factors from their study that affected innovation diffusion included fifteen innovation attributes (initial cost, continuing cost, rate of cost recovery, payoff, social approval, saving of time, saving of discomfort, regularity of reward, divisibility for trial, complexity, clarity of results, compatibility, association with dairying, mechanical attraction, pervasiveness) that with the exception of association with dairying, are relevant for any innovation. The outcome for their study was rate of adoption among farmers and they found that innovations perceived as most rewarding and least risky would be adopted most quickly.

Some would argue that fourteen of Fleigel & Kivlin’s factors could be collapsed into Rogers’ five: compatibility, complexity, relative advantage, trialability and observability. Fliegel & Kivlin’s list of innovation attributes that affected innovation adoption match Tornatzky & Klein’s (1982; 1983) ten
commonly cited innovation attributes known to affect innovation adoption: compatibility, relative advantage, complexity, cost, communicability, divisibility, profitability, social approval, trialability, and observability.

Tornatzky & Klein (1982) in their meta-analysis reviewed seventy-five articles concerning innovation characteristics and their relationship to innovation diffusion/adoption. Similar to Fliegel & Kivlin, they outlined the methodology flaws in the body of literature along with a generalization of findings. This was a landmark study as it was the most comprehensive look at the literature since the early 1970’s and it outlined an ideal innovation attribute study, which would have: included longitudinal data, focused on both adoption and implementation as dependent variables, included valid and reliable measurement scales that were reproducible for other researchers to use, studied interaction effects of innovation and studied several innovations at one time to allow more powerful generalizations.

What they found was that 2% of the studies they examined actually predicted adoption and implementation and over 90% explained adoption or implementation in a post-hoc fashion. They also found that 93% of the studies looked at adoption alone as a yes/no dichotomous outcome and only 7% looked at any combination of adoption and implementation. Fifty-four percent of the studies were conducted by survey, 20% were secondary data analysis, 17% were case studies, 7% were theoretical and only 1% were experimental in nature. Nineteen percent of the studies they examined had the attributes rated by decision makers, 5% were rated by expert judges, 11% were measured on cost/profit alone and 60% were inferred. Of the seventy-five studies, 47% examined only one attribute, 36% measured 2-5, 11% measured 6-9 and 7% measured 10 or more innovation attributes. Fifty-eight percent of the studies were done at the individual level while 33% where conducted at the organizational level. They found that compatibility and relative advantage were the two characteristics most positively related to adoption (p<.05). A problem with this finding is neither compatibility or relative advantage consistently had a strict definition attached to it in any of the studies. The only other consistent finding in the meta-analysis was that complexity was negatively related to adoption (p<.062).
Similarly, Cooper & Zmud (1990) in a study of weather forecaster’s perceptions of an innovative computer-based training system, found relative advantage, complexity and compatibility to be significant adoption factors. Like Fliegel & Kivlin, Surry also believed that there was a need to clearly define the innovation characteristics, develop viable measurement scales and to use repeated measures data. These suggestions were common themes throughout the early body of literature outside of higher education.

Research in K-12 education.

The K-12 body of literature on teacher adoption of instructional technology is informative to scholars in higher education because future K-12 teachers get trained at the higher education level. It is a matter of utmost importance that higher education institutions send the future K-12 teachers out into their jobs with enough training and understanding for them to infuse instructional technology into their classrooms. Understanding factors that influence teacher adoption of instructional technology may help to understand issues facing faculty.

Scholars in the K-12 sector use predominantly Rogers’ innovation diffusion framework and Hall, Wallace & Dossett’s (1973) Concerns Based Adoption Model, (which will be discussed as an alternative to Rogers in a later section) as frameworks for their studies. Buckenmeyer (2001), in a study that included 144 secondary teachers from a suburban school district, classified teachers as adopters and non-adopters and examined the factors that had a relationship with technology adoption within the categories. She found that the use of a trial period with the technology and formal college classes on approaches to learning to use technology had a positive correlation with adoption of technology. For the non-adopters, descriptive statistics showed the need for time, technical support, and incentives for learning the technology. Buckenmeyer listed five general implications for administrators promoting technology adoption among teachers: staff development opportunities, time, prompt technical support, incentives, and positive attitudes towards technology. Although these findings are informative, they were based on single order correlations and descriptive statistics, therefore lack generalizability.
Cartas (1998), in a similar study of 135 teachers in thirteen schools in San Diego, found that potential adopters were more likely to implement technology innovations if they had a favorable perception of the complexity, compatibility and relative advantage of the technology. He used linear regression to predict adoption in a post-hoc fashion. Wyner (1974) and Holloway (1977) also found relative advantage and compatibility to be significant perceptions among potential adopters of instructional technology in high schools.

Bussey, et al. (2000), conducted a study based on Rogers’ (1995) framework, whose purpose was to determine factors, which might predict the adoption of technology by secondary technology education and industrial arts teachers in New Mexico. This study’s unique contribution to this body of literature is the rigorous research design and methodological approach. They pre-determined that a random sample of size 169 was needed to obtain estimates with 95% confidence and they used inferential statistics to determine factors that predicted adoption of technology by the teachers. Their questionnaire included summated indices measuring the level of adoption, perceptions of the attributes of technology and the influence of change agents and opinion leaders on adoption. They conducted a pilot test to examine the reliability of the indices. Their response rate was 66% and to check for non-response bias, a follow up phone interview was scheduled with ten of the non-respondents. Respondents had significantly lower levels of adoption, lower perceptions of the attributes and were older than non-respondents. Unfortunately, the authors collapsed twelve levels of adoption (a major potential strength of the study) into a dichotomous yes/no adoption outcome and included one index for perceptions of innovation attributes. Their regression analyses explained 44% of the variance in adoption with perceptions of attributes, influence of change agents, teaching endorsement held and years of teaching as significant predictors. The obvious strengths of this study include the upfront sampling design, pilot test, non-response bias examination and proper analytical techniques. The weaknesses include the collapse of the adoption index, and the summated index of the perceptions of the innovation characteristics.
Bussey, et al., also asked teachers to indicate perceived barriers and promoters to adoption of technology. Inadequate budgets, facilities, resources and administrative support, fear of change, and lack of incentives were cited as barriers while personal interest, workshops, grant funding, and opportunities for professional advancement were cited as promoters of adoption of technology. Dias (1999) also found the most common barriers to teacher adoption of technology to be time, training, resources and support. Siegel (1995) added that staff development is imperative for technology integration in the schools. “The idea is not only to teach them how to use the hardware and software, but how to integrate it seamlessly into the curriculum” (p. 34). Additionally, Dooley (1999) posited that the greatest single educational system barrier for an innovation is the system itself. Teachers teach in the manner in which they were taught. Until the higher education system embraces technology and integrates it seamlessly into the classroom, the K-12 teachers will continue to struggle with instructional technology.

Waugh & Punch, (1987) asserted that most change in schools fails because teachers and administrators underplay and often ignore changing people’s values, attitudes and behavior. The result is that the innovation is not well received and is often in conflict with entrenched traditions of teaching. Echoed by Ellsworth (1998), effective Teacher Education programs must ‘practice what they teach by modeling the use of emerging technologies as tools to enhance the learning process’ (p.32). Based on Rogers’ individual innovativeness categories, Ellsworth posited that the adoption process has reached no farther than the early majority leaving approximately 50% of prospective teachers without the necessary competencies to integrate technology into the curriculum.

Dooley (1999) used Rogers’ innovation-decision process as the basis for a more holistic model of diffusion of computer technology in the schools. She included contextual factors impacting change in the schools, the role of principals and teachers, the teacher’s concerns (self, task, impact) (Hall, Wallace & Dossett, 1973) and where the individual was in the innovation –decision process. The end product was a holistic systemic approach that she tested in two schools using a qualitative approach to
data collection. She found her model to be informative in predicting the teacher diffusion/adoPTION
process of instructional technology.

Like many other scholars in K-12, Sherry, et al. (2000), used Rogers’ innovation diffusion
theory and Hall, Wallace & Dossett’s CBAM theory to lay the foundation for a newly integrated model
of innovation diffusion. The authors’ experience with both of these models was that they were too
linear in nature and did not fit the data they were observing in the schools. They hypothesized that the
process of infusing technology-based learning was not linear. Teachers are co-learners and co-explorers
with their technology savvy students. Through their evaluation of several educational technology
initiatives, they found that teachers go through four distinct stages as they develop expertise with the
technology. Teachers evolve from learners to adopters to co-learners/co-explorers to a
reaffirmation/rejection decision. It is at the final stage where the teachers decide whether the
technology is working for them, is compatible with their present values, is contributing to their self-
efficacy and is worth their time and effort. They validated their model in a three-year evaluation project
of a Technology Innovation Challenge Grant in the schools in Vermont. They found that in addition to
the four stages they proposed, there is a fifth stage of teacher as leader where the leaders become
capacity builders.

The teacher as learner stage is an information-gathering stage similar to Rogers’ knowledge
stage. Teacher as adopter is where the teachers begin to experiment with the technology, begin to try it
out in the classrooms and share experiences with their peers. This stage is very similar to Rogers’
persuasion stage that includes a trial period and a period of forming attitudes about the innovation. The
teacher as co-learner stage involved developing a relationship between the technology and the
curriculum rather than concentrating on tasks. This stage is specific to education and does not truly
match any of Rogers’ stages but could be contained within the implementation stage. Teacher as re-
affirmer or rejecter is the stage at which the teacher begins to develop a greater awareness of the
outcomes and begins to assess the impact of the innovation on student learning and performance. It is
at this stage that the teacher begins to disseminate exemplary successes to peers. The final stage, teacher
as leader, is where the teachers’ skills become portable and they are able to observe others, collect data,
share experiences with peers and suggest improvements. This innovation diffusion model was
constructed specifically for teachers in schools so its context is limited.

Research in higher education.

Four types of research in higher education use Rogers’ model. The first is focused on
innovation characteristics that affect innovation adoption. The second focuses on the innovation-
decision process. The third is research focused on differentiating among the adopter categories
proposed by Rogers and in particular, the demographic and personal characteristics that distinguish
innovators and early adopters from the mainstream adopters and laggards. The final body of research
deals with the rate of adoption and factors influencing the rate of adoption.

