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THE EFFECT OF A NEW VERSION OF SOFTWARE ON ITS USE:
A CASE STUDY OF A COURSE MANAGEMENT SYSTEM

By
John A. Beckett

A DISSERTATION

Submitted to
H. Wayne Huizenga School of Business and Entrepreneurship
Nova Southeastern University

In partial fulfillment of the requirements
for the degree of

DOCTOR OF BUSINESS ADMINISTRATION

2007

A Dissertation
Entitled

THE EFFECT OF A NEW VERSION OF SOFTWARE ON ITS USE:
A CASE STUDY OF A COURSE MANAGEMENT SYSTEM

By

John A. Beckett

We hereby certify that this Dissertation submitted by John A. Beckett conforms to acceptable standards, and as such is fully adequate in scope and quality. It is therefore approved as the fulfillment of the Dissertation requirements for the Degree of Doctor of Business Administration.

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2007

CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed _____
John A. Beckett

ABSTRACT

THE EFFECT OF A NEW VERSION OF SOFTWARE ON ITS USE: A CASE STUDY OF A COURSE MANAGEMENT SYSTEM

by

John Allen Beckett

Course Management Systems (CMS) are used to support the growing trend of colleges and universities to offer classes at a distance, and to use technology to provide resources and communication with and for students in traditional classroom settings. Actual use and success of these systems has been mixed in practice, however, for reasons which are not entirely clear.

The theory of Diffusion of Innovations (DOI) described and codified by Everett M. Rogers in 1962 is used to describe how innovations are selected, adopted, and brought to bear on the needs of people with jobs to do. Gary C. Moore and Izak Benbasat extended this theory with constructs specific to Information Technology (IT).

This study applies the Moore and Benbasat constructs to the area of CMS, in a situation where software is being upgraded through the installation of a newer version. We investigate how the Moore & Benbasat constructs describe the impacts on the diffusion of the CMS in a specific case study.

ACKNOWLEDGEMENTS

This dissertation is dedicated to those who have made it possible.

God, the ultimate source of all power, has generously provided the many resources necessary for this project through His servants – however they see or relate to Him.

Barbara, my wife of 34 years, has stood by me faithfully through my graduate education. She has encouraged me to carry on, tolerated my absence from family responsibilities, and been an active participant – often checking for errors and language in various papers including this one. My son Robert has helped with wording where concepts were difficult to communicate.

Dr. Jared Bruckner, dean of the School of Computing at Southern Adventist University, has provided release time for my doctoral program. He has encouraged or goaded me as the situation demanded. I am delighted to see the process finishing as he retires. Dr. Richard Halterman, our new dean, has carried on with these functions.

The administration of Southern Adventist University has generously provided financial support, allowing me to focus on learning and research.

My committee deserves special mention for their unique contributions. As my committee chair, Dr. Jay Aronson has encouraged me to reach higher from the moment we met. He has noticed both what I was doing well, and what needed improvement. He was quick to stop me when my research was heading for a dead end, saving me much time. As methodologist, Dr. Randi Sims' ruthless concern for proper presentation in research reports was necessary and helpful. To others doing dissertation research, I would say to get a methodologist who has no patience with fools if you would not become a fool. To function as reader, Dr. Willard Munger kindly stepped aside from his role as a fellow instructor in my department. He provided invaluable mentorship in the research and dissertation process. He repeatedly pointed out logical traps and ways one might avoid them.

Finally, my survey respondents at Southern Adventist University helped tremendously by giving me a high response rate for high-quality statistical results. Their time and attention is much appreciated.

There is not room to properly recognize all the others who have contributed to this research. They include Dr. George Babcock, Dr. Gordon Bietz, Dr. Paul Dion, Dr. Jan Haluska, Dr. Lawrence Hanson, Henry Hicks, Dr. Dan Lim, Dr. Steve Pawluk, Dr. Don Van Ornam, and Larry Turner.

TABLE OF CONTENTS

| | Page |
|---|------------|
| LIST OF TABLES | vii |
| LIST OF FIGURES | x |
| CHAPTER I | 1 |
| INTRODUCTION | 1 |
| Statement of the Problem..... | 2 |
| Objective of the Study | 3 |
| Theoretical Framework..... | 3 |
| Challenges..... | 6 |
| The Usage Controversy..... | 6 |
| Definitions..... | 9 |
| The Missing Link to Performance | 12 |
| Attempts to Tie ITU to Usage..... | 12 |
| The Ease-Of-Use Dropout | 13 |
| Diffusion Theory’s Nay-Sayers | 15 |
| Importance of the Topic..... | 18 |
| Setting and Methodology..... | 19 |
| Scope and Limitations..... | 19 |
| Advantages and Limitations of the Study Setting..... | 20 |
| Summary | 20 |
| CHAPTER II..... | 21 |
| REVIEW OF LITERATURE | 21 |
| Introduction..... | 21 |
| Relationships Between Theories..... | 22 |
| Original Models | 25 |
| Diffusion of Innovations (DOI) | 25 |
| Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB) models | 26 |
| Technology Acceptance Model (TAM)..... | 27 |
| Model of Personal Computer Utilization (MPCU)..... | 28 |
| Computer Self-Efficacy Model (CSE)..... | 28 |
| Task-Technology Fit Model (TTF)..... | 29 |
| Eclectic Models..... | 30 |
| TAM-TTF | 30 |
| “Decomposed” TPB | 30 |

| | |
|--|----|
| TAM2 | 31 |
| Unified Models | 31 |
| UTAUT | 31 |
| TTF-UTAUT..... | 32 |
| Gallivan’s Overall Perspective | 32 |
| Tangential Theories and Constructs..... | 33 |
| Success Factors Theory..... | 33 |
| Habit Construct | 35 |
| Adaptive Structuration Theory | 36 |
| Compatibility and Connectedness Constructs | 37 |
| Over-Arching Trends | 38 |
| What Matters Most?..... | 38 |
| Critiques of Research Designs | 39 |
| The Subjective Norm Shift | 39 |
| Conclusions..... | 40 |

CHAPTER III **43**

RESEARCH METHODOLOGY **43**

| | |
|---|----|
| Introduction..... | 43 |
| Overview | 43 |
| Research Methodology | 44 |
| Theoretical Framework | 44 |
| Research Model | 45 |
| Study Setting..... | 45 |
| Population | 45 |
| Anonymity | 46 |
| Technology Studied | 47 |
| Variables | 47 |
| Intention to Use (ITU)– Dependent Variable | 47 |
| Actual Use (AU) – Dependent Variable | 48 |
| Relative Advantage (RA) – Independent Variable | 48 |
| Compatibility (CO) – Independent Variable..... | 49 |
| Ease of Use (EU) – Independent Variable | 49 |
| Triability (TR) – Independent Variable | 49 |
| Result Demonstrability (RD) – Independent Variable..... | 50 |
| Voluntariness (VO) – Independent Variable | 50 |
| Intervention Participation (IP) – Independent Variable..... | 51 |
| Size of Class (SC) – Independent Variable..... | 51 |
| Visibility – Independent Variable | 51 |
| Research Questions..... | 52 |
| Hypotheses | 53 |
| Survey Instrument..... | 57 |
| Prior Studies Using Similar Measures and Procedures..... | 59 |

| | |
|---|-----------|
| Reliability of the Instrument | 60 |
| Procedure | 62 |
| Data Analysis and Strategy | 62 |
| Limitations | 63 |
| Conclusions/Summary | 63 |
| CHAPTER IV | 65 |
| ANALYSIS & PRESENTATION OF FINDINGS | 65 |
| Introduction..... | 65 |
| Fundamental Analysis of Data..... | 65 |
| Survey Procedure | 65 |
| Response Rate..... | 66 |
| Respondent Demographics | 67 |
| Missing Data | 67 |
| Outliers..... | 67 |
| Analysis of Measures – Instrument Validity and Reliability..... | 67 |
| Analysis of Hypotheses..... | 68 |
| Analysis of Hypothesis One..... | 68 |
| Analysis of Hypothesis Two..... | 69 |
| Analysis of Hypothesis Three..... | 71 |
| Analysis of Hypothesis Four..... | 73 |
| Analysis of Hypothesis Five..... | 74 |
| Analysis of Hypothesis Six..... | 76 |
| Analysis of Hypothesis Seven | 78 |
| Analysis of Hypothesis Eight..... | 79 |
| Analysis of Hypothesis Nine | 81 |
| Analysis of Hypothesis Ten..... | 82 |
| Analysis of Hypothesis Eleven | 84 |
| Analysis of Hypothesis Twelve | 85 |
| Analysis of Hypothesis Thirteen..... | 87 |
| Analysis of Hypothesis Fourteen | 89 |
| Analysis of Hypothesis Fifteen..... | 91 |
| Analysis of Hypothesis Sixteen | 92 |
| Analysis of Hypothesis Seventeen..... | 94 |
| Analysis of Hypothesis Eighteen | 95 |
| Conclusion | 97 |
| CHAPTER V | 98 |
| SUMMARY AND CONCLUSIONS | 98 |
| Introduction..... | 98 |
| Summary..... | 98 |
| Interpretations | 99 |

| | |
|--|------------|
| Generalizability..... | 119 |
| Implications for the Case Study Setting..... | 119 |
| Implications for Practice..... | 120 |
| Implications for Research..... | 121 |
| Suggestions for Future Research..... | 122 |
| Reliability and Validity..... | 124 |
| Limitations..... | 124 |
| Conclusions..... | 125 |
| References..... | 126 |
| Appendix A – Survey Cover Letter..... | 135 |
| Appendix B – Survey Instrument..... | 137 |

LIST OF TABLES

3.1 Construct Summary52

3.2 Statistical Techniques56

3.3 Scale Validation – Previous Studies (Cronbach’s Alpha)61

4.1 Cross Tabulation – Survey Response Rates.....66

4.2 Scale Validation – This Study (Cronbach’s Alpha).....68

4.3 Relative Advantage and Intention to Use, Correlation and Descriptive Statistics,
Information Distribution Technology69

4.4 Relative Advantage and Intention to Use, Correlation and Descriptive Statistics,
Assignment Turn-in Technology69

4.5 Relative Advantage and Actual Use, T-Test, Information Distribution Technology ..70

4.6 Relative Advantage and Actual Use, T-Test, Assignment Turn-in Technology71

4.7 Compatibility and Intention to Use, Correlation and Descriptive Statistics,
Information Distribution Technology72

4.8 Compatibility and Intention to Use, Correlation and Descriptive Statistics,
Assignment Turn-in Technology72

4.9 Compatibility and Actual Use, T-Test, Information Distribution Technology73

4.10 Compatibility and Actual Use, T-Test, Assignment Turn-in Technology.....74

4.11 Ease of Use and Intention to Use, Correlation and Descriptive Statistics, Information
Distribution Technology75

4.12 Ease of Use and Intention to Use, Correlation and Descriptive Statistics, Assignment
Turn-in Technology76

4.13 Ease of Use and Actual Use, T-Test, Information Distribution Technology.....77

| | |
|--|----|
| 4.14 Ease of Use and Actual Use, T-Test, Assignment Turn-in Technology..... | 77 |
| 4.15 Trialability and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology..... | 78 |
| 4.16 Trialability and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology | 79 |
| 4.17 Trialability and Actual Use, T-Test, Information Distribution Technology..... | 80 |
| 4.18 Trialability and Actual Use, T-Test, Assignment Turn-in Technology..... | 80 |
| 4.19 Results Demonstrability and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology..... | 81 |
| 4.20 Results Demonstrability and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology | 82 |
| 4.21 Results Demonstrability and Actual Use, T-Test, Information Distribution Technology | 83 |
| 4.22 Results Demonstrability and Actual Use, T-Test, Assignment Turn-in Technology | 84 |
| 4.23 Voluntariness and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology..... | 85 |
| 4.24 Voluntariness and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology | 85 |
| 4.25 Voluntariness and Actual Use, T-Test, Information Distribution Technology | 86 |
| 4.26 Voluntariness and Actual Use, T-Test, Assignment Turn-in Technology..... | 87 |
| 4.27 Intention to Use and Intervention Participation, T-Test, Information Distribution Technology | 88 |

| | |
|---|-----|
| 4.28 Intention to Use and Intervention Participation, T-Test, Assignment Turn-in Technology | 89 |
| 4.29 Intervention Participation and Actual Use, Cross Tabulation and Chi-Squared, Information Distribution Technology | 90 |
| 4.30 Intervention Participation and Actual Use, Cross Tabulation and Chi-Squared, Assignment Turn-in Technology | 90 |
| 4.31 Size of classes and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology | 91 |
| 4.32 Size of classes and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology | 92 |
| 4.33 Class Size and Actual Use, T-Test, Information Distribution Technology | 93 |
| 4. 34 Class Size and Actual Use, T-Test, Assignment Turn-in Technology | 93 |
| 4.35 Visibility and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology | 94 |
| 4.36 Visibility and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology | 95 |
| 4.37 Visibility and Actual Use, T-Test, Information Distribution Technology..... | 96 |
| 4.38 Visibility and Actual Use, T-Test, Assignment Turn-in Technology..... | 96 |
| 5.1 Hypotheses Overview | 100 |

LIST OF FIGURES

| | |
|---|----|
| 2.1 Map of Diffusion of Innovation-Related Theories | 23 |
| 3.1 Model and Variables | 57 |

CHAPTER I

INTRODUCTION

This chapter provides an overview of the dissertation. It begins by providing (a) the statement of the problem, (b) the background of the problem, (c) the objective of the study, (d) the theoretical framework of the study, (e) the scope and limitations of the study, and concludes with (f) the summary and future work.