The first set of studies examined how and which innovation attributes affect adoption. In a
study that examined faculty adoption and use of Internet technologies in a Saudi Arabian university,
Allehaibi (2001) randomly sampled and surveyed 500 faculty members to find out what innovation
attributes contributed to adoption of internet technology and what stage of concerns the faculty
members were in. He found that all five of Rogers’ innovation attributes were significant predictors of
Internet adoption. His study also included an examination of the adopter categories where he found
69% of faculty using technology were late adopters (using internet technology less than two years)
compared with 31% who were early adopters (using technology for more than two years). In a similar
study, Hightower (1991) found all five of Rogers’ innovation attributes to be identified by factor
analysis and significant predictors of adoption of instructional technology. Jones & Laffey (2000) used a
convenience sample of 16 MBA students enrolled in a course to test Rogers’ innovation characteristics
for a new digital collaboration tool used in the course. The authors conducted focus groups and
interviews and allowed the themes to emerge from the qualitative data. Their results indicated that
relative advantage, compatibility, complexity, trialability, observability and culture were themes
identified by participants. What the authors found, however, was that the students did not adopt the collaborative tool because they did not believe it had tangible benefits above and beyond what they were already using. The themes that emerged from the analysis allowed the researchers to suggest a model that added culture (strong culture which provides leadership and support for the new technology, incentives/rewards to use it, and encourages risk-taking) to Rogers’ existing list of five attributes that affect adoption. Similarly, Winslow (1993) in a study of instructional computing in textiles and clothing in higher education found that perceived educational benefits and faculty rewards influenced adoption among faculty.

Spotts & Bowman (1995) created a survey to measure faculty knowledge and experience with instructional technology. They tested the survey’s validity with an expert panel of university computing consultants and administrators and also conducted a confirmatory factor analysis on the constructs they had predetermined. Inferential statistics were used to test for differences among faculty characteristics and/or technology knowledge and experience. What they found was that less than 40% of faculty had knowledge and experience at the good to expert level with computer spreadsheets or statistical computing, while less than a third had knowledge and experience at that level with computer assisted instruction. Only 16% of faculty reported good or expert knowledge of presentation software and computer conferencing and 13% for multi-media software. Finally, fewer than 20% of faculty used any instructional technology in the classroom on a regular basis. The unique contribution of this study is the psychometrically tested survey that was created because several scholars have since used the Spotts & Bowman survey in diffusion/adoption studies that examine the affect of instructional technology attributes on adoption.

Beggs, (2000) in a study of 348 full-time faculty at the State University of West Georgia, found that improved student learning, advantage over traditional teaching, equipment availability, ease of use, time needed to learn, compatibility with materials, training, administrative support, personal comfort and colleague use were rated as highly influential of faculty adoption of instructional technology. They
used the survey created by Spotts & Bowman (1995). Only descriptive statistics were used and as such, the findings are limited in predicting adoption of instructional technology. In a similar study, Groves & Zemel (2000) used the same survey with 135 faculty and graduate student instructors at the University of Tennessee and found the same factors to be related to adoption of instructional technology, only the order was slightly different. Again, only descriptive statistics were calculated so the extent to which these factors actually predict adoption of instructional technology is unknown. Jacobsen, (1998) in another study using descriptive statistics, reported that technology: enables faculty to make their subject more interesting, enables students to work collaboratively, gives students the basic computer skills they need for the workforce and gives faculty personal gratification to learn new skills.

Marcus (1985), in a study of adoption of a computer-based text-processing system at Stanford that included 250 subjects, collected data at three time points in the first eight months of the innovation diffusion process. She utilized a logistic regression model to compare data collected at different time points. She found that adoption is a function of three factors: perceived value, resources and communication with other adopters where perceived value appears to exert the strongest influence. Roberts (2000) also found that perceived value of technology was instrumental in faculty adoption of digital technology in teaching at Brigham Young University. In particular, he found three key values: increased effectiveness, improved efficiency and adequate incentives that were significant predictors of faculty adoption of technology in the classroom. He based his framework on Vroom's expectancy-valence theory that states workers believe that participation will have certain desirable consequences and they perceive participation as a means to satisfy their needs. In this context, faculty desires refer to increased student learning.

In a similar case study at Northwest Missouri State University, Massy & Wilger (1998) found that faculty overwhelmingly reported the importance of the institutional context in their decision to integrate technology into their teaching. They believed that because Northwest Missouri’s mission statement defines the University as ‘learner-centered’, faculty would take on the extra challenges to
meet the needs of the students. Faculty also cited the institution’s culture of quality and their ability to have a say in administrative decisions about technology as promoters of technology integration even though no faculty member is forced to use it.

In an ex-post facto study of faculty adoption of instructional technology across fifteen institutions in Nebraska, Waugh (2002) found discipline and age, but not rank and gender to be significant personal characteristics related to adoption.

Another theme of research focuses on Rogers’ innovation-decision process. Hightower (1991) in a study of faculty members in the College of Business and College of Law at Georgia State University found the stages of the model, knowledge, persuasion, decision, implementation and confirmation, to be necessary and sufficient to describe the potential adopters’ decision process. He also found that the stages occurred in the order suggested by Rogers. Knuetel (1995) in qualitative case study of 16 faculty at the University of Michigan found that the stages outlined by Rogers were parallel to those that emerged from the interview data. The stages included awareness, conceptualization, decision and implementation. Moreover, he found that faculty reported lack of time as the number one concern for integrating technology into their courses. Malayery (1986) used Rogers’ model to analyze the innovation –decision process in a study of medical faculty at the University of Jordan in Amman. His study focused on the stages of adoption as well as the factors that influenced adoption. With a random sample of 42 faculty his results showed that the adoption of instructional innovations involved a process consisting of several interrelated stages described by Rogers. He also found that the factors that influenced faculty adoption of instructional technology included faculty development programs, personal conviction, motivation and experience, availability of time, and organizational support.

Mitra, LaFrance & McCullough (2001) examined the influence of gender on Rogers’ five innovation attributes. Their analysis utilized data gathered from a longitudinal study of computerization of the teaching and learning process at a small private liberal arts university in the Southeast. They constructed their survey to elicit Rogers’ five innovation attributes: relative advantage, compatibility,
complexity, trialability and observability. Their confirmatory factor analysis yielded valid and reliable results of five summated indices representing these attributes. They found significant differences between men and women on all measures except observability at the baseline. Trialability and compatibility remain the two attributes with consistent gender differences over time. Teo & Lim (1996), however, found gender differences between job fit and voluntariness but not between usefulness, trialability and complexity. However, this study was conducted on undergraduate computer use so which explain the difference in findings.

Less empirical research exists that attempts to identify the differences between the adopter categories. Hightower (1991) in a previously cited study discovered that Rogers’ innovation attribute relative advantage was found to discriminate between adopters and non-adopters. His results showed that non-adopters were more apt to report that they had not adopted because they did not see a relative advantage over what they were already doing in the classroom.

Geoghegan (in Gilbert, 1995) of IBM outlined his thoughts on the chasm between the ‘techies’ and the ‘teachies’ or the early adopters and the mainstream faculty who have largely not adopted. He believes that the gap that exists has been inadvertently widened by the well-intentioned actions of what he calls the “Technology Alliance” (early adopters, IT support staff and technology vendors). The support systems that exist on most campuses to foster adoption of instructional technology have been put in place by and for the early adopters assuming that all potential adopters need the same kinds of support structures. The net effect of the existing structures has allowed the innovators and early adopters to be at near saturation of adoption while the mainstream adopters rarely ever adopt and when they do, it is rarely sustained. Geoghegan believes that the barriers cited by others (Albright, 1996; Beggs, 2000; Baldwin, 1998; Gilbert, 1995; Jacobsen, 1998; Liaw, 2001; Massy & Wilger, 1998; Rogers, 1999; Rogers, 2000; Werner, 2001; Williams & Peters, 1997; Zhoa, 2001) are not the principal cause of the lack of faculty adoption. He cited mainstream adopters as more conservative and focused on the problems, processes and tasks at hand than on the tools and technology that help them. He used this
belief as the basis for his hypothesis that early adopters favor revolutionary change, are: visionary, strongly technology focused, risk-takers, experimenters, self-sufficient, and horizontally networked (many cross-disciplinary links). Mainstream adopters, however, favor evolutionary change; they are conservative, process focused and risk-averse, want compelling evidence of value, need significant support, and are vertically networked (few cross-disciplinary links). He also posited that early adopters tend to be ‘boutique’ operators and poor role models for the mainstream faculty. What is being overlooked is that the mainstream adopters need something qualitatively different from the early adopters in terms of support.

None of the 30 plus studies that I examined in the higher education literature utilized rate of adoption as an outcome. The reason for this may be because it requires longitudinal data, which researchers are less willing to spend the time and money necessary to collect. This type of research is more common in the business and farming sectors where the rate of adoption is of utmost interest to the manufacturers and marketing companies. The barriers to technology include: lack of time, inability to receive credit towards tenure and promotion, insufficient or obsolete hardware and software, inadequate facilities and support services, lack of information about good practice, underestimation of the difficulties, inadequate training and professional development, and the time trade-off not being worth it (Albright, 1996; Beggs, 2000; Baldwin, 1998; Gilbert, 1995; Jacobsen, 1998; Liaw, 2001; Massy & Wilger, 1998; Rogers, 1999; Rogers, 2000; Werner, 2001; Williams & Peters, 1997; Zhao, 2001).

In summary, historical studies of innovation diffusion (Fliegel & Kivlin, 1966) and (Tornatzky & Klein, 1982) reveal that Rogers’ innovation attributes (relative advantage, complexity, observability, trialability and compatibility) have not changed and are still the most commonly used metric for examining factors that affect innovation diffusion/adoption. Furthermore, the majority of the literature that examines factors affecting the adoption of instructional technology in higher education identified Rogers’ innovation attributes. Of these attributes the literature suggests that relative advantage and compatibility may be the most important factors affecting faculty adoption of instructional technology.
Mitra, LaFrance & McCullough (2001) found that there were differences in the ways males and females perceive the effects of the innovation attributes on adoption. Outside of these five attributes, other factors that appear often in the literature which affect faculty adoption of instructional technology include: staff development opportunities, time, prompt technical support, incentives and positive attitudes towards technology (Buckenmeyer, 2001). There is a need for a strong culture, which provides leadership and support for the new technology, incentives/rewards to use it, and encourages risk-taking (Laffey, 2000). Proof of improved student learning, advantage over traditional teaching, equipment availability, ease of use, time needed to learn, training, administrative support, personal comfort and colleague use (Beggs, 2000) were also cited. Perceived value, resources and communication with other adopters (Marcus, 1986; Rogers, 2000), mission statements and institutional culture (Massy & Wilger, 1998), faculty development programs, personal conviction, motivation, and experience (Malayery, 1986) were cited. Academic discipline and age (Waugh, 2002), gender (Mitra, LaFrance & McCullough, 2001), and potential adopter personal traits (Geoghegan, in Gilbert, 1995) were the personal attributes cited that affected adoption and instructional technology.

Barriers to adoption of instructional technology identified in the literature included: lack of time, inability to receive credit towards tenure and promotion, insufficient or obsolete hardware and software, inadequate facilities and support services, lack of information about good practice, underestimation of the difficulties, inadequate training and professional development, and the time trade-off not being worth it (Albright, 1996; Beggs, 2000; Baldwin, 1998; Gilbert, 1995; Jacobsen, 1998; Liaw, 2001; Massy & Wilger, 1998; Rogers, 1999; Rogers, 2000; Werner, 2001; Williams & Peters, 1997; Zhoa, 2001)

A gap identified in the higher education literature and the more recent K-12 literature is the lack of rigorous research design. The majority of the studies cited were pseudo-case studies with convenience samples that attempted to make generalized statements about faculty adoption of
instructional technology. Studies that actually utilized a random sample did not assess or account for non-response bias. Furthermore, the statistical techniques utilized were predominantly descriptive in nature, which provides evidence that factors are related to adoption, but no statistical significance, prediction or causation can be inferred. Another gap in the literature seems to be the lack of strict adherence to reproducibility of the study. I was only able to find one survey attached as a web-link or an appendix that was psychometrically tested. Moreover, few of the authors offered definitions of Rogers’ five innovation characteristics and none of the authors attempted to deconstruct the framework.

The strengths of the literature appear to be the consistent use of Rogers’ framework, but the theory is taken for granted and not really explored. Another strength of this literature is the sheer number of studies conducted in the context of higher education, which allows researchers to critically analyze and build on previous results.

Alternative Models for Adoption/Diffusion

The second most commonly cited adopter-based theory of diffusion is Hall, Wallace & Dossett’s (1973) Concerns-Based Adoption Model (CBAM). This model differs inherently from Rogers’ innovation diffusion theories in that CBAM is a macro level theory where the goal is systemic change. The idea of CBAM is to bring about change specifically in educational settings by understanding the social, political and interpersonal characteristics of the school or college (Surry & Farquhar, 2002).

The CBAM was formulated by Hall, Wallace & Dossett (1973) while developing affective methods for in-service teacher training modules at the K-12 level. There are seven key assumptions of the CBAM that have direct relevance to the process for concerns-based in-service teacher training (Hall, 1978). The first is that change in schools and colleges in a process, not an event. CBAM assumes that teachers, students and administrators will move through a series of stages that produces change. The second assumption is that the individual needs to be the primary focus of intervention for
classroom change. CBAM places the emphasis on working with the individual teachers and administrators and their roles in how the innovation is adopted. The third assumption states that change is a highly personal experience. CBAM assumes that the change process has a personal dimension whereby the individuals and their feelings, perceptions and motivations are much more influential to adoption of an innovation than the amount of technical support for the innovation. The fourth assumption is that a full description of the innovation is a key variable in the change process. Too often, individuals are unclear about what the innovation is actually supposed to look like. The fifth assumption is that there are identifiable stages that individuals will pass through with their perceptions and skills levels with the innovation. The sixth assumption is that in-service teacher training can be best facilitated by the use of a client-centered diagnostic model. CBAM assumes that the facilitator will be able to diagnose where the teacher is at and prescribe the proper intervention so that the teacher can proceed with innovation adoption. The last assumption to CBAM is that the change facilitator needs to work in a systematic way. Again, this assumes that the facilitator will be able to adapt to where the in-service teacher is and prescribe the proper level of intervention with constant awareness of the larger organizational process.

There are three dimensions of the CBAM, however I will only address two in this study: the teacher’s Stages of Concern about the innovation (SoC), the teacher’s Level of Use of the innovation (LoU). Stages of Concern includes the teachers’ perceptions, feelings, motivations and frustrations about the innovation (Hall, Wallace & Dossett, 1973; Hall, 1978; Hall & Loucks, 1978). Along with the work of Fuller (1969, 1970), Hall, Wallace & Dossett identified seven stages of concern about an innovation that move from self, to task, to impact. The stages include: awareness, informational, personal, management, consequence, collaboration and refocusing.

Recall Rogers’ innovation – decision framework: knowledge, persuasion, decision, implementation, confirmation and reinvention. The awareness and informational stages of Hall, Wallace & Dossett’s model are similar to Rogers’ knowledge stage. This is the point at which the
teacher becomes aware of the innovation and begins to show an interest in learning more. The personal stage is the same as Rogers’ persuasion stage and involves the teachers’ affective concerns about the demands, rewards and benefits of the innovation. The management stage is Rogers’ decision and implementation stage and is the point at which the teacher focuses attention on the tasks of using the innovation. The consequence and collaboration stages are similar to Rogers’ confirmation stage where the teacher is looking for evidence of the benefits of the innovation and ways to collaborate with other adopters. Refocusing is the same as Rogers’ reinvention stage where the process is focused on changes or adjustments to the innovation that make sense for the adopters’ contexts. The research on the CBAM has shown that individuals do not have concerns on only one stage at a time, but have a profile of concerns with some being stronger than others at different times in the adoption process (Hall, Wallace & Dossett, 1973). Hall, Rutherford & George, (1977) conducted a series of cross-sectional and longitudinal studies to develop a reliable and valid measurement procedure for the seven stages of concern.

The second dimension for assessing how involved individuals are in the change process is the Levels of Use (LoU). The LoU focuses on the individual’s behavior. Eight levels of use have been identified (Hall, 1978; Hall, Wallace & Dossett, 1978) including: nonuse, orientation, preparation, mechanical use, routine, refinement, integration and renewal (see Hall, Loucks, Rutherford & Newlove, 1975 for a more complete description of the LoU). Loucks, Newlove & Hall (1975) developed a focused interview to measure LoU that has been tested repeatedly with longitudinal data (Hall, 1978).

CBAM is the second most commonly cited diffusion model in education. Corwin & Marcinkiewicz (1998) conducted a longitudinal study of faculty (n=85) at three institutions in North Dakota to examine variables that might predict computer use by faculty over time. They measured computer usage, computer anxiety, subjective norms, innovativeness and stages of concern for faculty. They utilized: the Levels of Computer Use scale (Marcinkiewicz & Welliver, 1993) to measure computer usage; the Computer Anxiety Index (Simonson, et. al, 1987) to measure computer anxiety, a
Subjective Norms Scale (Marcinkiewicz & Regstad, 1996) to measure subjective norms; the Innovativeness Scale (Hurt, Joseph & Cook 1977) and the Stages of Concern Questionnaire (Hall, George & Rutherford, 1977) to measure faculty’s stages of concern. In the first phase of the study the authors found the Subjective Norms Index to be a significant predictor of computer usage and age and innovativeness to be somewhat predictive. Subsequently, a fixed effects model for university was applied to the data and the Subjective Norms Index was no longer significant indicating that the institution had a larger effect on computer use than did the predictors. Results on the Stages of Concern Questionnaire indicated that faculty at one campus had few concerns about managing computers but had some concern about the consequences for students. A different campus indicated some concerns including: wanting more information, intense personal concern about managing computers and their consequences for them. At time two, stages of concern had shifted to concerns about looking for ideas from others and collaboration. Differing cultures of the campuses are thought to have influenced the faculty responses to the stages of concern.

Gray (2001), in a study on twenty in-service teachers and two pre-service teachers, administered the SoCQ on the first day of a summer course and again at a follow up session in the Fall semester. Results of the SoCQ at time 1 indicate group’s highest concerns were Hall, Wallace & Dossett’s (1973) stages 0 (awareness), 1 (information), 2 (personal). The post-test revealed a decrease in the relative intensity of concerns in stages 0,1 and 2; however, although awareness did decrease, it still remained the highest area of concern. The individuals who participated in this study indicated that time, meaningful content and collaboration as having the most effect on their willingness and ability to change what and how they teach. Dooley (1999), in a similar study of in-service teachers, used qualitative methods to find that low users of technology had a higher percentage of self concerns, middle users shifted more to task or management concerns, and high users were more concerned about the impact of the innovation had on their students. She also found that the principals and facilitators tended to range between implementation and confirmation on Rogers’ innovation-decision model.
The strengths of the CBAM model are: it includes two distinct constructs in the innovation adoption process, stages of concern (SoC) and levels of use (LoU). Hall, Wallace & Dossett’s Level of Use enables scholars to examine the spectrum of use that is needed to further understand the adoption process in place of the dichotomous yes/no adoption decision. Unfortunately, none of the studies examined for this review included an analysis of teacher or faculty Level of Use. The predominant use of the CBAM theory appears to be on Stages of Concerns, which is important for facilitators and administrators but used alone, is limited in its ability to predict levels of use. This model does, however, allow faculty to be in multiple stages at once with a profile of concern. The weakness of the theory is that it is designed specifically for in-service teachers. Although, with a change of context, I think this theory could be applied particularly well to higher education.

In a different type of alternative stage model, Prochaska, DiClemente and Norcross (1992) proposed a stage model for changing addictive behaviors. They argued that there were five stages that an individual must pass through to go from knowledge to behavior change. Their stages included: pre-contemplation (awareness), contemplation (serious thought), preparation (intentions), action (behavior change) and maintenance (continued behavior). This model parallels Rogers’ model but is focused on the change of behavior and the sustained behavior change.

Fung (1992) in a similar stage framework called the Six-A innovation model outlined a five-step process that individuals go through in adopting innovations. The initial stages of his framework included: awareness, attitude formation, decision to adopt/reject, learning and trialing, and routinised application. Again these five stages closely resemble Rogers’ (1995) innovation-decision framework: knowledge, persuasion, decision, implementation and confirmation. The point that Fung wanted to make was that after the fifth stage, the innovation becomes something that is no longer new to the user and is a matter of routine, thereby giving reason to suggest that perhaps assimilation better describes that stage after the implementation stage. He introduced the term “facimilation” to indicate facilitating the assimilation of an educational innovation. His final framework included: awareness, attitude
formation, adoption (3 sub-stages: adoption of idea, adoption for trial and adoption in practice),
adaptation, action and application, hence the six A’s. He suggested that the whole process of innovation
adoption is a non-linear one that consists of re-cycling loops through the six stages. This model was
supported by the data collected by the author in a Hong Kong school.

Another similar stage model proposed by Hooper and Reiber (1995) that focused specifically on
adoption of computer-based instructional technologies included five stages: familiarization, utilization,
integration, reorientation, and evolution. Because this model was constructed explicitly for instructional
technology, the integration phase has its emphasis on faculty making a choice about instructional
delivery that is most appropriate for the intended educational outcomes. There are several other
innovation diffusion/adoption stage models that parallel Rogers’ work but do not add to the model in a
significant manner (Havelock, 1973; Hamelink, 1984). See Table 1 for an overview of the adopter-level
innovation diffusion stage models.