The path of innovation is not a smooth uphill climb. At the point of adoption, the value of an innovation is negative. At this point cost has been incurred for scanning, selection, and commitment (Rogers 2003, p. 14). But no benefit has yet resulted. Positive value derives only from actual use pursuant to the mission of the individual or organization.

At implementation time, alignment between the innovation and the individual or organization may be poor. Examples of poor alignment include:

- A cumbersome interface between the individual and the technology, resulting in confusion or additional work to accomplish the job.
- Lack of knowledge about how to use the technology efficiently, resulting in reduced efficiency.
- A technology whose product is not what the organization needs, resulting either in failure to accomplish the mission or reduced efficiency.
- Increased workload due to parallel runs of old and new systems.

Adjusting alignment for maximum effect may involve changes in the innovation, changes in its use, changes in understanding of the innovation, or even changes in the organization's mission. This process of adjustment is, due to its multidimensional nature, necessarily "messy" and difficult to study. Yet it is a critical part of deriving benefit from innovations.

While numerous research studies have considered initial adoption and implementation of new technologies, they usually treat each technology as a discrete entity unrelated to previous technologies used. This is best indicated by the fact that they fail to specify the technology being replaced. However, innovations do not exist in a vacuum. Innovations are usually adaptations or extensions of existing technology. They are likely to be invoked in an atmosphere involving substantial existing technology. Rogers (2003, p. 15) suggests that it is appropriate to do research which takes existing technology into account. Accordingly, this research focuses on a change from one version of a technology to another: a software system upgrade.

Statement of the Problem

Research is needed to determine what interventions effectively align a new technology and its application environment, for maximum value to the organization. This case study explores events and consequences along that path.

Objective of the Study

This research specifically examines the link between support activities, and secondary adoption, also known as implementation. This required measurement of initial attitudes and usage, final attitudes and usage, participation in activities made possible by interventions, and perceptions of the value of interventions. This research provides empirical evidence showing which interventions are most effective at facilitating effective use of an upgrade to an innovation.

Moore and Benbasat (1991) developed an instrument to “measure the perceptions of adopting an Information Technology innovation.” This instrument has high construct reliability and is touted by the authors as being parsimonious. This research applies the same instrument to a new situation, an upgrade case.

Theoretical Framework

Rogers (1962, 1971, 1983, 1995, 2003) has popularized the term “Diffusion of Innovations” (DOI) through five editions of his book. It is a *tour de force* tracing the history of DOI research, discussing the various aspects of DOI in detail, and calling for research in the future. This dissertation views the issues studied from a DOI perspective, but touches on alternative views that have also obtained a hearing in the research world.

DOI is a much-studied topic, for several reasons:

1. Stakeholders wish to see the best methods in use, so as to maximize their return on investment – whether that return is money or services, and whether that investment is

money or some other resource such as time or raw materials. This holds true across the entrepreneurial spectrum from investor to environmentalist. If the wrong innovations are selected or implementation fails, the needs of the stakeholders are not served.

2. Vendors of technology equipment and services wish to improve their position in the marketplace. For them, this means identifying trigger factors that will provoke both initial purchase behavior and repeat or continuous purchase behavior on the part of customers. Regardless of the merits of technology being sold, if it is not purchased it helps nobody – least of all those who have created it.
3. Technology managers wish to maximize the value of investments their firms make in technology, by aligning technology use with the needs of the firm. If technology use does not serve the needs of the firm, it is poorly aligned. If it serves the needs of the firm well, alignment is good. While this may involve changes in the technology or choices of which technology to use, value may also be maximized by manipulating perceptions that drive behaviors necessary to exploit innovations (Leonard-Barton & Deschamps, 1988; McCarthy, Aronson, & Claffey, 2002). At the very least this means that technology purchased is actually used.

Hebert and Benbasat (1994) suggest that:

...beliefs behind the behavior can be changed. Measuring perceptions is important at Lewin's "unfreezing" stage and helps uncover reasons instrumental in "unfreezing" or changing behavior, which are important to a

potential user. This information is helpful in the implementation stage in converting “behavioral intent” to “behavior.” Thus they advocate a proactive approach in which attitudes are influenced, rather than expecting attitudes to automatically change on the assumption that perceptions are correct.

A wealth of studies (e.g., Agarwal and Karahanna, 2000; Ely, 1990; Lucas and Spittler, 1999; Mathieson, Peacock, and Chin, 2001; Van Slyke, Lou, and Day, 2002) considers attitudes toward technology and resultant adoption of technology. They trace the progress of an innovation through the initial sense of need through identification of possible solutions, and often end with a measurement of intention. This is understandable, because all of these elements can be studied by administering surveys and submitting the results to computerized statistical analysis. But this approach leaves a gap, which this research attempts to close to some degree: Is the selected technology actually used?

In a related issue, DOI studies have largely ignored the issues of the reliability of the technology and support which, if effective, turns potential “show-stopper” problems into minor events. Whereas adoption keys on perception (and produces no value except purchase commitment), actual use yields value but depends heavily on successful implementation (Zmud & Apple, 1992). The need for reliable technology seems obvious. Igarria, Guimaraes, and Davis (1995) found end-user support including training positively related to use. Igarria et al. (1997) refined this conclusion by showing that large organizations can support better training programs than small organizations, and that this shift favors easy-to-use software for small organizations. Orlikowski et al.

(1995) suggested that “intermediaries” who both structure and interpret the technology, would be helpful in obtaining usefulness from it.

Challenges

Even limiting the scope of research to the topic of actual use, one faces significant challenges. The most obvious is, “What do we mean by use?” It could be that a software program being studied is actually running on the user’s computer – but are they starting it out of habit and ignoring the output (meanwhile gritting their teeth that their PC takes so long to boot up)? So instrumenting the equipment or software to record objective actions has limited utility. We could ask them if they use it, but empirical studies have cast a shadow on that approach as well – as people often mis-apprehend their own behavior or tailor responses to meet assumed expectations or even manipulate those who are asking the questions.

The Usage Controversy

This study aims to measure actual usage. Anything less, is less than what is needed. Ajzen (1985, p. 29) clarifies this point: “...behavioral intention can best be interpreted as an intention to *try* performing a certain behavior.” Carrying this thought a step further, we find the theory of IS Continuance, which has shown (Bhattacharjee, 2001b) that during early stages of the diffusion cycle people may be influenced either for or against an innovation by a number of factors, but once an innovation has been encountered by users (whether in reality or in perception – as in the case where an

innovation is viewed as merely incremental), the influence of overwhelming strength is its perceived usefulness to the person who has encountered it.

Many researchers (e.g., Agarwal and Karahanna, 2000; Ely, 1990; Lucas and Spittler, 1999; Mathieson, Peacock, and Chin, 2001; Van Slyke, Lou, and Day, 2002) use Intention to Use (ITU) as a proxy for use of an innovation. In these cases ITU is selected as a proxy, based on the assumption that intention implies actual use (Hebert & Benbasat, 1994; Rai, Lang, & Welker, 2002). Ajzen (1996) used Willingness to Pay as an improvement on this proxy.

The assumption that ITU is useful as a proxy for innovation is questionable. Several researchers (Rawstorne, Jayasuriya, & Caputi, 1998, 2000; Schewe, 1976) have found no clear link between ITU and actual use. Others (Davis, Bogozzi, & Warshaw, 1989; Robey, 1979) see a link. Not deterred by ambivalent evidence, researchers seem to assume a link has been proven. A review of the literature showed clear division on the best proxy for use: Of 58 prominent empirical studies, 16 (27%) made no attempt to determine actual use.

Although actual usage may be difficult to determine, some researchers apparently become so convinced of the value of ITU that they do not collect actual usage data when it is available. For instance, Venkatesh (1999) investigated the effect of training mode on ITU, when the target technology (a virtual workspace) could easily have been instrumented to collect actual usage data.

Even if actual use is measured, success is not guaranteed. There is the question of whether self-reported use corresponds to actual use. Szajna (1996) and Straub, Limayem,

and Karahanna-Evaristo (1995) measured both and found significant differences. Chin (1996) responded to the latter with three arguments:

Looking at the results of Straub, Limayem, and Karahanna-Evaristo (1995), Chin (1996)) showed that they did not show computer-measured use to be particularly effective (although it was not as bad as ITU). Chin delved into philosophical definitions of reality and concluded that what is measured by technical means may not be any more “real” than what people claim (e. g. ITU). Chin made much of the difference between measures dependent on one’s perspective (e. g. a screwdriver may be a screwdriver to one person, a poorly-designed hammer to another, and an object composed of wood and iron to a third).

Chin’s conclusion was that we could not merely use a computer to capture usage information, and automatically assume this is a superior view of the reality of usage than self-reporting. As an example, he cites a case where users would routinely activate monitoring functions on their computer – then proceed with work heedless of the information they conveyed because it was not useful. Today’s workstation landscape in which functions are installed for automatic execution with or without the user’s conscious cooperation bolsters that argument.

Trice and Treacy (1988) found significant differences in usage results depending on the specific measure used. They suggest that better results will be obtained “if the measures chosen correspond to the measures suggested by an appropriate reference theory.”

Hence, Chin and Marcolin (2001) and Jaspersen, Carter, and Zmud (2005) support Rogers' (2003, p. 440) call for more research on what happens *after* new technologies are adopted: the implementation phase. Some (e.g., McCarthy, Aronson, and Claffey, 2002) have taken up this mantle, and this research fits in this stream.

While those who stop at ITU have data with which to calculate statistics, some consider usage an integral part of a multi-phase diffusion process (Rogers, 2003, p. 425-428; Agarwal & Prasad, 1997; Gallivan, 2001; Goodhue & Thompson, 1995; Goodhue, 1998). They consider usage as one of the steps along the path of diffusion. This study focuses on the links between perceptions, ITU, and actual usage.

Definitions

For clarity, it is important to formally define some important relevant terms.

Information Technology could refer to any technology involving information. This is limited to technologies involving electronic communication, recording, and display. Taylor and Todd (1995a) recognized that an IT "system" involves hardware, software, support, and service as a whole. This research studies two aspects of a technology.

Diffusion (Rogers 2003, p. 5) is the entire process by which an innovation becomes known to people, selected by them as a vehicle to aid them in their success, and brought to bear on the challenges they face.

The first stage of diffusion is adoption. Rogers (2003, p. 421) refers to this stage as “initiation,” and breaks it down to three sequential events: knowledge, persuasion, and decision. Adoption begins with the identification of one or more needs, continues with scanning for possible solutions followed by some sort of evaluation of the applicability of each possible solution to ones’ needs. The end point of adoption is a decision to commit resources to the innovation. These resources could be money with which to purchase the right to use it, statements of official sanction, personnel to implement and/or support it, or a hybrid (as in the case of open source software, where adoption may mean an organization contributes to it in order that all may have its benefits).

The second stage of diffusion is implementation. Sometimes termed secondary adoption (Gallivan, 2001), during this stage the innovation is made operational by establishing the conditions that provide for its success. Rogers (2003, p. 421) points out a mutual adjustment that takes place during this phase between the organization and the innovation in order to obtain traction on the problem at hand. These may include creating a technical environment such as a server operating system or network, support, and actual use by its intended beneficiaries. This last aspect of implementation is of crucial importance because an adoption decision in and of itself produces no benefit to the firm – only use of an innovation reaps the rewards it has to offer.

The third stage of diffusion is routinization, in which an innovation loses its identity as a separate entity. Perhaps this onset of this stage could be identified as the time when someone asks why the innovation is called “new.”

Usage: for the purpose of this study, Usage is defined as activity recorded by automated system logs or detected by manual inspection of the system, as opposed to measurement by user reports or intentions.

Voluntariness: Several researchers (Agarwal & Prasad, 1997; Moore & Benbasat, 1991; Van Slyke, Lou, & Day, 2002; Valier, 2004) have added voluntariness to Rogers' original group of Relative Advantage, Compatibility, Complexity, Trialability, and Observability. Voluntariness may not always be a characteristic "influencing" use or non-use of an innovation. If peoples' jobs depend on use of an innovation – as with an ERP (Enterprise Resource Planning, an integrated system that provides support for a wide span of activities in a firm's value chain) or GSS (Group Support System, an integrated set of tools for communicating and recording designs and decisions) – the reality of that fact will select out those whose attitudes prevent them from utilizing it. They may have negative attitudes about the innovation due to malfunctions or extra work it might create due to poor design, and they might be provoked to change the technology in some way (Morrison, Roberts, & Hippel, 2000; Garud & Rappa, 1994), but the perception of its being mandatory hardly affects usage behavior of those who remain in their jobs.