** Insert Table 1 Here **

Different from the alternative stage models, Herling (1994) in a study of the adoption of two
computer communication technologies by faculty in selected United States mass communication
schools, found that three major beliefs held by an individual affect adoption behavior: functional
benefits of the innovation, innovation amenability and innovation adaptability. He also found that
adoption behaviors exist at several different qualitative levels, supporting Hall, Wallace & Dossett’s
(1973) Levels of Use. What was different about Herling’s study was that he used Ram’s model of
innovation resistance as his framework. Ram (1987, 1989) highlighted criticism of innovation diffusion
research including the pro-innovation bias and suggested that scholars examine the factors affecting
resistance to use rather than factors affecting adoption. According to Ram (1989), perceived risk of
adoption and cognitive resistance to adoption affects adoption and usage behaviors. Perceived risk is
presented as an individual’s hesitation to adopt an innovation and it is a function of fear of
performance, fear of financial costs, fear of social ridicule and fear of psychological discomfort.
Rastegary (1989) also found that risk and complexity and the factors that reduce these two things affected faculty adoption of microcomputers at a large Research I institution.

In another completely different type of model, Casmar (2001) conducted a study using grounded theory to study adoption of computer technology by faculty in a college of education. Interviews were conducted until the categories were saturated and the data were triangulated with observations. In his model, faculty were thought to exist on a two-dimensional continuum with usage style on the X-axis on a continuum from concrete to flexible and their approach to technology in the Y-axis on a continuum from practical to visionary. The end product was four conceptual usage-styles. Faculty with a concrete-practical style adopted most slowly. Faculty exhibiting a concrete-visionary style adopt somewhat rapidly. Faculty exhibiting a flexible-practical style adopt slowly and faculty exhibiting a flexible-visionary style are most likely to adopt very rapidly. This model focused on faculty characteristics and was somewhat of a typology of faculty leaving out a large set of characteristics about the technology itself and the institutional or departmental context.

In a study that focused on motivation and self-efficacy, Ertmer (2001) outlined a responsive instructional design process that enabled teachers and faculty to adopt new educational innovations. Self-efficacy refers to one’s personal beliefs about their ability to learn or perform actions at an aspired level (Bandura, 1997). As such, self-efficacy is thought to mediate the relationship between skill and action. Pajares (1992) noted that self-efficacy, or teachers’ beliefs about their ability to use computers in instruction may affect their ability to adopt instructional technology. McKinney, Sexton and Meyerson (1999) found that subjects with lower self-efficacy expressed early concerns (self concerns, from Hall, Wallace & Dossett’s Stages of Concern) while subjects with higher self-efficacy reported later stages of concern (impact concerns). Thus, teachers who have higher levels of self-efficacy with computers are more likely to adoption instructional technology more eagerly, expend more effort, and persist longer than those with lower levels of self-efficacy (Ertmer, 2001).
Further research on self-efficacy by Schunk (1996) proposed four operationalized constructs that help measure self-efficacy. They include: vicarious experiences (observation), social persuasion (encouragement), physiological indicators (emotions, anxiety), and personal mastery (successful task completion). Personal mastery is thought to be the most beneficial for mainstream adopters and laggards. Ertmer (2001) has constructed a responsive instructional design process tailored to the mainstream adopters and laggards whereby instructional designers meet with faculty in an iterative fashion to meet and challenge faculty at their current level of use. She argued that we can further the adoption process by designing development programs that help faculty experience some initial success.

Zhao and Cziko (2001) outlined the final alternative model that is distinctly different than Rogers; Hall, Wallace & Dossett; and those listed above. Zhao & Cziko used Perceptual Control Theory (PCT) as the framework for teachers’ adoption of instructional technology. Perceptual Control Theory is a model of behavior based on control theory (Powers, 1973) and it maintains that human and other living organisms control perceptual input and do not control motor output. Basically, humans have a hierarchy of goals. They vary lower-level goals to attain higher-level goals. Technology can be viewed as a possible means to achieve goals at a higher level. PCT dictates that teachers’ perceptions of technology in relation to their hierarchy of goals will explain why faculty do or do not adopt technology in the classroom. If a teacher has a goal of delivering high quality instruction, he/she may think about integrating technology to meet this goal. If the teacher perceives his/her instruction to be excellent then he/she will likely not change anything he/she is currently doing. This theory states that there are three necessary conditions for a teacher to use technology: 1. the teacher must believe that technology can be the means to achieving a higher level goal, 2. the teacher must believe that using technology will not disrupt other higher level goals that he/she thinks are more important, and 3. the teacher must believe that he/she will have the ability and resources to use technology. This theory is highly related to self-efficacy and motivation theory and focuses on the needs/goals of the individual to drive behavior.
In summary, these models offer alternative frameworks to faculty adoption of instructional technology, some similar to the stage models offered by Rogers (1995). The factors identified in this body of adoption literature that differ from Rogers’ innovation diffusion theory include: Stages of Concern and Levels of Use (Hall Wallace & Dossett, 1973); computer anxiety, subjective norms (Corwin & Marcinkiewicz, 1998); innovation amenability and adaptability (Herling, 1994); potential adopter usage style (Casmor, 2001); perceived risk (Rastegary, 1989; Ram, 1989); self-efficacy and instructional support design (Ertmer, 2001; McKinney, Sexton, & Meyerson, 1999); and potential adopters’ perceived goals (Zhao & Cziko, 2001).

The strengths of the literature in this section include Hall, Wallace & Dossett’s Levels of Use construct: nonuse, orientation, preparation, mechanical use, routine, refinement, integration and renewal that allows the researcher a spectrum of use that is not considered in the majority of the research done on innovation adoption. This eliminates the dichotomous outcome and allows for more complex models predicting use. Another strength is the inclusion of qualitative studies that are methodologically rigorous and that frame the adoption process in the faculty experience. Some of the weaknesses include frameworks that are based on a limited sample or a case study and stage frameworks that are not inherently different than Rogers’ model or add no new information to the process.

Section III: Literature Review of Sustained Use of Instructional Technology

The construct of sustained use does not appear in Rogers’ innovation diffusion literature but it does appear in Hall, Wallace & Dossett’s (1973) alternative Concern’s Based Adoption Model. Hall, Wallace & Dossett’s Level of Use construct allows researchers the ability to assess use of instructional technology beyond the dichotomous adoption (yes/no) outcome. There has been an increased interest in another body of literature that examines factors that predict and explain the utilization of information technology by end-users (Hartwick & Barki, 1994). Two well-known models
of technology use include the technology acceptance model (TAM) (Davis, 1989) and the task-technology fit model (TTF) (Ajzen, 1991), both developed in the Information Science field. These two theories are specific adaptations of Ajzen & Fishbein's (1975,1980) Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB) (Ajzen, 1991; Mathieson, 1991) from the social-psychology literature. A detailed history of the Theory of Reasoned Action is beyond the scope of this study, but much like Rogers’ innovation diffusion theories, TRA is the framework for most, if not all of the technology usage studies. Therefore, this section includes a brief introduction to TRA, empirical research on TAM and TTF, empirical research on a blended TAM/diffusion theory model, a critical review of the strengths and weaknesses of this body of literature and how this literature fills gaps in the innovation diffusion literature.

**Theory of Reasoned Action**

Research on attitudes began in the late 1950’s and much of the work focused on attitude measurement and theory. Fishbein (1967) introduced the Theory of Reasoned Action, which focused on predicting behavior in laboratory and applied settings. The theory underwent years of refinement and testing (Fishbein & Azjen, 1975) and in 1980, Ajzen and Fishbein released a follow up work on *Understanding Attitudes and Predicting Social Behavior*.

The Theory of Reasoned Action is based on the assumption that humans are rational beings and make systematic use of all available information. Ajzen & Fishbein (1980) argue that people consider the implications of their actions and that no social behavior is controlled by unconscious motives or thoughtless in nature. The goal of the theory is to predict and understand human behavior. The authors assume that a person’s intentions to perform are the immediate determinants of behavior. Because the goal is to understand behavior and not intentions, the authors argue that it is necessary to identify factors that influence intentions. According to the Theory of Reasoned Action, a person’s behavioral intentions are a function of two factors; one personal in nature and the other a normative influence. The personal factor is the individual’s positive or negative attitude toward the behavior. The
normative factor is the individual’s perception of the social pressures to perform the behavior, which is called the subjective norm. Together, both factors are predictors of intentions and the relative weights for each factor may differ from one individual to the next. Research on attitudes led Ajzen & Fishbein (1980) to believe that attitudes toward behavior are a function of personal beliefs. According the theory, the beliefs that underlie attitudes toward the behavior are called behavioral beliefs and beliefs that underlie the subjective norms are normative beliefs.

A distinct difference between Ajzen & Fishbein’s work and many others that attempt to predict behavior is that attitudes in their framework refers specifically to attitudes towards the behavior and not attitudes towards objects, people, or institutions. Although there is plenty of evidence to suggest that attitudes towards people, objects and institutions are related to behaviors, they are not an integral part of the authors’ theory because there is no necessary, predictive relationship to behavior. Therefore, all personality traits and demographic characteristics are considered external variables that may be controlled for statistically.

Ajzen & Fishbein (1980) caution that behaviors are inherently different from outcomes. For measurement purposes, an outcome could be a set of behaviors, or many different sets of behaviors, which could lead to the same outcome. For example, if the outcome was adoption and sustained use of instructional technology, then either a distinct behavior or a set of behaviors would need to be identified that qualify for adoption and sustained use. In other words, operationalizing the construct is of utmost importance in identifying beliefs and attitudes about the construct.

In summary, personal and normative beliefs influence attitudes and subjective norms respectively; these two factors, weighted accordingly, influence intentions, and intentions influence behavior. The authors argue that an interest in understanding behaviors is important so that we can eventually influence or change behaviors. According to the TRA, behavioral change is ultimately the result of changes in beliefs. This implies that we have to expose individuals to new information, which produces a change in their beliefs, either personal or normative. The authors propose that by producing
a change in beliefs, we can produce a change in attitudes, which can change intentions, which ultimately brings about the desired behavioral change. See the Appendix for the conceptual framework for TRA.

Technology Acceptance Model

Information systems researchers have studied and tried to understand how people’s beliefs and attitudes affect their computer usage behavior (Adams, Nelson & Todd, 1992; Davis, 1986; Davis, 1989; Davis, Bagozzi & Warshaw, 1989; Dishaw & Strong, 1998; Lederer et al., 2000; Moore & Bembasat, 1995; Straub, Keil & Brenner, 1997; Taylor & Todd, 1995; Venkatesh, 2000; Venkatesh & Davis, 2000). Ajzen & Fishbein’s (1980) Theory of Reasoned Action (TRA) which first emerged in 1967, is a well-researched behavioral intention model that information systems researchers adopted from social-psychology that is very general and predicts all human behavior. Davis, (1986) in his doctoral dissertation introduced an adaptation of TRA, called the Technology Acceptance Model (TAM) that was specifically designed to predict computer usage behavior. TAM has become one of the basic frameworks that IS researchers use today and has been tested empirically by others in general (Adams, Nelson & Todd, 1992; Davis, Bagozzi & Warshaw, 1989; Lederer et al., 2000; Venkatesh, 2000; Venkatesh & Davis, 2000), across genders (Venkatesh & Morris, 2000), and across cultures (Straub, Keil & Brenner, 1997).

Davis (1986) intended the Technology Acceptance Model to provide an explanation of the predictors of computer acceptance and usage behavior across a broad range of computer technologies and user populations (Davis, Bagozzi & Warshaw, 1989). He also wanted the model to be parsimonious and generalizable. Because the model is based on Ajzen & Fishbein’s TRA (1980), the goal of TAM is to identify the external variables that impact personal beliefs, attitudes and intentions to use computer technologies. Davis focused on two beliefs as the primary predictors of attitudes towards technology acceptance and usage: perceived usefulness (Bagozzi, 1982) and perceived ease of use (Bandura, 1982; Deci, 1975). Perceived usefulness is the potential user’s subjective belief that the technology application/system will increase or improve job performance. Perceived ease of use is the potential
user’s belief that the technology application/system will be effortless or easy to use. These two predictors had been identified in the literature previously and, through factor analysis, had been shown to be statistically independent dimensions (Davis, 1989; Hauser & Shugan, 1980; Larcker & Lessig, 1980; Swanson, 1987).

Like TRA, TAM suggests that application/system use is predicted by intentions to use, which is predicted by attitudes towards usage. Where TAM differs is that Davis argued that perceived usefulness and perceived ease of use are the only beliefs necessary to predict attitudes towards usage. He also included external variables and their impact on perceived usefulness and ease of use. Davis also argued that perceived usefulness has a direct effect on intentions to use the application/system, which is counter to TRA. The weights for the effects of U and EOU are statistically estimated through linear regression whereas, the weights for TRA were predetermined by the subject. The last difference between TRA and TAM is that TAM does not include subjective norms as a predictor of attitudes towards the behavior. See Appendix A for the TAM framework.

Davis (1989) developed measurement scales for perceived usefulness and perceive ease of use. Explicit definitions were given to the two constructs, followed by a comprehensive literature review on why these two constructs are important predictors of system usage. Both scales exhibited convergent and discriminant validity as well as reliability. Findings from the study suggest that usefulness was significantly more predictive of usage than ease of use.

In a follow up study, Davis, Bagozzi & Warshaw (1989) examined 107 full-time MBA students at the University of Michigan to assess the predictability of TAM and to compare it to TRA. A word-processing program that was to be used voluntarily, was available to the MBA students in the computer labs. The survey instrument was created to elicit the students beliefs, attitudes and intentions towards usage and was administered twice during the semester. The actual usage was a self-reported measure of use using several Likert scale measures. The instrument and scales were tested with Cronbach’s alpha for reliability.
The authors found that behavioral intention was significantly correlated with usage and none of
the other constructs had a larger effect on usage above and beyond intention to use which suggests that
intentions fully mediate the effects of the other variables. The TRA model explained 32% and 26% of
the variance in intentions to use at time 1 and 2 respectively. TAM explained 47% and 51% of the
variance in intentions to use at time 1 and 2 respectively. Within TAM, perceived usefulness (U) had a
very strong effect at both time periods, furthermore, U had a larger effect at time 2. Perceived Ease of
Use (EOU) had a significant direct effect on intentions to use, which is counter to TAM. Therefore,
there is evidence to suggest that attitudes mediate beliefs less than postulated by TRA and TAM.

In summary, the students’ application use was predicted reasonably well by their intentions to
use, perceived usefulness was a major factor in predicting intentions to use and perceived ease of use
was a significant secondary factor in predicting students’ use of the word-processing package. The study
provided evidence that both TRA and TAM are powerful and parsimonious models that predict
behavior based on perceived usefulness, perceived ease of use and intentions to use.

Shortly after, Adams, Nelson & Todd (1992) replicated Davis et al.’s (1989) work using the
scales that Davis (1989) developed to examine the validity of the scales across a variety of technologies.
The first study examined electronic and voice-mail usage for employees across 10 organizations. The
results showed that the ease of use and usefulness scales developed by Davis held up in the replication.
A structural equation model indicated evidence to support Davis et al.’s (1989) findings that usefulness
is the key predictor of usage and that the path for ease of use was not significant. In a second sample of
73 MBA students, results were not consistent across software packages. For Wordperfect, usefulness
was not significant yet ease of use was, which is counter to previously reported results. For Lotus 1-2-3,
the usefulness path was significant and the ease of use path was only marginally significant and
negative, indicating that as complexity of the package increases, usage increases. Results for the Harvard
Graphics package indicate that ease of use was marginally significant and usefulness was not. The
authors posited that because they used a sample of students that perhaps the subjective norms to use
the software superceded the effects of ease of use and usefulness. The limitations of this study are common to usage studies and they are: self-reported measures of usage, cross-sectional in nature, and small sample sizes to estimate complex structural equation models.

A body of research similar to that outlined above shows consistent results with perceived ease of use and usefulness using TAM. The research indicates that behavioral intentions are significant predictors of usage, usefulness is the predominant factor in predicting usage and ease of use is a secondary predictor of usage (Haynes & Thies, 1991; Hendrickson & Collins, 1996; Igbaria, et al., 1995; Mathieson, 1991; Morris & Dillon, 1997; Straub et al., 1997; Taylor & Todd, 1995).

Lederer, et al. (2000), conducted a study on a sample of 163 subjects to determine web site usage for employees of a company. The unique feature to this study was that they used a holdout sample to test the validity of ease of use and usefulness scales and then used the remaining sample to test the structural equation model for TAM. The results support TAM showing usefulness with a strong and significant effect and ease of use with a significant but lesser effect. The R-square for the model predicting web-site usage was low at 15%.

In recent years, scholars have begun to explore extensions to TAM. Jackson, Chow & Leitch (1997) incorporated user involvement constructs and other psychological constructs into TAM and called it a Technology Acceptance Model Extension (TAME). Their model consisted of the original TAM, but it also contained exogenous variables including situational involvement (participation), intrinsic motivation, argument for changing the system and prior use all predicting usefulness, attitudes and behavioral intentions. A structural equation model in LISREL indicated that 87% of the covariance among the factors that lead to one’s behavioral intention to use the application/system is explained by the model. Results revealed that constructs significantly related to attitude were ease of use, situational involvement and intrinsic motivation. Attitude, however, was not significantly related to behavioral intention to use the system. Ease of use and usefulness both have positive influences on behavioral intentions to use the system. Jackson et al. conclude that although TAME is a statistically better fit to
the data, it does not do a better job of explaining the variance in behavioral intention to use the system than just TAM.

Others with extension models include Venkatesh (2000) and Venkatesh & Davis (2000). Because the empirical evidence exists for ease of use and usefulness to predict behavioral intentions, scholars have begun to examine the determinants of perceived ease of use as a predictor of usefulness and behavioral intentions. Venkatesh (2000) added computer self-efficacy, perceptions of external control (environment), computer anxiety, computer playfulness, perceived enjoyment and objective usability as predictors of perceived ease of use. He tested this model with three longitudinal field studies with three time points.

The first was a study with 70 employees from a retail electronic store. The second study was a large real estate company of 160 employees and the third study included 52 employees from a financial firm. At time 1, the results show that computer self-efficacy, perceptions of external control, computer anxiety (negative) and computer playfulness were all significant predictors of perceived ease of use. Ease of use was a significant predictor of usefulness and both were significant predictors of intentions to use the system. At time 2, all six of the additional factors were significant predictors of perceived ease of use. Notable at time 2, is the increase in the strength of the effect of usefulness on behavioral intentions and the decrease of ease of use. Moreover, this model explained 54% of the variance in behavioral intentions. At time 3, all additional factors were significant except for computer playfulness. The strength of prediction by usefulness increased again and the strength of ease of use on behavioral intentions decreased once again. Furthermore, the model predicted 60% of the variance in behavioral intentions.

In a subsequent study Venkatesh & Davis (2000) extended TAM to predict perceived usefulness. Factors that were added included: voluntariness, experience, subjective norms, image, job relevance, output quality and result demonstrability and the proposed model was called TAM2. Recall that Ajzen & Fishbein’s (1980) model of TRA included subjective norms as a predictor of attitude but
Davis et al. (1989) found that subjective norm had no significant effect on intentions over and above perceived usefulness and perceived ease of use. Here the authors add subjective norms as a predictor of perceived usefulness. Closely related is the variable image, which is directly linked to subjective norms. It is an individual’s response to a social norm to establish a favorable image. Notice that the proposed list closely resembles Rogers’ (1995) innovation characteristics. Job relevance and output quality are much like compatibility and relative advantage and result demonstrability is very much like observability. So for all practical purposes, one could state that Venkatesh & Davis are blending Rogers’ innovation characteristics into TAM to help predict perceived usefulness instead of predicting the outcome adoption or sustained use.

Results were consistent with much of the prior research. Perceived usefulness was a strong predictor of intention and perceived ease of use was a significant yet weaker predictor. The effect of subjective norm on intention was significant when the usage was mandatory, however when usage was voluntary, subjective norm was not a significant predictor of intention to use. TAM2 explained between 37% and 52% of the variance in behavioral intentions. As for predicting perceived usefulness, subjective norm, image, result demonstrability, perceived ease of use, and an interaction term between job relevance and output quality were all consistently significant across all four studies at all three time points. Moreover, TAM2 explained up to 62% of the variance in perceived ease of use. Limitations to these two studies include small sample sizes and self-reported usage. Strengths of these two studies include longitudinal data, psychometrically tested instruments, well-formulated a priori theoretical frameworks and a statistical analysis that allows for causal relationships to be established (SEM).

Following the work on the extended TAM models, Venkatesh & Morris (2000) investigated gender differences in adoption and sustained use of technology in the workplace. Their longitudinal study consisted of 342 workers being introduced to a new software system, measured at 3 points in time (right after training, one month after training and three months after training). The framework they utilized was TAM with subjective norm, gender, experience and other control variables added. At
all three time points, men’s usage decisions were more strongly influenced by their perceptions of usefulness while women were more strongly influenced by perceptions of ease of use and subjective norm. After the researchers statistically controlled for income, occupation, education levels and prior experience levels, the gender differences still remained significant.

In the only study that I could find of its type, Straub, Keil & Brenner (1997) tested TAM across three cultures. Their study compared TAM across firms in Japan, Switzerland and the US. They administered the same instrument that was tested for validity and reliability, to employees of three different airlines to study adoption and email usage. Straub et al. calculated a cultural index (CMSI) based on Hofstede’s (1980) work that included four dimensions: power-distance, uncertainty avoidance, masculinity and individualism. All three countries had highly different CMSI indices yet the patterns for Switzerland and the US were similar. The researchers hypothesized that TAM would predict well for the US and Switzerland but not for Japan. Perceived usefulness was significant both in the US and Swiss samples, but not for the Japanese, and perceived ease of use was not significant in any of the three samples. The authors hypothesized that cultural tendencies toward more uncertainty avoidance, greater power distances between managers and workers and less individualism disassociate usefulness from usage patterns. Although this comprehensive review of the literature is focused on higher education, global positioning of some universities warrants the investigation of factors affecting faculty adoption and sustained use of instructional technology across cultural boundaries.