Voluntariness is part of the instrument used and validated by Moore and Benbasat (1991), and is included in this research to maintain consistency with former research.

The Missing Link to Performance

It is interesting to note that only one study in the group reviewed (Lucas & Spitler, 1999) presumed to make any link at all between diffusion of an innovation and measurably superior work performance of individuals. Venkatesh (2003) agrees, stating "...little or no research has addressed the link between user acceptance and organizational usage outcomes." One may presume that this implies either that the entire field of innovation research is either in its infancy, or that that researchers are reluctant for any number of reasons such as research difficulty or the possibility that this moves the research complexity to a higher level.

Watson et al. (1996) attempted to survey benefits vs. costs in Executive Information System (EIS) implementations, and found that with the exception of On-Line Transaction Processing (OLTP) applications, little was being done to produce benefit/cost information. They found some indication that routinizing (Rogers 2003, p. 428) tended to produce the perception that benefit/cost was beyond question and needed no justification.

Attempts to Tie ITU to Usage

Taylor and Todd (1995a) found the link between ITU and actual usage is significantly affected by experience. In terms of the previous discussion of the linkage between SRU and computer-measured usage, their study method is instructive. They used SRU, but collected the data at a time and place likely to maximize accuracy (exiting from a computer lab). This raises the question of when and how SRU is collected: on-the-spot,

under duress of some sort, weeks or months later, or without framing with respect to time. If the Internal Revenue Service expects expense records to be kept contemporaneously, why should we expect less of an experimental design collecting information as important as actual usage?

Furthermore, as users become more experienced, their perception of control replaces the perception of usefulness as a predictor of ITU. Rawstorne, Jayasuriya, and Caputi (2000) looked at the other side of this issue and found that ignorance about a system caused a disconnect between ITU and actual use. Their case in point was nurses entering data into patient records. Without their traditional clipboards the nurses found it necessary to take notes at bedside, and then enter information into the computer at the nurses' station at the end of the shift. It is interesting to note that today hospitals use entry devices that are either portable or located right in the patient's room.

The Ease-Of-Use Dropout

Both Davis, Bogozzi, and Warshaw (1989) and Agarwal and Prasad (2000) demonstrated that as users become more experienced, they become less affected by ease of use and more concerned with usefulness of the technology and their control over information. This supports the contention of Venkatesh and Davis (1996) that user training might merit more emphasis versus improving interface design.

Karahanna, Straub, and Chervany (1999) showed that intention shifts from the person's environment at adoption to experience with the technology at the stage of continued use. Contractor, Seibold, and Heller (1996) discovered less of a difference.

One might conjecture that as time goes on, people become more computer-savvy and are able to handle variations in systems better.

Bhattacharjee and Premkumar (2004) studied the issue from another angle using Expectation-Confirmation theory. They trace the technology diffusion cycle through three stages:

1. Subjects follow guidance from their leaders.
2. Subjects refine their use of technology based on their own personal experience.
3. Subjects reject technologies that do not fit their needs.

The authors suggest that leaders should collect information about negative experiences and correct problems before the third stage.

Brancheau and Wetherbe (1990) found a related difference: younger people are more willing to try innovations than older people. Interestingly, this study showed Information Systems departments playing only a minor role.

Burkhardt (1994) discovered a difference between beliefs about personal competence versus beliefs about the technology. This study showed that supervisors had more influence over beliefs about personal competence, while peers had more influence over beliefs about the technology. This is not surprising, since supervisors have more to say about one's promotion status while peers are those with whom one does the work assigned.

Duplaga and Astani (2003), studying the implementation of Enterprise Resource Planning (ERP) systems, found that the *rate* of implementation had a significant effect

on success. Larger organizations which committed resources to move forward quickly tended to have more success than smaller organizations forced to move with measured tread. It should be noted that ERP systems are complex and involve a broad fabric of inter-relationships, so one might reasonably expect incremental implementation to be less successful since each increment would require the overhead of an unfreeze-change-refreeze cycle. Discrete innovations with less-complex relationships to other functions might well show better success with incremental implementation.

Diffusion Theory's Nay-Sayers

Some writers (e. g. Luftman, 1993) simply ignore the perception aspects of the diffusion process, assuming that a properly-designed system will yield benefits without regard to perceptions of the users. Others (e. g., Mabert, Ashok, & Venkataramanan, 2001) cite time needed for success to build. Robey, Ross, and Boudreau (2002), studying ERP, suggest that time is needed for assimilation of new technology. It is also possible that widely differing views of a specific innovation will yield unanticipated (and often undesirable) results, as described by Manning (1996).

Long spans of time can confound plans based on diffusion (or any other) theory. It is entertaining to read Mooers' (1960) predictions that we would eventually be able to successfully store millions of pieces of data and find them, and that the meaning of this heap would also be made clear by technology. In the former case the writer under-shot the mark, and in the latter case success continues to elude us. For both reasons he was led to incorrect conclusions about the impact of technology on people.

More seriously, Downs and Moore (1976) complained that diffusion theory is “unstable” – meaning that results do not reliably follow from the theory. They identify the cause as a lack of clarity, and suggest that there are different types of innovations and each appeals to different socioeconomic groups. Often, the distinguishing factor is cost. An innovation which costs \$50 may, for instance, be considered unreachable by one group but trivial by another. Tornatzky and Klein (1982) performed a meta-analysis, confirming this concern.

Not surprisingly given this situation, Surry and Farquhar (1997) are not optimistic that *any* parsimonious solution to predicting adoption can be found: “The decision to adopt an innovation, however, often defies simple logic. Successful products must meet a myriad of considerations beyond simple instructional effectiveness or user wants.” Perhaps Gallivan (2001) is correct in emphasizing the political dimension. Swanson (1974) was moved to declare that “... managers who involve themselves with the MIS will appreciate the system, and that managers who are uninvolved will be unappreciative.”

Diffusion theory is not alone in attracting criticism. Igarria, Parasuraman, and Baroundi (1996) investigated TTF constructs as well as several others, and concluded that 72% of usage variation was still unexplained – suggesting that we are looking at the wrong things.

It is also possible that an innovation itself is a bad idea (Rifkin, 2003, p. 23). Reasons abound: The innovation may fit poorly with strategy. It may be frustrating to use

because of poor human-interface engineering or because it does not perform properly. It may actually increase effort required to get the job done.

An additional barrier may be loss of functionality. As new technology is created, whether it is explicitly an upgrade of former technology or an alternative intended to eclipse former technology, former characteristics may not be carried forward. This is particularly the case in character-mode applications:

- Perfect Writer initially provided single-key access to most editing functions. A later upgrade required a minimum of two keystrokes for all editing functions.
- Turbo Prolog 1.0 had single key block definitions for search and replace. Version 2.0 replaced these with double-key sequences in order to bring consistency with other Borland products.

Alternatively, an idea may not yet have seen its time. Fichman, Kemerer, and Chris, (1993) suggested after non-empirical analysis of the case of Object Orientation (OO), that it was unlikely to see early adoption. The term “early” is operative here, because widely-used WWW technologies such scripting languages and database access depend heavily on OO techniques and constructs – even if some of them do not implement all the concepts of OO.

Rogers (2003, p. 436-471) cites a number of cases in which innovations had consequences which, in sum, were negative: snowmobiles among the Skolt Lapps, steel axes among Australian aborigines, dichlorodiphenyltrichloroethane (DDT), and the Internet. A key concept is that change produces other changes, which may turn out to be

worse than the original problem. Put another way, solving problems is difficult. Far easier is *moving* problems. For example, Rogers (2003, p. 446-448) cites a case in which oral rehydration therapy (ORT) sharply reduced infant mortality in developing countries in the 1980s. This did not in itself reduce misery, however, as the children who would otherwise have died after suffering briefly found themselves growing up in a society unprepared to accommodate them by feeding, educating, and employing them. A necessary cognate to ORT was family planning – something far more difficult to diffuse in a population however necessary it might have been to complement ORT. In a way, ORT made the problem worse – because children were dying of starvation over longer periods of time rather than suddenly due to disease.

Importance of the Topic

Adoption – selection of a technology “solution” by upper management – is of great interest to sellers of technology, and impacts cost of operation. The next phase, actual implementation of the technology by users, is where value is produced in an organization. Whereas Rogers (2003, p. 20) considers implementation to be one of the phases of diffusion – a phase in which modification of the innovation occurs, some (Van Slyke, Lou, & Day, 2002) exclude implementation and use from the definition of diffusion. An axiom, on which this research is based, is that these later activities merit study because without them no value is produced. Of particular interest in this case study is the effect of innovation quality and support on the perception of effectiveness. Since the value of the innovation is a result of its intrinsic value and the support which aligns

users with it and it with them, this research makes no effort to separate innovation quality and support.

Setting and Methodology

The setting of this study is a small, private university in the southeastern United States that has been using WebCT, a Course Management System (CMS), to supplement traditional instruction methods in residential education. An initial baseline was established to determine the infusion level (Gallivan, 2001) of three innovations contained in the CMS. This research project studied perceptions and usage after an upgrade which involved changes from several sources:

1. Improvements in the technology as a new version of the CMS was deployed.
2. Improvements in support, as the support management sensed the need for additional training and/or adjustments in the configuration of the CMS.
3. Further diffusion of the technology as users “infected” others with a desire to use it and show them how.
4. Changes in mandatory/non-mandatory status of the technologies studied.

Scope and Limitations

This study identifies perceptions that facilitate secondary adoption, and perceptions that do not facilitate secondary adoption. Inasmuch as it is a case study, its applicability is limited to cases with similar characteristics.

Advantages and Limitations of the Study Setting

Due to the small setting for this study, information was highly available to the researcher. Access to the Course Management System was granted so that actual use of technological features could be assessed. An open-minded approach of the administration toward utilization of the system resulted in little pressure from administrators for or against use of the CMS.

Limitations are typical of a case study. The group studied yielded a relatively small data set which somewhat limited statistical power. In addition, the ability to generalize conclusions may be limited by the specific environment, which may not be similar in some ways to other environments.

Summary

This chapter has introduced the problem and the objective for moving this research forward. It has also provided a graphic overview and text description of the theory base for this research, shown the importance of this topic and the need for future research, and explored scope and limitations issues. The next chapter will review literature relevant to this study.

CHAPTER II

REVIEW OF LITERATURE

This chapter presents a review of literature on Course Management Systems (CMS) and Diffusion of Innovations (DOI). The first section is an introduction to the literature, focusing on DOI. Following this section are brief overviews of alternative theories related to DOI, Gallivan's (2001) re-framing of the topic, Ely's (1990) frame of success factors, tangential theories, and conclusions.

Introduction

There is no clearly-documented beginning to man's interest in how people make choices that change their lives. At first, this was thought of in prescriptive terms. For millennia, a concept (which pervaded most cultures) known in Western culture as the "golden rule" has *prescribed* appropriate action. Bentham and others, attempting to establish a definition of "good" as they abandoned the doctrine of the divine right of kings, suggested that components of a decision about of courses of action *should* (note the prescriptive stance) be selected for the greatest good of the greatest number.

Azjen and Fishbein (Ajzen, 1985; Fishbein & Ajzen, 1975) reformulated this idea as *descriptive*, suggesting that for each decision there are multiple components that if known could perhaps be manipulated to achieve behavior desired by others. A major shortcoming of this approach is that constructs are created ad hoc for each study, limiting the ability of researchers to develop theory.

Meanwhile, Rogers (2003, p. 15) developed the Diffusion of Innovations (DOI) theory using a consistently-applied set of constructs for perceptions, relating them to intent to adopt. Noting difficulties applying this theory to IT innovations, Moore and Benbasat (1990) focused on adjusting the constructs to yield consistent results.

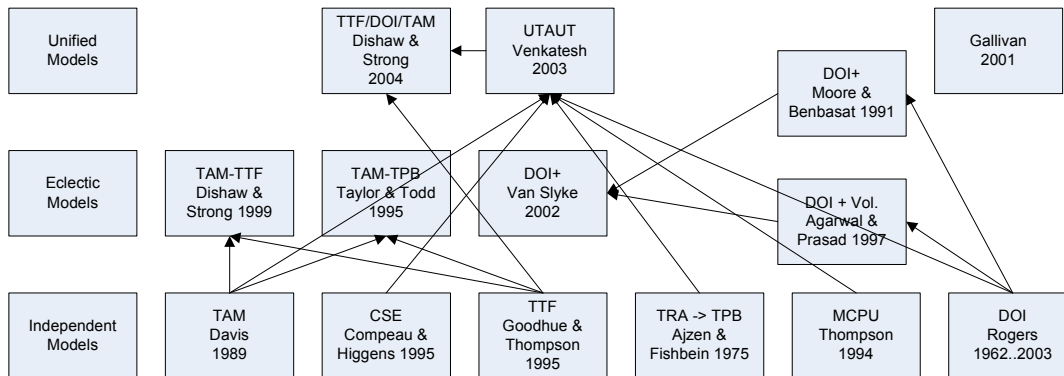
Ely (1990, 1999) divided adoption into primary and secondary phases. Primary Adoption considers the commitment of resources to the technology and thus applies to sales of the technology on the vendor side and cost of the technology on the buyer side. Secondary Adoption is actual implementation and adjustment of the technology to an organization's needs, yielding actual value.

Secondary Adoption is of interest to vendors only as they provide support, but intense interest of users as they finally obtain benefits. It is through implementation and use that value is generated for the firm (Zmud & Apple, 1992).

Relationships Between Theories

Study of diffusion has yielded a tapestry of theories and ways in which they relate to each other. Figure 2.1 is a generalized overview of these relationships.

Figure 2.1 Map of Diffusion of Innovation-Related Theories



In earlier phases of research, models which each came from a specific set of premises arose. During the eclectic phase, authors attempted to relate these models to each other. The trend in this century has been to develop over-arching models that drew from previous models, into unified theories. Meanwhile Gallivan (2001) described DOI in terms which included political realities and yielded the concept that DOI is actually a multi-step process which includes adoption (commitment to pay), implementation (delivery to the level below), and actual usage at each level.

Interestingly, Gallivan (2001) assumed that innovations come only from levels above in the organization, culminating at the top level with whichever authority selects available innovations and makes them available by purchase and support. Thus the innovations available to an individual are subjected to screening, yielding a smaller number than those selected at the interface between the firm and the environment. This pyramid-form approach is questionable. Although it is outside the scope of this dissertation to cover alternative routes innovations may take into an organization, several come to mind:

1. Organizational units may create innovations themselves.
2. Innovations can be made available by free sharing in various ways, notably use of Open Source. Piracy is a variation on this theme with a negative moral/ethical dimension.
3. Innovations may be brought in from outside the organization by personal purchase (whether funded by the firm or by the individual), or piracy.
4. Innovations may be promulgated by firms with an interest in having them widely used. An example of this would be a downloadable plug-in made available freely over the Internet.

Gallivan's (2001) description of a multi-step process may not be limited to activities within a single firm. The Internet, for example, was the result of a large number of players committing to implement a number of innovations (which any of them could have and in some cases had, implemented in incompatible ways) using common methods so that everything could inter-operate. Now we have the prospect of an innovation being deployed in an environment where the creator is unlikely to know or even care what sort of equipment/software the user might have at hand. The next step in this is Web Services, where the interface information is all that is characterized and the creator has no idea how or where the service is being used (e.g., Google Maps).

Some researchers have raised the issue of how the technology, or use of it, relates to the way the company works. Bagchi, Kanungo, and Dasputa (2003) suggested that effective use of an Enterprise Resource Planning (ERP) system requires re-modeling of the organization. Ba, Stallaert, and Whinston (2001) raise the issue of alignment between

the technology available and the corporate incentive plan. Austin (2001) cited “Moorers Law” to explain why non-use sometimes occurs: If information acquired through technology raises the cost of doing one’s job, the system is less likely to be used.

Next is a discussion of various important theories mentioned in Figure 2.1.

Original Models

Diffusion Of Innovations (DOI)

Through five editions of his book by that name, Rogers (1962, 1971, 1983, 1995, 2003) has promoted and traced a thread of research based on five fundamental factors he terms Perceived Characteristics of Innovations (PCIs), and which he posits are key to understanding adoption decisions. He describes them thus in the introduction to his book:

- Relative Advantage – The degree to which an innovation is perceived as better than the idea it supersedes.
- Compatibility – The degree with which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.
- Complexity – The degree to which an innovation is perceived as difficult to understand and use.
- Trialability – The degree to which an innovation may be experimented with on a limited basis.
- Observability – The degree to which the results of an innovation are visible to others.

These five constructs were developed in studies of agricultural innovations, but have had some difficulty being applied to Information Technology. Numerous efforts have been made (Agarwal & Prasad, 1997; Moore & Benbasat, 1991; Venkatesh et al., 2003) to adjust the list of PCIs to give more predictive power to the model. Rogers' theory is highly pervasive in the literature, and few papers attempt to explain adoption or diffusion theory without relating to DOI.

In time, DOI as applied to Information Technology adoption by individuals, has added the constructs of Image and Volunteerism (Agarwal & Prasad, 1997).

Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB)

Icek Ajzen and colleagues have developed the TRA (which morphed into the TPB) over the years. This concept is a mathematical expression of long-standing approach of assigning values to various perceptions in an attempt to explain how people make decisions. As stated by Fishbein and Ajzen (1975, p. 29), the TRA states that:

“... a person's attitude toward any object is a function of his beliefs about the object and the implicit evaluation responses associated with those beliefs. The central equation of the theory can be expressed as follows:

$$A_0 = \sum_{i=1}^n b_i e_i$$

where A_0 is the attitude toward some object, O ; b_i is the belief i about O , i. e., the subjective probability that O is related to attribute i ; e_i is the evaluation of attribute i ; and n is the number of beliefs.”

TPB (Ajzen, 1985, 1991) extends the theory so that it “takes into account perceived as well as actual control over the behavior under consideration” (Ajzen, 1985).

Connor and Armitage (1998), however, showed evidence that TPB was hardly definitive and needed additional constructs.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was proposed by Davis (1989) as having extreme simplicity, yet strong predictive power. Adams, Nelson, and Todd (1992) replicated the initial research, but concluded that it only explained about a third of the total variation. Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) were found to predict Intention to Use (ITU). Various studies have shown different coefficients for PEOU and PU, and Venkatesh (2000) suggested determined that this may be due to a shift from PEOU in early days of a technology, to PU once it becomes routinized. Davis, Bogozzi, and Warshaw (1989) obtained similar results, showing PEOU dropping in its importance with experience. In a separate study Davis (1989), suggested that “perceived ease of use may be casual antecedent to perceived usefulness.” In a replication, Hu et al. (1999) discovered that higher-level professionals are less likely to be affected by PEOU, suggesting that the shift from PEOU to PU may relate to self-efficacy which is likely to grow over a longer period of time in less-intelligent users.

Numerous studies (Agarwal & Karahanna, 2000; Agarwal & Prasad, 2000; Dishaw & Strong, 1999; Mathieson, Peacock, & Chin, 2001; Moore & Benbasat, 1990; Rawstorne, Jayasuriya, & Caputi, 2000; Taylor & Todd, 1995b) have attempted to

connect TAM to other theories in hopes of increasing explanatory power by various combinations, or contrast TAM with other theories (Davis, 1989).

Gefen and Straub (1997) considered a different aspect: gender differences. They found that women differ from men in their expectations of new technology, but actual use is the same.

Ginzberg (1981) discovered a link between realistic expectations and happiness with the application, suggesting that expectation management is a significant component of perceived system success. Oliver (1980) obtained similar results.

Model of Personal Computer Utilization MPCU

The Model of Personal Computer Utilization (MPCU) theory of Thompson, Higgins, and Howell (1991, 1994), based on a model proposed by Triandis (1980), considers factors which influence Intention to Use, thus indirectly influencing actual use. The factors in their first study (Thompson, Higgins, & Howell 1991) are: Social Norm, Affect, Complexity (considered an obstacle), Job Fit, Long-Term Consequences, and Facilitating Conditions. Their 1994 study (Thompson, Higgins, & Howell, 1994) added Experience to the model.

Computer Self-Efficacy Model (CSE)

Howard and Mendelow (1991) confirmed the intuitive connection between computer literacy and choice to use computers. Compeau and Higgins (1995a) refined this concept by researching the effect of peoples' *perception* of their ability to use

computers and its effect on their *actual success* in using computers. In an extension of this research (Compeau, Higgins, & Huff, 1999), their hypothesis of a positive relationship was validated and extended to a wider group of subjects. A separate study by the same authors (Compeau & Higgins, 1995b) found that with further experience the effect of CSE on performance became less. Later studies have considered the effect of habit and affect (mood). Verplanken, Aarts, and Van Knippenberg (1996) showed habit to affect choices significantly, but Bamberg, Ajzen, and Schmidt (2003) discounted habit, while Limayem, Cheung, and Chan (2003) found it to be a moderator between other factors and ITU. Limayem and Hirt (2003) saw habit as a construct that increased TAM's explanatory power.

Task-Technology Fit Model (TTF)

TTF theory considers to study alignment between IT and needs (Goodhue & Thompson, 1995; Goodhue, 1995) This study was replicated and the model validated by Dishaw and Strong (1998) in a software maintenance environment. While Goodhue and Thompson (1995) did not show explanatory power in TTF, they suggested that, "A more compelling interpretation is that in this case the causal effect works in the other direction...For example, perhaps individuals who use the systems a great deal and are very dependent on them will be more frustrated by problems. ...the quality of the data, production timeliness, and relationship with IS all predicted higher perceived impact of information systems, beyond what could be predicted by utilization alone."

Mark Dishaw and his colleagues have produced a series of articles relating TTF to other theories. Dishaw and Strong (1999) determined that a combined TAM/TTF model

produces better predictions than TAM alone. Dishaw, Strong, and Bandy (2004) proposed testing a combination of TTF and the Unified Theory of Acceptance and Use of Technology (UTAUT).

In the end, TAM may not be a viable alternative to DOI. Plouffe, Hulland, and Vandebosch, (2001) compared TAM to DOI, concluding that DOI had better parsimony and explained more variation in ITU.

Eclectic Models

TAM-TTF

Dishaw and Strong (1999) saw overlap between TAM and TTF, and created a combined model called the TAM-TTF. The combined model had more predictive power than TAM alone. They note significantly that while TAM is a mature theory, TTF was still undergoing evolution and as such the TTF constructs they used should be considered tentative.

“Decomposed” TPB

Taylor and Todd (1995b) “decomposed” TPB by using constructs from Rogers (1995). They then compared TPB, the “decomposed” TPB, and TAM (Davis, 1989). They found TAM to explain 34% of behavior, TPB to explain 34% of behavior, and “decomposed” TPB to explain a “moderate” increase of 36%. Their conclusion was that additional factors were far more significant, and situation-specific.

TAM2

Venkatesh and Davis (2000) studied TAM with additional constructs (Subjective Norm, Experience, Image, Job Relevance, Output Quality, and Result Demonstrability) to explain Perceived Usefulness, in four longitudinal studies. They found Subjective Norm consistently lost impact as experience grew. Perceived usefulness was impacted directly by Subjective Norm, Image, Job Relevance, and Result Demonstrability. Experience negatively moderated Subjective Norm, and Output Quality positively moderated Job Relevance. Subjective Norm impacted Intention to Use, but Intention to Use explained only 52% of variation in Usage Behavior.

Unified Models

Attempts have been made to unify the various theory streams, as combinations lost parsimony. Perhaps most notable so far is UTAUT.

UTAUT

Venkatesh et al. (2003) gathered constructs from TAM, CSE, TRA/TPB, MCPI, and IDT to formulate the Unified Theory of Acceptance and Use of Technology (UTAUT). They concluded that different groups of people fit different models, and that a single model did not explain variation in behavior well.

TTF-UTAUT

In yet another attempt to create a comprehensive model, Dishaw, Strong, and Bandy (2004) suggested adding TTF constructs to UTAUT. As of this writing, their results have not been published.

Gallivan's Overall Perspective

Gallivan (2001), in a non-empirical paper, encapsulated the entire concept of perceptions and decisions in a framework based on organizational politics. He described adoption as being two (or more) phases. The first phase involves the search for and selection of a technology to meet a business problem. The second phase involves the subsequent implementation and use. He made the point that for each level at which a decision is made, the phases of adoption and implementation apply. At high levels, implementation consists of passing the innovation to the next lower level. At lower levels, adoption means acceptance of what is passed down from above. At the final level where it is brought to bear on the organization's needs, implementation means making it actually work.

Gallivan (2001) suggests that authoritarian structures influence early stages in the process, but not necessarily latter stages. By extension, one might posit that an adoption decision has a limited ability to penetrate down the organization chart – suggesting a reason why large organizations may appear unwieldy.

Rawstorne, Jayasuriya, and Caputi (1998) note a difference between what they term “symbolic adoption” and “actual adoption” which map to the primary and secondary adoption phases of Gallivan (2001) .

Interestingly, Gallivan (2001) did not in his politically-schemed framework consider the possibility that an innovation might come to an implementer from a source other than above:

- Freely downloadable from the Internet
- Self-purchase by individuals from an outside source
- Illegal copying from an outside source
- Open-source
- Creation within the organization

An alternative view was suggested by Surry and Ensminger (2003), who validated Ely's (1990) model in the Education domain using eight conditions: Dissatisfaction, Skills, Resources, Time, Rewards, Participation, Commitment, and Leadership; in lieu of Rogers' (2003) PCIs.