Wolski & Jackson (1999) conducted the only study found on applying TAM and TRA to faculty in a higher education setting. The study examines faculty adoption of instructional technology at the University of Arizona. The organizational context for this study is interesting. Five years prior to the study, a deliberate decision was made to place a large group of faculty as a “Faculty Development Team” on campus. They were charged with preparing faculty for the use of new technology in the classroom and to help faculty focus on “student-centered” teaching. Later this task was passed on to an instructional development team at the University. The study involved two frameworks, TRA and TAM.
Upon examination of TAM, Wolski & Jackson hypothesize that the omission of the subjective norm from TAM may work in the corporate sector, but that it was a mistake to eliminate it from studies in educational contexts. Their idea was that in a higher education context, where there is a potential influence of faculty/student relationships and where faculty closely align themselves within communities of peer scholars, it does not seem plausible that faculty would chose (not chose) to use technology without any reference to others approval or disapproval of its use. They also posited that Davis et al.’s (1989) TAM model lacked a full set of beliefs influencing attitudes given the balancing that faculty do with their time across teaching, research and service. Wolski & Jackson expanded the list of potential beliefs that may affect attitudes towards use to include subjective norms, incentives, rewards and training. The problem with this study is that is incomplete. The authors never reported any findings from the survey instrument that they used, but instead recommend that scholars and administrators use TRA and TAM to help identify factors that affect attitudes and intentions to use. It is unfortunate that the study was never carried out to assess whether or not an expanded TAM fit the data generated in a higher education context.

Blended TAM / Innovation Diffusion Models

In the previous section, Venkatesh & Davis (2000) proposed an extended TAM that was actually a blended model of TAM and Innovation Diffusion framework. They did not intentionally use Rogers’ innovation characteristics in their framework but they used constructs that appeared in the IS literature to expand their framework. This section includes the work of scholars who have intentionally blended the two distinct yet theoretically related bodies of research.

Moore & Benbasat (1995) developed a model that was informed by Rogers’ innovation diffusion theory (1995), Ajzen & Fishbein’s TRA (1980) and Davis et al’s TAM (1989). The dependent variable in this study was personal workstation usage. The researchers focused on two dimensions of usage: diversity and intensity of use (Thompson et al., 1991). Tornatzky & Klein (1982), cited previously, in a meta-analysis of the innovation diffusion literature found that compatibility, relative
advantage and complexity (ease of use) were consistently associated with innovation adoption and diffusion. Rogers’ (1995) also identified trialability and observability (result demonstrability and visibility) to be associated with innovation adoption and diffusion. One characteristic that does not appear in Rogers’ framework but is included in this model is image. Rogers claimed that image was subsumed within relative advantage but the authors of this study felt it may be a motivating factor on its own. In addition to the constructs outlined here, computer avoidance, identified by Igbaria (1993), was included to assess how aversion or avoidance reactions would negatively influence usage behaviors. Following the factors outlined by Rogers and the innovation diffusion literature, the authors included subjective norm identified by Ajzen & Fishbein (1980) as a factor affecting both attitudes and usage.

Another factor in the model directly affecting both attitudes and usage is voluntariness. This construct was identified as an extension of Ajzen & Fishbein’s TRA by Ajzen (1991) with his Theory of Planned Behavior (TPB). The basic difference in TPB from TRA is the addition of whether or not the individual has volitional control over his behaviors or the extent to which an individual can decide whether or not he/she acts. Like TRA, TPB is general in nature and not designed specifically to predict technology acceptance/usage. See the Appendix for a complete view of Moore & Benbasat’s framework.

Data were gathered from users and non-users of personal-work-stations (PWS) in seven organizations. A total of 810 surveys were distributed with a response rate of 67%. Moore & Benbasat split the sample into two groups and used the first to assess and calibrate the scales and the model and the second sample to validate the results. Results indicated that all paths in the SEM were statistically significant. Compatibility had the highest influence on attitude, followed by relative advantage and ease of use. The strongest predictors of subjective norm were superiors and senior management. Furthermore, diversity was a more influential indicator of usage than intensity. In terms of the latent variables structure, attitude had a significant positive effect on usage and in fact attitude had the
strongest effect of the three latent variables on usage. Subjective norm had a significant effect on both usage and attitude and voluntariness had a negative effect on both usage and attitude.

The strengths of this study lie in the strong theory underlying the *a priori* framework. When using a structural equation model, it is ultimately the responsibility of the researcher to identify all possible relevant factors based on science to be included in the model. It was a large enough sample for the authors to use a hold out sample to validate the results. A limitation of this study is that it was cross-sectional, and therefore, no causal relationships could be inferred. The model did bring together two distinct yet related bodies of literature and found constructs from both to be significant predictors of IT usage.

In a similar yet slightly different study, Taylor & Todd (1995) developed a blended framework and compared the blended framework to TAM and TPB (Theory of Planned Behavior). Their study consisted of approximately 1000 students at a mid-sized University. A total of 786 participants completed the survey of which 582 were undergraduates and 204 were MBA students. Usage of the technology was purely voluntary and the data collection was longitudinal over a 12 week period.

The three models that were tested were TAM, TPB, which is similar to TRA with the addition of a perceived behavioral control variable and what the authors called a Decomposed TPB. Their suggested framework included attitudes, subjective norm and perceived behavioral control all predicting behavioral intention. Predicting attitude were perceived usefulness, ease of use and compatibility. Predicting subjective norm were peer influence and superior influence and predicting perceived behavioral control were self-efficacy, resource facilitating condition and technology facilitating condition. Perceived behavioral control also had a direct effect on usage behavior.

Results indicated that TAM provides a good fit to the data and it accounts for 34% of the variance in usage behavior, 52% of the variance in intention and 73% of the variance in attitude. Ease of use and usefulness were significant, however the path from attitude to intention was not significant. Results also indicated that TPB provided a good fit to the data and its predictive power was comparable.
to TAM. The addition of normative and control beliefs add only slightly to the prediction of behavioral intention and perceived behavioral control does not add predictive power to understanding usage behavior over and above TAM. The Decomposed TPB provided essentially the same fit as the pure TPB model with only a slight increase in $R^2$. Perceived usefulness is a significant predictor of attitude while ease of use and compatibility are not. Attitudes, subjective norm and perceived behavioral control were all significantly related to intention and both intention and perceived behavioral control were significantly related to usage behavior.

Strengths of this study again include the strong theory behind the development of the framework and a complete comparison of findings across models as well as with prior studies. The authors’ attempt at decomposing TPB in lieu of losing parsimony was intended to increase understanding of the variables that influence the latent constructs. This study adds insight into the factors that predict attitudes, intentions and behaviors.

In the original framework of this comprehensive literature review, there was to be a third section that included literature that considered both adoption and sustained use. In the one hundred and ninety one articles that were examined only two studies met that criteria and both were extensions of TRA and TAM, therefore, I conclude this section with these two models. The alternative models were integrated within the two existing literature review sections where they fit better conceptually than on their own.

These last two studies considered both adoption and sustained use of technology, although not instructional technology in a higher education setting. They are similarly based on TRA and TAM, however one study looks at adoption as a prerequisite and predictor of sustained use and the other looks at adoption and sustained use as separate outcomes with two distinct models.

In the first study, Agarwal & Prasad (1997) examined initial use of the World Wide Web and intentions to continue such use in the future, that is, routinize technology use. The model used in this study was developed from a literature review of the IS literature as well as the innovation diffusion
literature and is similar to the blended models previously presented (Moore & Benbasat, 1995; Taylor & Todd, 1995; Venkatesh & Davis, 2000). The model included current use and future use intentions as the two outcomes with current use predicting future use intentions. Predicting both of those outcomes is a set of innovation characteristics identical to Moore & Benbasat (1995) that included: relative advantage, ease of use, compatibility, trialability, visibility, result demonstrability and image. Also predicting the adoption and future use outcomes is voluntariness (Moore & Benbasat, 1995; Taylor & Todd, 1995). Results indicated that visibility, compatibility, trialability and voluntariness were all significant predictors of current usage. Overall, they accounted for 48% of the variance in current use. Relative advantage and result demonstrability were the only two significant predictors of future use intentions and they accounted for 46% of the variance in the model. Current use was not a predictor of future intentions to use, therefore, momentum generated by initial use cannot be relied upon for sustained use.

In the second study, Karahanna, Straub & Chervany (1999) utilized a framework from TRA to develop two distinct models for adoption and sustained use. Their reasoning for examining two models was to understand the difference in pre-adoption and post-adoption beliefs and attitudes. The body of literature examined so far fails to consider this distinction (Adams et al., 1992; Davis, 1989; Davis et al., 1989; Mathieson, 1991; Moore & Benbasat, 1995; Taylor & Todd, 1995).

The research model combined aspects of TRA with aspects of Rogers’ innovation diffusion theory in order answer two research questions: Is the relative importance of attitude and subjective norm in determining behavioral intention the same for potential adopters and users of IT? Do potential adopters and users of IT hold the same behavioral and normative beliefs? The model is identical to the TRA model shown in the Appendix where behavioral beliefs included: perceived usefulness, image, compatibility ease of use visibility, result demonstrability and trialability and the normative beliefs included: top management, supervisor, peers, friends, MIS department and local computer specialists. The only other difference from TRA is the effect of perceived voluntariness on behavioral intention. In
the first model, the outcome is intention to adopt and in the second model, the outcome is intention to use.

Results are based on a cross-sectional sample of 268 respondents. Of the 268, 107 were from potential adopters and 161 were from users. After a non-response bias check, results indicated that in this context, Windows adoption in a single organization is solely determined by normative considerations from the social environment while intention to continue to use Windows is determined by user attitude and voluntariness. In the second research question, perceived usefulness is the only belief predicting both attitudes towards adoption and attitudes towards use. Image is significant predictor for users but not adopters. Visibility, result demonstrability, ease of use and trialability are significant predictors for potential adopters. In summary, potential adopters have a richer set of beliefs affecting attitudes towards adoption while users are solely concerned with usefulness and image. The limitations of this study are: only one organization was sampled, data are cross-sectional not allowing for causal links, and the detection of attitude and belief changes over time.