Tangential Theories and Constructs

Success Factors Theory

Ely (1990) notes that adoption yields nothing of value to the organization, but reaping advantages of an innovation is an entirely different act – probably performed by an entirely different group of people. Gersick (1991) treated the other side of the coin, suggesting that significant changes can be highly disruptive. As an alternative to theories which focus on perceptions, Ely (1990, 1999) cites a number of important success factors in implementation. These are described below in terms of a technology innovation in the Solomon Islands (Chand et al., 2005) where rural subsistence farmers have been successfully equipped with email.

1. Dissatisfaction with the status quo. The people served by the project were isolated from friends and relatives, and travel by available means (usually hand-paddled canoes) was time-consuming and fatiguing.
2. Existence of knowledge and skills. From each village to be served, a volunteer operator was selected and trained at a central site.
3. Availability of resources. A tapestry of government grants provided equipment for each site and infrastructure. The system uses shortwave radios to communicate, and the remote sites use photovoltaic energy sources to make them autonomous.
4. Availability of time. Surprisingly, this has proved a constraint. Kaitu'u (personal communication via email, February 17, 2006), a station operator, expressed consternation with expectations that he spend much time he needs to be cultivating crops, transmitting and receiving email for a the local equivalent of \$27 US per month – far from enough to make up for the cost to his farming activity. A cognate problem is cultural concepts of time: At some stations the local operator has not kept the schedule as posted, leading to frustration among users (Chand et al., 2005, p. 49) .
5. Rewards or incentives exist. Simply being able to communicate with a several-hour turnaround instead of days or weeks of travel, is sufficient incentive for users. For the operator, the fees paid by users form an incentive (although it is not enough to really be worth his while as stated above).
6. Participation. Once a few people tried the system and discovered it worked, more came on board until it became a routine part of life in the community.

The facilitative efforts of operators helped, since communication did not require active participation of email receivers.

7. Commitment. Reliable access to the system is important. The operator considers his service to be an important community asset. The computer used has “died” once, and was out of commission for some weeks as a result. The community having no alternatives, simply had to be patient.
8. Leadership. The central site at the capital is well-organized and its leaders have managed to transcend political upheaval in the country.

Habit Construct

Limayem and Hirt (2003) and Limayem, Hirt, and Chin (2001) studied the effects of habit on IT usage, concluding that habit moderates the link between intention to use and actual usage. A person who has actually used a specific behavior is more likely to carry forth their reasoned decision to use it in the future. Verplanken, Aarts, and Van Knippenberg (1996) found that habit had a strong influence on behavior for routine activities. Oulette and Wood (1998) went a step further, asserting that application of rational thinking to behavior is less likely in routine situations – meaning that if you wish someone to think, you should set up circumstances that they will perceive as unusual. They divide such circumstances into rarely-performed behaviors, and choices made in the face of uncertainty. Ajzen (2002) cautioned, however, that habit is difficult to measure because one may actually be measuring *previous* decisions.

Adaptive Structuration Theory

A major challenge for diffusion study is the complexity of life. There is a dynamic relationship between various actors involved in diffusion. DeSanctis and Poole (1994) describe this view as Adaptive Structuration Theory (AST). Creators of technology may adapt it as they discover needs for an improved fit between the technology and targeted users. The users may adapt the technology (Morrison, Roberts, & Hippel, 2000) or use it in unanticipated ways (e. g. a monkey climbing a stick before it falls over to reach a banana hung from the ceiling, rather than using the stick to knock the banana down). Or, new technology can impact culture directly. As stated by DeSanctis and Poole (1994):

Change occurs as members of organizational groups bring the structural potential of these new technologies into interaction, appropriating available structures during the course of idea generation, conflict management, and other group decision activities.

This researcher experienced AST when performing the simple task of moving an email server. Careful planning reduced the downtime to less than ten minutes. The process was interrupted and slightly lengthened by a demand (issued while the server was being rolled down the hall) that the system be switched back on instantly so that payroll could be run. The person who was responsible for signing off on minor exceptions to payroll policy had within two years switched from avoiding all direct computer use, to near-total dependence on email for an essential step in the organization's processes. The idea of using paper to establish a trail for those decisions had not only become secondary, it had vanished. This stage is termed "routinization" by Rogers (2003, p. 428) .

Compatibility and Connectedness Constructs

New technologies, if radical, can suffer initially from a lack of connectedness with existing technologies. Rogers (2003, p. 15) uses the construct Compatibility to describe this dimension. Hiltz and Turoff (1981), for instance, studied email in an early incarnation. Their research determined that users wanted “group conferences, notebooks for text composition, and self-defined commands.” The universal connectivity considered foundational 25 years later was a distant dream.

A related issue is competing technologies that have similar value. Kraut et al. (1998) describe such a situation, with two video-telephone systems which were introduced into a company simultaneously. In time one of them prevailed and the other withered – for no particular reason other than chance. This was a simple case in which the two systems were incompatible. If they had been partially compatible (able to communicate cross-system, but with somewhat reduced capability), one may safely assume that the results would have been murky from a research standpoint.

Thus the issue of compatibility confounds researchers. This phenomenon may illuminate the analysis of Igbaria, Parasuraman, and Baroundi (1996), who were unable to identify any construct that explained a major portion of usage variation.

Verplanken, Aarts, and Van Knippenberg. (1996) showed that habit injects a non-rational element that should be accounted for. Seemingly to the contrary, Davis, Bagozzi, and Warshaw (1989) compared TRA with TAM, determining that Behavioral Intention is a filter through which one’s thoughts must pass before action occurs.

Over-Arching Trends

What Matters Most?

Agarwal and Prasad (2000) studied an innovation used by technology professionals. As have others such as Van Slyke, Lou, and Day (2002) and Jurison (2000), they found the perception of relative advantage overwhelmingly more important than other characteristics of the innovation. They noted that absence of ease of use as a factor may have been due to the nature of the group studied: people whose livelihood depended on their job being difficult or impossible for others to do. King and Rodriguez (1981) apparently concur, finding that while participative design improved attitude toward systems, actual use and consequent quality of decisions was unaffected.

Increased complexity may change the picture. In a study of Computer Aided Software Engineering (CASE) adoption, Purvis, Sambamurty, and Zmud (2001) determined that management championship and knowledge embeddedness contributed most to adoption. Management championship implied that one's investment in converting to the new technology was likely to be rewarded, and knowledge embeddedness meant that one could use the system as a tool for accomplishing work rather than adding it to the many things one is already doing – similar to the situation where an organization's Web site cases to be an added responsibility and becomes the selected conduit for communication with various stakeholders both external and internal – e.g., customers, clients, etc.

Critique of Research Designs

One might wonder why perceived complexity is routinely assumed by researchers to be a negative factor for adoption. In fact, complexity in an IT system may be a tool which can be brought to bear on complex problems so this term may not be useful (e.g., GPS receivers and cell phones, both highly complex technologies but simple enough to be operated by anybody). Perhaps a term such as “difficult to use” would be better.

A shortfall of many existing research designs is that they consider technology adoption to be a single event (perhaps because a single event is easier to study), whereas value is often produced by multiple cycles of adoption in which both the innovation and peoples’ skills are adjusted to align with organizational needs (DeSanctis & Poole, 1994). To some extent this adjustment relates to differences in perception of those organizational needs between actors at the level of those who commit resources, and actors at the level of implementation and utilization.

Zmud and Apple (1992) recognize this limitation of snapshot studies, noting that “Incorporation remains a key but under-studied area of innovation research. The failure to gain the full potential of an adopted innovation foreshadows lost opportunities for growth and profits for the adopting organization.”

The Subjective Norm Shift

Before implementation, perceptions are based on what people see of the innovation: opinions of early adopters, a felt need for improvement, and the face appearance of the innovation. After implementation perceptions switch to the user’s own experience (Agarwal & Prasad, 1997; Bhattacharjee, 2001a; Bhattacharjee & Premkumar,

2004; Davis, Bogozzi, & Warshaw, 1989; Karahanna, Straub, & Chervany, 1999). This suggests that for best results managerial intervention in the early stages should focus on perception, then shift to support of functionality. Davis (1989) implied this when he said, “Perceived ease of use may be causal antecedant to perceived usefulness.”

Cooper (1990) appears to agree. He found that during the adoption stage, classical DOI constructs seem to work. In later stages (“infusion”), learning and leadership models appear to apply more.”In our MRP study, it was suggested that the lack of explanatory power of task differences on infusion levels is very likely attributed in part to political forces within an organization.” He suggested that studies consider both rational and political forces, and be longitudinal. Hartwick and Barki (1994) concur, stating:

Early in the ISD process, subjective norm is the crucial determinant. One intends to use the system because others expect it. Later, when the system is operational, attitude is the crucial determinant. One intends to use a system because one feels its use is good, useful, and valuable.

Venkatesh and Morris (2000) and Venkatesh, Morris, and Ackerman (2000) studied gender roles in the diffusion cycle. In both studies, it was found that men use computers because they are useful, while women use computers because they are easy to use and because other people influence them to try.

Conclusions

This chapter has traced the development of diffusion theory through its ancient roots, initial applications of the diffusion concept, and early eclectic models. This path concludes with consolidated models being proposed and tested as researchers attempt to reconcile the paradox of richness versus parsimony.

Through this history in which difficulties applying Rogers (2003) concepts to IT innovation have provoked numerous extensions and combinations with other theories, the original constructs continue to be used with only a few extensions.

Certain over-arching trends appear worthy of special notice.

1. As subjects become closer to an innovation, the operative PCIs shift from subjective norm to usefulness. This intuitively correct, because people will use the best evidence available to them – what other people tell them before they have experienced an innovation, then their own experience. It also may explain some of the complaints
2. Simultaneously, ease of use is transformed from a positive influence to a neutral or possibly negative influence. At the outset, ease of use facilitates adoption. In time, ease-of-use features become unimportant because necessary procedures become a habit. Ease-of-use features may even prove a barrier to efficiency or fail to discriminate between those “into” the technology and those who are not members of the inner circle.

The end-point of research varies from Intention to Use (ITU) to declared use to measured use. ITU’s connection to use is controversial. Declared use captures perceived importance, but has questionable reliability – especially if time lags are present. Measured use may capture habit patterns in which a subject is accustomed to having a tool available on their desktop, but may rarely or never use it. The latter problem may increase in the future, as IT specialists prepare standard “dashboards” for users which include tools that may or may not be used – or even understood.

In the maelstrom of uncontrollable variables that affect adoption and use of new technologies, it is appropriate to study the progress of innovations in a bounded setting. Such a case study was performed for this research, as outlined in the next chapter.

CHAPTER III

RESEARCH METHODOLOGY

Introduction

This chapter next describes the research framework and methodology. First is a review of the purpose of the study, the research model, and its variables. The research questions to be examined are next, followed by the research hypotheses. Also discussed are the setting, the method of administration of the survey, and statistical tests used.

Overview

This research investigated the way the diffusion process occurs in a particular situation: the case of a software upgrade. The theoretical framework for this research is Rogers' (2003) Diffusion of Innovations (DOI), as adapted and tested by Moore and Benbasat (1991). This framework utilizes the concept of Perceived Characteristics of an Innovation (PCIs).

The survey instrument used in this study was developed by Moore and Benbasat and has been empirically tested by Van Slyke, Lou, and Day (2002). As with Moore and Benbasat, Van Slyke, Lou, and Day did not take into account previous technologies. In addition, the end-point of their investigation was Intention to Use (ITU).

This research expands the body of knowledge by examining the way the PCI-to-usage chain functions when an innovation is based on prior innovations. Furthermore, it carries through to actual usage. This research investigated the diffusion of a software upgrade of a Content Management System (CMS). The particular CMS package is WebCT.

Research Methodology

Theoretical Framework

This research used the Perceived Characteristics of Innovations (PCI) constructs as originally defined by Rogers (1962) and expanded/adapted by Moore and Benbasat (1991). This stream of research also includes Agarwal and Prasad (1997) and Van Slyke, Lou, and Day (2002).

Moore and Benbasat separated Rogers' "Observability" into two constructs: Result Demonstrability (ability of the user to see results of the innovation) and Visibility (ability of others to see a person using the innovation.) They also added Voluntariness. Moore and Benbasat found all constructs significant.

Agarwal and Prasad tested all of the Moore and Benbasat dependent variable constructs against both Intention to Use and Actual Use. Of all the constructs, only Result Demonstrability was unequivocally supported for Actual Use although most were supported for Intention to Use.

Van Slyke, Lou, and Day repeated the test, but did not test Actual Use. They found Relative Advantage and Compatibility had strong support, Complexity and Result Demonstrability somewhat weaker support, and no significance to Visibility, Trialability, and Voluntariness.

In view of varying results in subsequent studies, this research utilized all of the Moore and Benbasat (1991) constructs in this research. This research also studied the effect of class size on Intention to Use and actual usage.

Research Model

The research model used in this research postulates that the PCI group and Intervention Participation (IP) are related to ITU and AU. IP is participation of target users in seminars given by the Office of Online Learning in preparation for the installation of the new version.

Study Setting

The setting of this study is a small, private university in the southeastern United States which uses a CMS for enhancing existing ground-based courses and, to a much smaller extent, delivering courses remotely. The university has approximately 2,200 students and is heavily focused on undergraduate education.

Population

As a case study, this research considers an entire population of professors in a given setting. The group studied consists of all professors who taught at least one class with at least six students during the Fall semester, 2006. The population size is approximately 160. As such it should generalize to similar environments, but its application in unlike environments remains untested. All instructors who had classes with six or more students at Southern Adventist University during the Fall 2006 semester were surveyed and their actual use of the software was measured by inspection. The former version of the CMS had been discontinued, and instructors were being required to migrate to the new version at this time. The survey instrument was administered on paper

as opposed to use of technology such as a Web-based survey, since the issue at hand is whether a certain technology will or will not be used.

Anonymity

While it is common practice to preserve anonymity of subjects in survey-based studies, this was unnecessary – and impossible given the study goals. A key aspect of this study was comparing attitudes with measured behavior. As such, anonymity of subjects would prevent the study from moving forward. So anonymity of subjects was not appropriate in this case.

Anonymity was unnecessary, however, for several reasons:

1. No information collected from subjects by this study is likely to be used to their advantage or disadvantage. Any judgments made as a result of this study will bear on the Office of Online Learning, not the professors who are subjects of the study.
2. When collected data is prepared for publishing in the final dissertation, coding was used so that later researchers could perform further analyses without identifying the specific subjects.
3. All data to be used by this study that might be used to the advantage or disadvantage of subjects, was already publicly available at <http://beta.southern.edu/Register/CourseSchedule.aspx> and as such is part of the ongoing culture of the organization whose professors are to be studied.

Technology Studied

WebCT is a Course Management System (CMS) originally developed in LINUX. At the time of the study, the current version was 4. A higher-level product, “Vista,” had been developed by WebCT for corporate customers. Vista was based on Microsoft technology including the Windows server platform and Microsoft SQL server. In order to consolidate their product line into a single stream, WebCT introduced a limited version of the Vista code base as the next version for educational institutions. This product is termed “CE6” for Campus Edition, version 6.

The reception of CE6 had been mixed. An informal poll of users in the mid-Atlantic regional users group indicated that sites were proceeding with measured tread out of respect for users of version 4. Since its design and code base did not stem from the previous version in use at this site, CE6 requires significant re-training and users at other sites have questions about its ability to use their courseware without difficulty. The university studied in this research is no exception. While CE6 became available in the summer of 2005, it was run only on an experimental basis for instructors who wished to try it in the winter of 2006. Deployment plans at the institution studied called for all users to migrate from version 4 of WebCT to CE6 by August, 2006.

Variables

Intention to Use (ITU) – Dependent Variable

Intention to Use. Respondents were asked to indicate their intention to use the technology. Intention to Use was measured using the Intention to Use scale (Moore & Benbasat, 1991). The Intention to Use scale consists of four items measured on a seven

point scale, ranging from Strongly disagree (1) to Strongly agree (7) and average. One of the items was reverse coded.

Actual Use (AU) – Dependent Variable

Behavior of respondents with respect to technologies being studied was observed. Actual Use was measured by manual inspection of class support sites in the Course Management System (CMS). If the technology being measured was being used for any class by that professor as evidenced by the CMS constructs used to support that technology, AU was coded “1” for that professor. If the technology being measured was not being used, AU will be coded “0.”

Relative Advantage (RA) – Independent Variable

Respondents were asked to indicate the extent to which they feel the “innovation is better than the idea it supersedes” (Rogers 2003, p. 15). Relative Advantage was measured using the Relative Advantage scale (Moore & Benbasat, 1991). The Relative Advantage scale consists of five items measured on a seven point scale, ranging from Strongly disagree (1) to Strongly agree (7) and average. In previous studies where specific values were reported (Agarwal & Prasad, 1997; Beckett & Aronson, 2005; Karahanna, Straub, & Chervany, 1999; Moore & Benbasat, 1991), Cronbach alpha values indicating scale reliability for Relative Advantage have been .90 or above.

Compatibility (CO) - Independent Variable

Respondents were asked to indicate the extent to which they feel the innovation is “consistent with the(ir) existing values, past experiences, and needs” (Rogers 2003, p. 15). Compatibility was measured using the Compatibility scale (Moore & Benbasat, 1991). The Compatibility scale consists of three items measured on a seven point scale, ranging from Strongly Disagree (1) to Strongly Agree(7) and average. In previous studies where specific values were reported (Agarwal & Prasad, 1997; Beckett & Aronson, 2005; Karahanna, Straub, & Chervany, 1999; Moore & Benbasat, 1991), Cronbach alpha values for Compatibility have ranged from .81 to .93.

Ease of Use (EU) - Independent Variable

Respondents were asked to indicate the degree to which they believe that using the innovation would be free of effort (Davis, 1989, p. 320). Ease of Use was measured using the Ease of Use scale (Moore & Benbasat, 1991). The Ease of Use scale consists of three items measured on a seven point scale, ranging from Strongly disagree (1) to Strongly agree (7) and average. In previous studies where specific values were reported (Agarwal & Prasad, 1997; Beckett & Aronson, 2005; Karahanna, Straub, & Chervany, 1999; Moore & Benbasat, 1991), Cronbach alpha values for Ease of Use have ranged from .80 to .91.

Trialability (TR) - Independent Variable

Respondents were asked to indicate the extent to which they feel the innovation “may be experimented with on a limited basis” (Rogers 2003, p. 16). Trialability was

measured using the Trialability scale (Moore & Benbasat, 1991). The Trialability scale consists of three items measured on a seven point scale, ranging from Strongly disagree (1) to Strongly agree (7) and average. In previous studies where specific values were reported (Agarwal & Prasad, 1997; Beckett & Aronson, 2005; Karahanna, Straub, & Chervany, 1999; Moore & Benbasat, 1991), Cronbach alpha values for Trailability have ranged from .71 to .95 except for Agarwal and Prasad (1997), which reported .30.

Result Demonstrability (RD) - Independent Variable

Respondents were asked to indicate the extent to which they feel the innovation provides tangible evidence of its benefits (Moore & Benbasat, 1991). Result Demonstrability was measured using the Result Demonstrability scale (Moore & Benbasat, 1991). The Result Demonstrability scale consists of four items measured on a seven point scale, ranging from Strongly disagree to Strongly agree. One of the items was reverse coded. In previous studies where specific values were reported (Agarwal & Prasad, 1997; Beckett & Aronson, 2005; Karahanna, Straub, & Chervany, 1999; Moore & Benbasat, 1991), Cronbach alpha values for Result Demonstrability have been .90 or above.

Voluntariness (VO) - Independent Variable

Respondents were asked to indicate “the degree to which use of the innovation is perceived as being voluntary, or of free will” (Moore & Benbasat, 1991). This scale consists of two items measured on a seven point scale, ranging from Strongly Disagree (1) to Strongly Agree (7). Each question for the Voluntariness construct was measured

using a 7-point scale from “Strongly Disagree” to “Strongly Agree and average. In previous studies where specific values were reported (Agarwal & Prasad, 1997; Beckett & Aronson, 2005; Karahanna, Straub, & Chervany, 1999; Moore & Benbasat, 1991), Cronbach alpha values for Voluntariness have ranged from .71 to .90 except for Agarwal and Prasad (1997), which reported .45.

Intervention Participation (IP) – Independent Variable

Participation of respondents in support intervention was measured by inspection of sign-in logs at seminars held during the summer of 2006 by the Office of Online Learning in preparation for the upgrade. Presence at one or more seminars was coded “1” and lack of presence at any of the seminars will be coded “0.”

Size of Class (SC) – Independent Variable

Size of Class is the largest class a given professor teaches. Size of Class is a numeric variable was determined by reviewing published information from the University Website based on enrollment on September 8, 2006, the day after the last day to add classes. The largest-sized class a teacher has was used as the basis for this measurement.

Visibility (VI) – Independent Variable

Visibility is the degree to which an innovation is visible to others (Moore & Benbasat, 1991) . This scale consists of four items measured on a seven point scale, ranging from Strongly Disagree (1) to Strongly Agree (7). Each question for the

Visibility construct was measured using a 7-point scale from “Strongly Disagree” to “Strongly Agree and average. One of the items was reverse coded. In previous studies where specific values were reported (Agarwal & Prasad, 1997; Beckett & Aronson, 2005; Karahanna, Straub, & Chervany, 1999; Moore & Benbasat, 1991), Cronbach alpha values for Visibility have ranged from .51 to .83.

The constructs to be used are summarized in Table 3.1, along with mapping to specific questions in the instrument and other sources.

Table 3.1 Construct Summary

| Construct | Code | Questions/Source |
|-------------------------------|------|----------------------------------|
| D: Intention to Use | ITU | 22, 23, 24, 25(rev) |
| D: Actual Use | AU | (Inspection of WebCT sites – V2) |
| I: Relative Advantage | RA | 1, 2, 3, 4, 5 |
| I: Compatibility | COM | 6, 7, 26 |
| I: Ease of Use | EOU | 8, 9, 16 |
| I: Trialability | TRI | 17, 18, 19 |
| I: Results Demonstrability | RD | 10, 11, 12(rev), 27 |
| I: Voluntariness | VOL | 20, 21 |
| I: Intervention Participation | IP | (Sign-in Log) |
| I: Class Size | CS | (Published Data) |
| I: Visibility | VI | 13, 14, 15(rev), 28 |

Research Questions

1. Are PCIs related to Intention to Use (ITU) and Actual Use (AU) after an upgrade for each technology?
2. Do subjects who participate in training seminars show a difference in Intention to Use and Actual Use after an upgrade?
3. Is there a difference in use of these technologies in large versus small classes?

Hypotheses

We propose the following hypotheses for the situation when an improvement to a CMS in the form of a software upgrade is deployed. These hypotheses were tested for both Information Distribution and Assignment Submission.

H1a: There is a positive relationship between Relative Advantage and Intention to Use.

H1o: There is not a positive relationship between Relative Advantage and Intention to Use.

H2a: Instructors who actually use a technology will score higher on the Relative Advantage scale than instructors who do not actually use the technology

H2o: Instructors who actually use a technology will not score higher on the Relative Advantage scale than instructors who do not actually use the technology

H3a: There is a positive relationship between Compatibility and Intention to Use.

H3o: There is not a positive relationship between Compatibility and Intention to Use.

H4a: Instructors who actually use a technology will score higher on the Compatibility scale than instructors who do not actually use the technology.

H4o: Instructors who actually use a technology will not score higher on the Compatibility scale than instructors who do not actually use the technology.

H5a: There is a positive relationship between Ease of Use and Intention to Use.

H5o: There is not a positive relationship between Ease of Use and Intention to Use.

H6a: Instructors who actually use a technology will score higher on the Ease of Use scale than instructors who do not actually use the technology.

H6₀: Instructors who actually use a technology will not score higher on the Ease of Use scale than instructors who do not actually use the technology.

H7_a: There is a positive relationship between Trialability and Intention to Use.

H7₀: There is not a positive relationship between Trialability and Intention to Use.

H8_a: Instructors who actually use a technology will score higher on the Trialability scale than instructors who do not actually use the technology.

H8₀: Instructors who actually use a technology will not score higher on the Trialability scale than instructors who do not actually use the technology.

H9_a: There is a positive relationship between Results Demonstrability and Intention to Use.

H9₀: There is not a positive relationship between Results Demonstrability and Intention to Use.

H10_a: Instructors who actually use a technology will score higher on the Results Demonstrability scale than instructors who do not actually use the technology.

H10₀: Instructors who actually use a technology will not score higher on the Results Demonstrability scale than instructors who do not actually use the technology.

H11_a: There is a positive relationship between Voluntariness and Intention to Use.

H11₀: There is not a positive relationship between Voluntariness and Intention to Use.

H12_a: Instructors who actually use a technology will score higher on the Voluntariness scale than instructors who do not actually use the technology.

H12₀: Instructors who actually use a technology will not score higher on the Voluntariness scale than instructors who do not actually use the technology.

H13_a: Instructors who participated in Intervention Participation will score higher on Intention to Use than instructors who did not participate in Intervention Participation.

H13₀: Instructors who participated in Intervention Participation will not score higher on Intention to Use than instructors who did not participate in Intervention Participation.

H14_a: There is a positive relationship between Intervention Participation and Actual Use.

H14₀: There is not a positive relationship between Intervention Participation and Actual Use.

H15_a: There is a positive relationship between the size of classes and Intention to Use.

H15₀: There is not a positive relationship between the size of classes and Intention to Use.

H16_a: Instructors who actually use the technology will have larger class size than instructors who did not actually use the technology.