**Task Technology Fit and Other Alternative Use Models**

An alternative to the TRA/TAM paradigm, the Task Technology Fit (TTF) model posits that ‘for technology to have a positive impact on individual performance the technology: must be utilized and be a good fit with the task it supports’ (Goodhue & Thompson, 1995 p. 213). Goodhue & Thompson developed TTF in response to the utilization research being based predominantly on attitudes, beliefs and behaviors. Their research focuses on how task characteristics and technology characteristics predict task-technology fit, which predicts performance impacts. By combining the fit model with the utilization models, Goodhue & Thompson developed a model where task characteristics and technology characteristics predict task-technology fit, which predicts beliefs and attitudes about utilization, which predicts utilization, which predicts performance impacts.

Task-technology fit is the degree to which a technology assists an individual in completing his/her tasks and is the correspondence between the task needs, individual abilities and the ability of
the technology to assist with the tasks. Performance impacts imply improved efficiency, improved effectiveness and/or higher quality.

The model was developed to answer three research questions: 1) Are user evaluations of task-technology fit affected by task characteristics and characteristics of the technology: 2) Does task-technology fit affect technology utilization? 3) Do user evaluations of task-technology fit have additional explanatory power in predicting performance impacts? Goodhue & Thompson tested this model with a large sample of 1200 computer users employing in 25 different technologies, working in 26 different departments in two different organizations. A response rate of 33% resulted in 400 usable surveys. The model indicated significant prediction of task-technology fit from task and technology characteristics. However, results provided little support for the relation between task-technology fit and utilization. Although the regression as a whole and three of the path coefficients were significant, the adjusted $R^2$ for the model predicting use was only 0.02.

The final study to be included in this review is an extension of TTF. Dishaw & Strong (1999) combined TTF with TAM to form a large complex model predicting IT usage. The model included the original TAM and the addition of TTF where task-technology fit predicted perceived usefulness, perceived ease of use and actual usage. Overall the integrated model predicted more variance in the outcome and this variance was explained by perceived usefulness, perceived ease of use, task-technology fit, and task characteristics. TAM’s weakness for understanding technology usage behavior is its lack of inclusion of the task characteristics and how well the technology aids the individual in completing the task. These results lend evidence to suggest that perhaps a blended model that includes task-technology fit may increase our understanding of the usage process.

In summary, research on technology usage in the Management Information Systems literature is predominantly based on Ajzen & Fishbein’s (1980) Theory of Reasoned Action (TRA), which posits that human behaviors, in general, are predicted by beliefs towards the behavior, attitudes and intentions to perform the behavior. Davis (1986) extended TRA to apply specifically to technology usage and
developed the Technology Acceptance Model (TAM). Davis et al. (1989) found that both TRA and TAM are powerful and parsimonious models that predict behavior based on perceived usefulness, perceived ease of use and intentions to use. They also provided evidence to suggest that TAM is more powerful when specifically predicting computer usage. Scholars who have utilized the TRA/TAM framework identified perceived usefulness of the technology to be a primary predictor of usage and perceived ease of use as a significant but secondary predictor of technology usage (Adams, Nelson & Todd, 1992; Davis, Baggozi & Warshaw, 1989; Lederer et.al, 2000; Venkatesh, 2000; Venkatesh & Davis, 2000). Venkatesh & Morris, (2000) found that women are affected more by perceived ease of use and subjective norms than males while males are affected more strongly by perceived usefulness. Furthermore, Straub, Keil & Brenner (1997) found there to be significant differences in the fit of TAM across cultures; a good fit for the US and Switzerland but a poor fit for data from Japan. Moreover, perceived ease of use and perceived usefulness had been identified in the literature previously and, through factor analysis, had been shown to be statistically independent dimensions (Hauser & Shugan, 1980; Larcker & Lessig, 1980; Swanson, 1987; Davis, 1989). Wolski & Jackson (1999) were the only authors found who attempted to apply TAM in a higher education context to predict faculty use of instructional technology, unfortunately, the study was incomplete and never presented results from data collection.

Blended models informed by Rogers' innovation diffusion theory (1995), Ajzen & Fishbein’s TRA (1980) and Davis et al’s TAM (1989) found that compatibility, relative advantage and ease of use were significant predictors of attitudes towards technology usage in a corporate setting. (Agarwal & Prasad, 1997; Moore & Benbasat, 1995; Taylor & Todd, 1995; Venkatesh & Davis, 2000). In addition, Karahanna, Straub and Chervany (1999) found that perceived usefulness was the only belief predicting both attitudes towards adoption and use. Image was a significant predictor for users but not adopters; and visibility, result demonstrability, ease of use and trialability were significant predictors for potential
adopters. Potential adopters had a richer set of beliefs affecting attitudes towards adoption while users were solely concerned about usefulness and image.

Goodhue & Thompson (1995) developed the Task-Technology Fit model that posited technology use would be affected by the fit of the technology to the task at hand. Their results indicated significant prediction of task-technology fit from task and technology characteristics, however, results provided little support for the relation between task-technology fit and utilization. Dishaw & Strong (1999) combined TTF with TAM to form a large complex model predicting IT usage. Results showed the integrated model predicted 51% of the variance in use and found that there was not a significant relationship between task-technology fit and perceived usefulness but there was a significant relationship between task-technology fit and perceived ease of use.

Critique of the Management Information Systems Models

The strengths of the Information Systems body of literature lie in the strong theoretical underpinnings to all of the proposed models and the sophisticated statistical techniques used to assess the adequacy of the models. All of the studies reviewed here include a literature review outlining the theoretical constructs included in the models and a rigorous questionnaire/scale construction process. All of the scales are tested for construct validity and reliability and once psychometrically tested, are used by other researchers in the field. This allows the body of knowledge to build on the studies previously conducted. Structural equation modeling is the analytical method of choice for these studies, which, with longitudinal data, allows the researcher(s) to make causal links between the latent constructs and the exogenous predictors. Another strength of the IS literature is the inclusion of a technology usage outcome that is based on more information than a yes/no adoption outcome (Adams et al., 1991; Davis et al., 1989; Moore & Bonbasat, 1995). As well, this body of literature has begun to explore intensity and diversity of usage patterns (Agarwal & Prasad, 1997).

Weaknesses of the Information Systems literature include contexts where technology usage is not always voluntary and that may be confounding the results of some of these studies. Furthermore,
the context for most of these studies is the corporate sector and the studies that were conducted in a higher education context were conducted using students in a business program and not faculty. Another weakness is self-reported technology usage where research shows that self-reported behaviors are actually overstated (Menzel, 1957; Coughenour, 1955). Some would say that cross-sectional data is a limitation of some of these studies but, in fact, cross-sectional data is the norm in social science research and when longitudinal data is collected, it provides a unique opportunity to assess causal structures that just are not possible with cross-sectional data.

Section IV: Discussion and Conceptual Framework

The study of innovation diffusion has a long history and spans almost every social science discipline. Rogers’ seminal work (1962, 1973, 1995) has influenced the empirical research on identifying innovation characteristics that affect the rate of adoption for the past forty years. Tornatzky & Klein (1982) in their meta-analysis of over 75 studies, revealed that compatibility and relative advantage were the two most positively related factors to adoption. Furthermore, they found that complexity had a consistently significant negative affect on adoption.

Instructional technology in higher education is considered an innovation and has been treated as such in the research related to it. Scholars who have studied faculty adoption of instructional technology suggest that relative advantage and compatibility may also be the most important factors affecting faculty adoption of instructional technology (Allehaibi, 2001; Cartas, 1998; Hightower, 1991; Holloway, 1977; Jones & Laffey, 2000; Wyner, 1974).

Variables that were identified in this review of the literature that affect adoption of instructional technology fall into six categories. The first category is potential adopter traits: risk aversion (Geoghegan, in Gilbert, 1995; Ram, 1989; Rastegary, 1989) gender (Mitra, LaFrance & McCullough, 2001; Venkatesh & Morris, 2000); potential adopter usage style (Casmar, 2001); personal conviction, motivation, experience, self-efficacy (Ertmer, 2001) and academic discipline and age (Corwin &
Marcinkiewicz, 1998; Waugh, 2002). The second category is potential adopters’ beliefs and attitudes: perceived goals (Zhao & Cziko, 2001), positive attitudes towards technology (Ertmer, 2001) and perceived usefulness and perceived ease of use (Adams, Nelson & Todd, 1992; Davis, 1986; Davis, Baggozi & Warshaw, 1989; Lederer et al., 2000; Venkatesh & Davis, 2000). The third category includes innovation characteristics: relative advantage over traditional teaching, compatibility with materials, (Beggs, 2000; Rogers, 1995), perceived value (Marcus, 1986; Rogers, 2000), ease of use, time needed to learn (Beggs, 2000; Malayery, 1986; Rogers, 1995), innovation amenability and adaptability, (Herling, 1994) trialability and visibility, (Karahanna, Straub & Chervany, 1999 Rogers, 1995). The fourth category is organizational and cultural context including faculty support: resources, equipment availability (Beggs, 2000; Marcus, 1986), staff development opportunities, prompt technical support, incentives (Buckenmeyer, 2001; Laffey, 2000; Malayery, 1986) instructional design support, (Ertmer, 2001), strong culture which provides leadership and support for the new technology and encourages risk-taking, mission statements, supportive institutional culture (Beggs, 2000; Corwin & Marcinkiewicz, 1998; Ertmer, 2001; Laffey, 2000; Malayery, 1986; Massy & Wilger, 1998; McKinney, Sexton, & Meyerson, 1999) and cultural context (Straub, Keil & Brenner, 1997). The fifth category is performance impact of the instructional technology: improved student learning (Beggs, 2000), result demonstrability (Karahanna, Straub and Chervany, 1999) The sixth category that overlays all other categories is communication with other adopters (Marcus, 1986; Rogers 1995).

TRA and TAM are powerful and parsimonious models that predict behavior based on and intentions and TAM specifically predicts intentions to use technology. Variables identified from this body of literature that help predict technology usage include: compatibility, relative advantage, perceived usefulness, perceived ease of use, image (Agarwal & Prasad, 1997; Karahanna, Straub & Chervany, 1999; Moore & Benbasat, 1995; Taylor & Todd, 1995; Venkatesh & Davis, 2000) and task-technology fit (Goodhue & Thompson, 1995).
Although this body of literature remains almost completely outside the realm of higher education, I believe these models add to the knowledge about innovation diffusion/adoption and sustained use of instructional technology in many ways. This literature fills gaps in the focus on the behavior and attitudinal theory, sets standards for methodological rigor and identifies scales for constructs that could be used by higher education scholars. Also, the study that was completed at the University of Arizona (Wolski & Jackson, 1999) showed that it may be possible to apply TRA/TAM to faculty use of instructional technology. The innovation diffusion literature is plagued by non-rigorous methodology and statistical techniques, both quantitative and qualitative. Even the research set in a more interpretive paradigm is lacking in theory building and reproducibility.