H16₀: Instructors who actually use the technology will not have larger class size than instructors who did not actually use the technology.

H17_a: There is a positive relationship between Visibility and Intention to Use.

H17₀: There is not a positive relationship between Visibility and Intention to Use.

H18_a: There is a positive relationship between Visibility and Actual Use.

H18₀: There is not a positive relationship between Visibility and Actual Use.

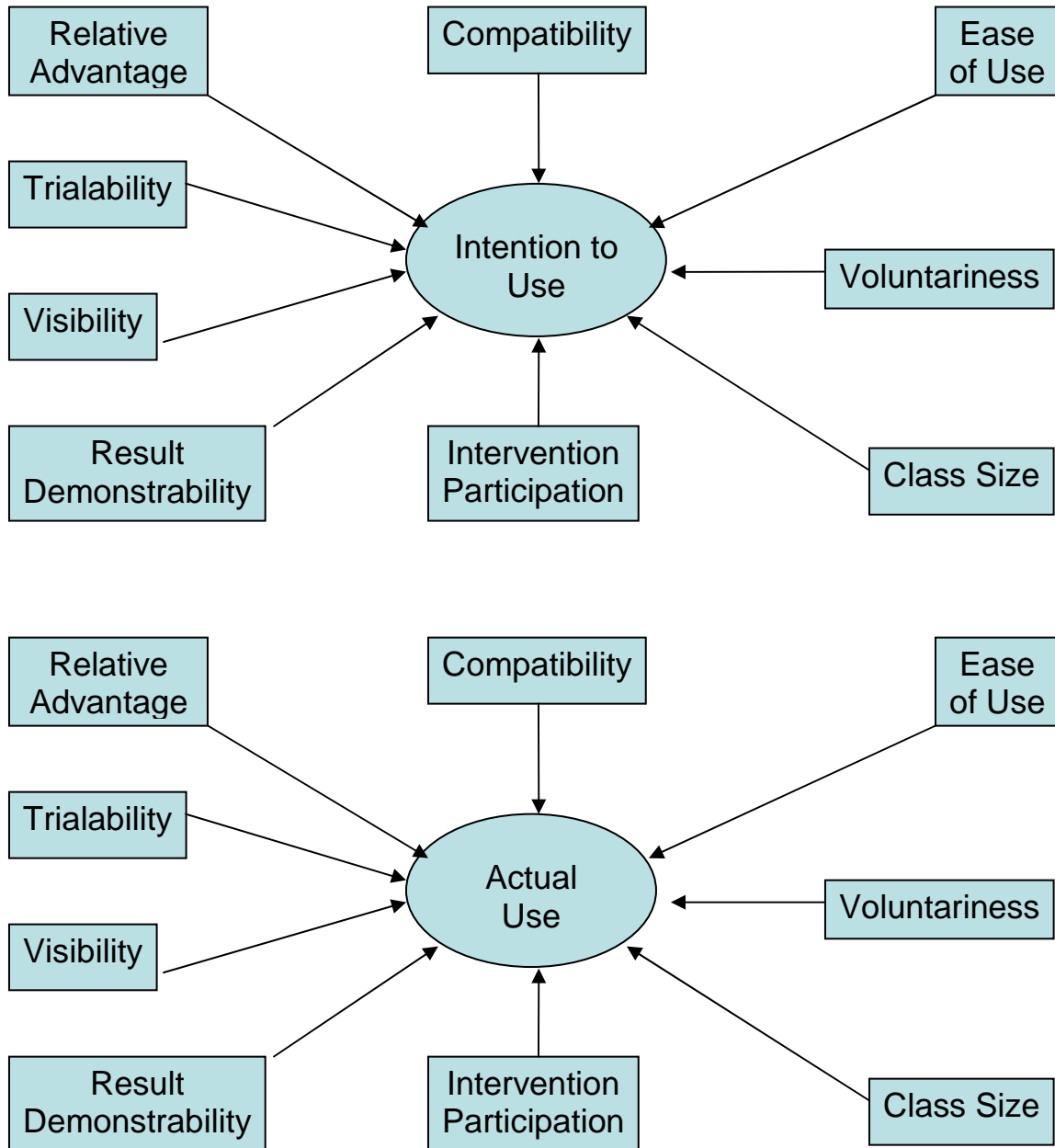
The hypotheses, variables, and statistical techniques are summarized in Table 3.1.

Table 3.2 Statistical Techniques

| Hypothesis | Independent Variable | Dependent Variable | Statistical Test |
|-------------------|-----------------------------|---------------------------|-------------------------------------|
| 1 | Relative Advantage | Intention to Use | Pearson's correlation coefficient r |
| 2 | Relative Advantage | Actual Use | <i>t</i> test |
| 3 | Compatibility | Intention to Use | Pearson's correlation coefficient r |
| 4 | Compatibility | Actual Use | <i>t</i> test |
| 5 | Ease of Use | Intention to Use | Pearson's correlation coefficient r |
| 6 | Ease of Use | Actual Use | <i>t</i> test |
| 7 | Trialability | Intention to Use | Pearson's correlation coefficient r |
| 8 | Trialability | Actual Use | <i>t</i> test |
| 9 | Results Demonstrability | Intention to Use | Pearson's correlation coefficient r |
| 10 | Results Demonstrability | Actual Use | <i>t</i> test |
| 11 | Voluntariness | Intention to Use | Pearson's correlation coefficient r |
| 12 | Voluntariness | Actual Use | <i>t</i> test |
| 13 | Intervention Participation | Intention to Use | <i>t</i> test |
| 14 | Intervention Participation | Actual Use | Chi-squared |
| 15 | Class Size | Intention to Use | Pearson's correlation coefficient r |
| 16 | Class Size | Actual Use | <i>t</i> test |
| 17 | Visibility | Intention to Use | Pearson's correlation coefficient r |
| 18 | Visibility | Actual Use | <i>t</i> test |

The hypothesized relationships among all the variables are shown in Figure 3.1.

Figure 3.1 Model and Variables



Survey Instrument

Moore and Benbasat (1991) used a multi-stage procedure for developing the instrument used in this study. An overview of that procedure is presented here, although a

detailed description may be found in Moore and Benbasat (1991). A copy of this study's expression of the instrument is found in Appendix I. The instrument shown in Appendix I was used for in Beckett and Aronson (2005), and was used without changes in this study.

In the first stage, Moore and Benbasat entered items from existing scales into a pool categorized according to Rogers' (1962, 1971, 1983, 1995, 2003) original five scales to which Moore and Benbasat (1991) added Voluntariness. A culling (for items with too-narrow focus) and expansion (for categories with insufficient items) process was used to assure that each PCI category had at least 10 items. A seven-point Likert scale from "Strongly Disagree" to "Strongly Agree" was used for all items. Additional refinement revised or eliminated items that appeared redundant or ambiguous.

Moore and Benbasat then submitted the resulting items to a panel of judges to ascertain if they had conceptual construct validity. This was done by having the judges themselves sort the items into categories to see if without prompting, the judges would place them in the classifications anticipated by the researchers.

Finally, the items were categorized by judges into the five categories defined by Rogers. Several rounds of this categorization and dropping of low-scored items resulted in high construct validity as shown by Cronbach's alpha, for all items.

Moore and Benbasat finally performed field tests of the instrument, yielding construct reliability figures as measured by Cronbach's Alpha (Kerlinger & Lee 2000, p. 655)56 ranging from 0.73 to 0.92. In view of its careful development and validation, this research used this instrument with only cosmetic changes.

Prior Studies Using Similar Measures and Procedures

Taylor and Todd (1995b) use items from the Moore and Benbasat (1991) instrument to measure perceived usefulness, ease of use, and compatibility, in their comparison of TAM and TPB. Plouffe (2001) adapted them for use in a comparison between TAM and DOI.

Hebert (1994) adapted the scale for a study of the relationship between attitudes/expectations and behavior. Revalidation was performed by panel inspection, and no statistical analysis of validity or reliability was performed.

This instrument was adapted by Karahanna, Straub, and Chervany (1999) in a longitudinal study of adoption/continuation. Cronbach's Alpha ranged in this case from .71 to .90.

The instrument was used by Agarwal and Prasad (1997) to measure PCIs as they attempted to relate DOI theory to TTF. In this regard they equated the TTF construct Ease of Use, with the DOI construct Complexity – and the TTF construct Usefulness with the DOI construct Relative Advantage.

Van Slyke, Lou, and Day (2002) used the same instrument with minor modifications, and re-validated it in a field study. Cronbach's Alpha was calculated, with scale reliabilities ranging from 0.77 to 0.96.

This instrument was also used by Venkatesh et al. (2003) to obtain PCIs as a component of their Unified Theory of Acceptance and Use of Technology (UTAUT).

While it would be tempting to use Web-based survey techniques, it is more appropriate to use traditional paper surveys when administering this survey. This research specifically consider questions of whether given electronic technologies are acceptable to

subjects. Using electronic means to collect data about whether one will use electronic technology or not is a *per se* truncation of the data sample – losing input from professors who simply do not prefer to use electronic technologies for communicating.

The alternative error would be failure to collect data from professors who prefer electronic communication to the exclusion of filling out paper surveys. In Beckett and Aronson (2005), virtually all the professors using the technologies under study submitted survey forms.

Reliability of the Instrument

In view of the use of this survey instrument in other studies, a full validation process was not deemed necessary. A comparison of Cronbachs's alpha figures of previous studies, as shown in Table 3.3, confirms this decision by showing similar results to previous studies.

Table 3.3 Scale Validation – Previous Studies (Cronbach’s Alpha)

| | Moore and Benbasat (1991) | Karahanna, Straub, and Chervany (1999) | | Agarwal and Prasad (1997) | Van Slyke, Lou, and Day (2002) | Venkatesh et al. (2003) | Beckett and Aronson (2005) | | |
|------------------------|---------------------------|--|--------------------|---------------------------|--|--|----------------------------|------------------|--------------------|
| | | Actual Users | Potential Adopters | | | | Information Distribution | Online Gradebook | Assignment Turn-in |
| Voluntariness | .82 | .71 | .74 | .45 | “Reliabilities ranged from .77 to .96” | “All internal consistency reliabilities were greater than .70” | .88 | .81 | .90 |
| Relative Advantage | .90 | .88 | .90 | .90 | | | .96 | .92 | .98 |
| Compatibility | .86 | .88 | .93 | .84 | | | .81 | .81 | .91 |
| Image | .79 | .84 | .83 | .85 | | | | | |
| Ease of Use | .84 | .87 | .90 | .80 | | | .84 | .90 | .91 |
| Result Demonstrability | .79 | .82 | .76 | .81 | | | .79 | .89 | .87 |
| Visibility | .83 | .90 | .98 | .51 | | | .55 | .73 | .59 |
| Trialability | .71 | .95 | .92 | .30 | .87 | .83 | .83 | | |

Procedure

The survey instrument was administered approximately halfway through the Fall semester 2006, and collected through February 19, 2007. During that time manual inspection of class sites in the CMS determined if the technologies studied were actually used.

Data Analysis and Strategy

H1, H3, H5, H7, H9, H11, H13, H15, and H17 were tested using Pearson's correlation. Correlation requires that both variables be continuous. Kerlinger and Lee (2000, p. 53) set forth several requirements for classifying a variable as continuous:

1. The variable has "a rank order, a larger value of the variable meaning more of the property in question than a smaller value."
2. The variable is contained within a range.

Likert scales of PCIs, and usage qualify as continuous because they meet this definition.

Sims (1999, p. 51) declares correlation as the appropriate statistical test for a bivariate hypothesis in which both variables are continuous. Since all variables to be used in these hypotheses are continuous and the hypotheses are bivariate, correlation will be used for data analysis.

H2, H4, H6, H8, H10, H12, H16, and H18 were tested using a t-test. The independent variable is binary, and the dependent variable is continuous as classified by Kerlinger and Lee (2000, p. 53). Sims (1999, p. 51) prescribes a t-test as appropriate for such cases.

H13 was tested using Chi-Squared. Both independent and dependent variables are binary. Sims (1999, p. 29) prescribes Chi-Squared as appropriate for such cases.

Limitations

Weems and Onwuegbuzie (2001) suspected that when reverse coding is used, “the positively worded items and the negatively worded items may not be measuring the same underlying trait.” One possible explanation of this may be culture: Some languages’ handling of double negatives (e.g., Spanish) will increase confusion. Another consideration is the amount of mental effort required to decode the question. In view of this factor, it may be better to code all items positively. Reverse coding in the instrument was preserved in order to leverage previous research and validation, but this issue must be recognized as having been left unaddressed.

It could be argued that lack of anonymity in this study may limit negative statements and ratings. The researcher’s lack of authority over respondees, combined with a mandate to preserve their anonymity with respect to supervisors, essentially eliminate this potential problem.

Conclusion/Summary

Chapter III presented the research design and methodology for this study. The sample and corresponding population were identified. The survey instrument was identified, and evidence of its validation was provided. The research variables and operational definitions, research questions, and hypotheses were set forth. The procedures, research and design, and an outline of data collection methods were presented.