Proposed Conceptual Framework

Throughout this comprehensive review, I have presented two very distinct bodies of literature: the first, a cross-disciplinary set of studies that included a large number within a higher education context, and the second, a narrowly focused body of literature from Management Information Systems. Both bodies of literature are predominantly based on two well-studied, empirically tested models. In proposing a conceptual framework for the factors that predict faculty adoption and sustained use of instructional technology, I am concerned that while some may agree that a well formulated, generalizable, testable theory is the goal, others may assume highly specified models that attempt to control for everything are worthless in describing and understanding phenomenon of interest. In the end, this may be a philosophy of science question: If we control for everything, what good is the model? But if we don’t control for everything identified in the literature how do we make inference and generalize to populations of interest? How do we make causal links? Or are we truly interested in understanding and explaining?

There are strengths and weaknesses in both the positivistic and hermeneutical paradigms (Kautz & Pries-Heje, 1995). For some, a case-study with semi-structured interviews with faculty on one campus may answer the research question of interest. For policymakers, a multi-institutional study with
structured sampling techniques and psychometrically tested scales may be needed to answer the research question of interest. Many researchers in the literature were challenging the dichotomy between the variance (prediction) and process models (stage) arguing that blending these two approaches would benefit the science. Other researchers were challenging the dichotomy in the adopter-based models covered in this review vs. the organizational-based models not covered in this review. Scholars argued that a blend of these two approaches would suit higher education best; faculty are predominantly independent contractors working within departments, within schools where administrative control can be either highly centralized or highly decentralized. This is of interest to faculty, instructional staff and administrators because resources and faculty support are key issues in faculty adoption and sustained use of instructional technology. Therefore, I propose a conceptual framework that is an integrated process/variance model that will allow researchers to approach this topic from either perspective. The model that is proposed is an attempt to try to incorporate as many constructs and factors identified in the literature that make sense for higher education. See Figure 2 for the framework.

**Insert Figure 2 Here**

The framework identifies constructs in bold and variables identified empirically in the literature. The solid arrows are effects that have been shown to be significant in the literature and the dotted lines are hypothesized relationships or relationships with mixed findings in the literature. This framework combines the variance and process models as it is longitudinal in nature and assumes that there are possibly different factors affecting faculty’s adoption of instructional technology from factors affecting faculty’s sustained use of instructional technology. It also presents a framework where the “external variables” are included for higher education contexts but may not be necessary in the theory of adoption and sustained use. The organizational context is important given the wide variety of institutional types in higher education and varying resources allotted to each institutional type.
Section V: Implications for Future Research

The future of research on adoption and sustained use of instructional technology has implications for higher education because improving teaching should be a goal for every faculty. Integrating technology is just one way faculty can bring their content to the students in new and innovative ways with potential positive effects on student learning. Faculty can fall into a vicious cycle calling for evidence that technology improves teaching and learning before they adopt. This proposes a conundrum as researchers are not able to gather evidence if there is not a critical mass of faculty using instructional technology in the classroom. Up until this point, policy makers and administrator have focused on early adopters but the research shows innovators and early adopters will have already adopted and the needs of the mainstream adopters and laggards are likely different (Geoghegan, in Gilbert, 1995). It is time for researchers in higher education to conduct methodologically rigorous studies that call for faculty participation in the design. Furthermore, in order to better understand the factors that affect the process of adoption and sustained use of instructional technology on local campuses, researchers need to collect data, (including faculty who have yet to adopt) over time.

A clear gap in the existing literature is the application of TRA, TAM and integrated type models in a higher education context. I used Wolski & Jackson’s (1999) examinations of how TAM falls short in a higher education context, to make sure that the dynamics of institutional culture and faculty support were included in the proposed model. There are growing concerns about part-time and adjunct faculty who are increasing in numbers but don’t have the time to integrate instructional technology. These faculty and are located predominantly on campuses with few resources and little support, therefore it is necessary for these types of institutions to be able to identify the needs of this group as a special set of potential adopters.

Another area of research that is just beginning to unfold is the performance impact of instructional technology. Performance impact in a higher education context implies “in what ways does technology improve teaching and learning”? This could be assessed after adoption in the model but
would be better assessed after faculty have achieved sustained use. Research shows that there is a dip in students’ learning outcomes at the onset of integration of technology but, after the faculty have had the chance to fully test and integrate the technology, learning outcomes supercede those measured before integration. The suggested indices for measuring the intensity and duration of use will now allow researchers to determine the effects of how much and how long faculty use instructional technology on student learning outcomes.

Qualitative studies designed to describe faculty experiences will also help bring relevance to the model and help us better understand the process. Although the model is designed to identify factors a priori, studies using grounded theory and phenomenology could also shed light on how campus culture, faculty support, and faculty beliefs and attitudes affect adoption and sustained use.

Another gap in the existing higher education literature is the lack of definitions and consistent and reproducible scales to measure the constructs in the model. The Management Information Science literature provides evidence of how researchers use previously created, psychometrically tested scales to facilitate the creation of a body of knowledge that is more generalizable to specific contexts. Creating such definitions and scales would help bring validity and reliability to the studies as well as help researchers conduct more rigorous studies with less up front design time.

Ultimately institutions would like to identify a robust set of predictors for adoption and sustained use of instructional technology. Just having this knowledge will not be enough. It may take action research to entice the mainstream adopters and laggards into adoption and use of instructional technology. Having the model, however, is the first step in identifying variables that are controllable at the institutional level.

Section VI: Conclusion

The future of higher education is at a crossroads. New delivery technologies, changing demographics, the emergence of the corporate university, and the complex global information
economy are creating a new competitive landscape for higher education. Scholars and policymakers posit that traditional universities will have to match the multimedia sophistication and global educational networking of their competitors (Duderstadt, 1998; Goldstein & Lozier, 2001; O’Donoghue, Singh, & Dorward, 2001). In order to meet these challenges head on, faculty must be willing to alter their "chalk and talk" pedagogy. In order to ensure that this occurs, faculty, administrators and policymakers must understand the factors that affect faculty adoption and sustained use of instructional technology.

The two bodies of literature that were examined for this review, innovation diffusion and technology acceptance/utilization are comprehensive and complementary. The integrated framework that emerged allows researchers to understand the interplay between faculty beliefs and attitudes and the effects institutional and departmental culture have on adoption and sustained use of instructional technology. The model has implications for increasing the rate at which faculty adopt and use instructional technology in traditional classrooms but also for identifying potential impacts of technology integration.

Finally, as one faculty member lamented: “I naively believed I could sail along until impending retirement renewed questions about my identity and sense of competence. Unfortunately, however, the pace of change in the late twentieth century does not permit such tranquility… Thus, I find that I am once again in an uncomfortable stage—too old to be completely at ease with technology, yet too young to ignore it. The fact is, technology is gradually transforming higher education” (Baldwin, 1998, p. 7).

Armed with this collective body of research, institutions can more meaningfully address faculty development efforts in supporting faculty adoption and sustained use of instructional technology. Administrators can also hold a hope that course websites, multi-media presentations and online chats with experts in the field will be present in all traditional classrooms sometime soon.
Rogers & Shoemaker (1973): A Model of Stages in the Innovation Decision Process

**Characteristics of the Decision-Making Unit**
1. Socioeconomic characteristics
2. Personality variables
3. Communication behavior

**Perceived Characteristics of the Innovation**
1. Relative advantage
2. Compatibility
3. Complexity
4. Trialability
5. Observability

**Communication Channels**

- Knowledge → Persuasion → Decision → Implementation → Confirmation

**Stages of Adoption**
- Adoption
- Rejection
- Continued Adoption
- Later Adoption
- Discontinuance
- Continued Rejection

Prior Conditions:
1. Previous practice
2. Felt needs or problems
3. Innovativeness
4. Norms of the social system
Table 1

Overview of adopter-based innovation diffusion/adoption stage models

<table>
<thead>
<tr>
<th>Author</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>Stage 6</th>
<th>Stage 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Havelock (1973)</td>
<td>Awareness</td>
<td>Information Seeking</td>
<td>Evaluation</td>
<td>Trial</td>
<td>Adoption</td>
<td>Integration</td>
<td></td>
</tr>
<tr>
<td>Hall, Wallace &amp; Dossett (1973)</td>
<td>Awareness</td>
<td>Information Gathering</td>
<td>Personal</td>
<td>Management</td>
<td>Consequence</td>
<td>Collaboration</td>
<td>Refocusing</td>
</tr>
<tr>
<td>Fung (1992)</td>
<td>Awareness</td>
<td>Attitude Formation</td>
<td>Adoption (Idea, Trial, Practice)</td>
<td>Adaption</td>
<td>Action</td>
<td>Application</td>
<td></td>
</tr>
<tr>
<td>Knuetel (1995)</td>
<td>Awareness</td>
<td>Conceptualization</td>
<td>Decision</td>
<td>Implementation</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Figure 2

Proposed Conceptual Framework for Faculty Adoption and Sustained Use of Instructional Technology in Traditional Classrooms

Communication Channels

- **Innovation Traits (Time 1)**
  - Relative advantage
  - Trialability
  - Compatibility
  - Result Demonstrability
  - Ease of Use

- **Innovation Traits (Time 2)**
  - Relative advantage
  - Compatibility
  - Ease of Use
  - Image
  - Performance Impact

- **Faculty Demographics**
  - Gender
  - Rank
  - Race
  - Department

- **Faculty Beliefs and Attitudes (Time 1)**
  - Feel Supported
  - Feel Valued
  - Subjective Norms
  - Stages of Concern

- **Faculty Beliefs and Attitudes (Time 2)**
  - Perceived Ease of Use
  - Perceived Usefulness
  - Feel Supported
  - Feel Valued
  - Subjective Norms
  - Stages of Concern

- **Adoption of Instructional Technology**

- **Levels of Sustained Use of Instructional Technology**
  - Intensity
  - Diversity

- **Organizational Context**
  - Administration Culture
  - Mission Statements
  - Budgetary Control
  - Resources / Infrastructure
  - Intellectual Property Policies Clearly Defined

- **Faculty Support**
  - Incentives
  - Rewards
  - Professional Development

- **Faculty Personality Traits**
  - Self-efficacy
  - Computer Anxiety
  - Motivation
  - Innovativeness
Appendix: Timeline for Behavioral Models for Technology Acceptance/Use


```
Behavioral beliefs → Attitude toward behavior → Intentions → Behavior

Normative beliefs → Subjective norms
```

2. Davis, Buggozi, & Warshaw’s (1989) Technology Acceptance Model, TAM.

```
External Variables → Perceived Usefulness

Perceived Ease of Use → Attitude Toward Using → Behavioral Intention to Use → Actual System Use
```


```
Perceived Voluntariness

Subjective Norm

Peers

Subordinates

Superiors

Relative Advantage

Image

Ease of Use

Compatibility

Trialability

Result Demonstrability

Avoidance

Visibility

Usage

Intensity

Diversity
```

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