Chapter IV will present the results of the data analysis and lead into Chapter V. Chapter V will encompass the conclusions to be drawn from the results of the data, a summary, and implications for future research.

CHAPTER IV

ANALYSIS & PRESENTATION OF FINDINGS

Introduction

This chapter presents the results of the statistical analysis methods described in the previous chapter. It begins with a summary of the results, followed by a demographic description of the study respondents. An analysis of the hypothesis testing is then conducted.

Fundamental Analysis of Data

In this section, the basic features of the data collected are described beginning with survey procedures, and continuing with the sample description and response rate. Demographic characteristics of the respondents are also presented.

Survey Procedure

One hundred seventy-five surveys were distributed to all instructors of classes in which at least six students were enrolled during the Fall semester at the institution used for this case study. Distribution began on November 6, 2006, and was performed by hand-delivering to faculty member or support staff person in each department. A second distribution was performed in early February, 2007, to maximize the return rate. In two cases faculty members were based at remote locations, so the form was mailed. All surveys distributed included postage-prepaid pre-addressed return envelopes.

Response Rate

One hundred twenty surveys were returned by February 19, 2007, for an overall return rate of 68.6%. Three of the four major sub-groups had response rates higher than 50%, and the fourth was nearly 50% at 46.8%. Babbie (2001, p. 256) suggests that 50% is an adequate response rate, so the overall response rate was deemed adequate for this study. See Table 4.1.

Table 4.1 Cross Tabulation – Survey Response Rates

| Full-Time Instructors | | | |
|-----------------------|-----------|------------|------------|
| Degree | Responses | Population | Percentage |
| Doctorate | 9 | 10 | 90.0% |
| Masters | 18 | 37 | 46.8% |
| No Graduate Degree | 1 | 4 | 25.0% |
| Total | 28 | 51 | 54.9% |

| Adjunct Instructors | | | |
|---------------------|-----------|------------|------------|
| Degree | Responses | Population | Percentage |
| Doctorate | 58 | 73 | 79.5% |
| Masters | 32 | 49 | 65.3% |
| No Graduate Degree | 2 | 2 | 100.0% |
| Total | 92 | 124 | 73.8% |

| All Instructors | | | |
|--------------------|-----------|------------|------------|
| Degree | Responses | Population | Percentage |
| Doctorate | 67 | 83 | 80.7% |
| Masters | 50 | 86 | 58.1% |
| No Graduate Degree | 3 | 6 | 50.0% |
| Total | 120 | 175 | 69.2% |

Since Hypotheses 14 and 16 did not require survey responses but depend on published data and Website inspection by the researcher, these hypotheses have 175 cases for a 100% response rate.

Respondent Demographics

The respondent sample includes 67 doctorates and 50 holders of the masters degree, as well as three with no graduate degree. Although similar to the degree makeup of the total group (83 doctorates, 86 masters, and six without graduate degrees), the sample shows a slight bias in favor of doctorates due to a higher response rate.

Missing Data

Some respondents either answered no questions regarding a given technology, or gave incomplete responses. If any answers for a construct were missing, the entire case was discarded for that construct in the specific hypothesis.

Outliers

As is customary with instruments using a Likert scale, no outliers were identified or discarded.

Analysis of Measures – Instrument Validity and Reliability

Since a previously validated instrument was used, testing for validity was not required. Cronbach's alpha values were, however, calculated for the PCI variables as shown in Table 4.2 to determine reliability. All Cronbach's alpha values were above the .70 suggested by Hair et al. (1998).

Table 4.2 Scale Validation – This Study (Cronbach’s Alpha)

| | Number of Items | Information Distribution | Assignment Turn-in |
|------------------------|-----------------|--------------------------|--------------------|
| Intention to Use | 4 | .879 | .856 |
| Relative Advantage | 5 | .947 | .982 |
| Compatibility | 3 | .849 | .854 |
| Ease of Use | 3 | .837 | .804 |
| Trialability | 3 | .778 | .889 |
| Result Demonstrability | 4 | .828 | .878 |
| Voluntariness | 2 | .795 | .871 |
| Visibility | 4 | .739 | .697 |

Analysis of Hypotheses

Each hypothesis was tested for two technologies: Information Distribution and Assignment Turn-in.

Analysis of Hypothesis One

H1a: There is a positive relationship between Relative Advantage and Intention to Use.

H1o: There is not a positive relationship between Relative Advantage and Intention to Use.

Relative Advantage and Intention to Use measures for the Information Distribution technology were gathered for 104 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Relative Advantage and Intention to Use. The mean Intention to Use was 4.08 (s.d. = 1.55). Mean Relative Advantage was 4.14 (s.d. = 1.59). The results of the correlation indicate that there is a significant positive relationship between Relative Advantage and Intention to Use ($r = .76$; $p < .01$). Thus, Hypothesis One is supported. See Table 4.3.

Table 4.3 Relative Advantage and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|--------------------|------|--------------------|---------------------------------|
| Intention to Use | 4.08 | 1.55 | |
| Relative Advantage | 4.14 | 1.59 | .76** |

***p < .01; n = 104*

Relative Advantage and Intention to Use measures for the Assignment Turn-In technology were gathered for 90 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Relative Advantage and Intention to Use. The mean Intention to Use was 3.88 (s.d. = 1.32). Mean Relative Advantage was 3.88 (s.d. = 1.69). The results of the correlation indicate that there is a significant positive relationship between Relative Advantage and Intention to Use ($r = .730$; $p < .01$). Thus, Hypothesis One is supported. See Table 4.4.

Table 4.4 Relative Advantage and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|--------------------|------|--------------------|---------------------------------|
| Intention to Use | 3.88 | 1.32 | |
| Relative Advantage | 3.88 | 1.69 | .73** |

***p < .01; n = 90*

Analysis of Hypothesis Two

H2a: Instructors who actually use a technology will score higher on the Relative Advantage scale than instructors who do not actually use the technology.

H2₀: Instructors who actually use a technology will not score higher on the Relative Advantage scale than instructors who do not actually use the technology.

The Relative Advantage measure was gathered for the Information Distribution technology for 104 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Relative Advantage scale than those who do not. The mean score on the Relative Advantage scale was 3.56 (s.d. = 1.54) for the 40 instructors who did not use the technology. The mean score on the Relative Advantage scale was 4.50 (s.d. = 1.53) for the 64 instructors who did use the technology. A one-tailed t test was used to determine if Relative Advantage is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Relative Advantage scale ($t = -3.04, p < .01$). Thus, Hypothesis Two is supported. See Table 4.5

Table 4.5 Relative Advantage and Actual Use, T-Test, Information Distribution Technology

| | Relative Advantage | |
|--------------------|--------------------|-------|
| | Non-Users | Users |
| Mean | 3.56 | 4.50 |
| Standard Deviation | 1.54 | 1.53 |
| Sample Size | 40 | 64 |

$$t = -3.04; df = 102; p < .01$$

The Relative Advantage measure was gathered for the Assignment Turn-in technology for 90 respondents who were instructors of classes with at least six students

during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Relative Advantage scale than those who do not. The mean score on the Relative Advantage scale was 3.67 (s.d. = 1.62) for the 80 instructors who did not use the technology. The mean score on the Relative Advantage scale was 5.62 (s.d. = 1.26) for the 10 Instructors who did use the technology. A one-tailed t test was used to determine if Relative Advantage is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Relative Advantage scale ($t = -4.49, p < .01$). Thus, Hypothesis Two is supported. See Table 4.6.

Table 4.6 Relative Advantage and Actual Use, T-Test, Assignment Turn-in Technology

| | Relative Advantage | |
|--------------------|--------------------|-------|
| | Non-Users | Users |
| Mean | 3.67 | 5.62 |
| Standard Deviation | 1.62 | 1.26 |
| Sample Size | 80 | 10 |

t = -4.49; df = 13.05; p < .01

Analysis of Hypothesis Three

H3a: There is a positive relationship between Compatibility and Intention to Use.

H3b: There is not a positive relationship between Compatibility and Intention to Use.

Compatibility and Intention to Use measures for the Information Distribution technology were gathered for 105 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Compatibility and Intention to Use. The mean Intention to

Use was 4.08 (s.d. = 1.55). Mean Compatibility was 3.81 (s.d. = 1.46). The results of the correlation indicate that there is a significant positive relationship between Compatibility and Intention to Use ($r = .70$; $p < .01$). Thus, Hypothesis Three is supported. See Table 4.7.

Table 4.7 Compatibility and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 4.08 | 1.55 | |
| Compatibility | 3.81 | 1.46 | .70** |

*** $p < .01$; $n = 105$*

Compatibility and Intention to Use measures for the Assignment Turn-In technology were gathered for 90 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Compatibility and Intention to Use. The mean Intention to Use was 3.88 (s.d. = 1.32). Mean Compatibility was 3.71 (s.d. = 1.45). The results of the correlation indicate that there is a significant positive relationship between Compatibility and Intention to Use ($r = .76$; $p < .01$). Thus, Hypothesis Three is supported. See Table 4.8.

Table 4.8 Compatibility and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 3.88 | 1.32 | |
| Compatibility | 3.71 | 1.45 | .76** |

*** $p < .01$; $n = 90$*

Analysis of Hypothesis Four

H4a: Instructors who actually use a technology will score higher on the Compatibility scale than instructors who do not actually use the technology.

H4b: Instructors who actually use a technology will not score higher on the Compatibility scale than instructors who do not actually use the technology.

The Compatibility measure was gathered for the Information Distribution technology for 105 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Compatibility scale than those who do not. The mean score on the Compatibility scale was 3.27 (s.d. = 1.33) for the 41 instructors who did not use the technology. The mean score on the Compatibility scale was 4.16 (s.d. = 1.45) for the 64 instructors who did use the technology. A one-tailed t test was used to determine if Compatibility is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Compatibility scale ($t = -3.18, p < .01$). Thus, Hypothesis Four is supported. See Table 4.9.

Table 4.9 Compatibility and Actual Use, T-Test, Information Distribution Technology

| | Compatibility | |
|--------------------|---------------|-------|
| | Non-Users | Users |
| Mean | 3.27 | 4.16 |
| Standard Deviation | 1.33 | 1.45 |
| Sample Size | 41 | 64 |

$$t = -3.18; df = 103; p < .01$$

The Compatibility measure was gathered for the Assignment Turn-in technology for 90 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Compatibility scale than those who do not. The mean score on the Compatibility scale was 3.54 (s.d. = 1.40) for the 80 instructors who did not use the technology. The mean score on the Compatibility scale was 5.03 (s.d. = 1.25) for the 10 instructors who did use the technology. A one-tailed t test was used to determine if Compatibility is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Compatibility scale ($t = -3.22, p < .01$). Thus, Hypothesis Four is supported. See Table 4.10.

Table 4.10 Compatibility and Actual Use, T-Test, Assignment Turn-in Technology

| | Compatibility | |
|--------------------|---------------|-------|
| | Non-Users | Users |
| Mean | 3.54 | 5.03 |
| Standard Deviation | 1.40 | 1.25 |
| Sample Size | 80 | 10 |

$t = -3.22; df = 88; p < .01$

Analysis of Hypothesis Five

H5a: There is a positive relationship between Ease of Use and Intention to Use.

H5o: There is not a positive relationship between Ease of Use and Intention to Use.

Ease of Use and Intention to Use measures for the Information Distribution technology were gathered for 105 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Ease of Use and Intention to Use. The mean Intention to Use was 4.08 (s.d. = 1.55). Mean Ease of Use was 3.94 (s.d. = 1.40). The results of the correlation indicate that there is a significant positive relationship between Ease of Use and Intention to Use ($r = .56$; $p < .01$). Thus, Hypothesis Five is supported. See Table 4.11.

Table 4.11 Ease of Use and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 4.08 | 1.55 | |
| Ease of Use | 3.94 | 1.40 | .56** |

*** $p < .01$; $n = 105$*

Ease of Use and Intention to Use measures for the Assignment Turn-In technology were gathered for 90 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Ease of Use and Intention to Use. The mean Intention to Use was 3.88 (s.d. = 1.32). Mean Ease of Use was 3.80 (s.d. = 1.28). The results of the correlation indicate that there is a significant positive relationship between Ease of Use and Intention to Use ($r = .65$; $p < .01$). Thus, Hypothesis Five is supported. See Table 4.12.

Table 4.12 Ease of Use and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 3.88 | 1.32 | |
| Ease of Use | 3.80 | 1.28 | .65** |

***p < .01; n = 90*

Analysis of Hypothesis Six

H6a: Instructors who actually use a technology will score higher on the Ease of Use scale than instructors who do not actually use the technology.

H6o: Instructors who actually use a technology will not score higher on the Ease of Use scale than instructors who do not actually use the technology.

The Ease of Use measure was gathered for the Information Distribution technology for 105 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Ease of Use scale than those who do not. The mean score on the Ease of Use scale was 3.41 (s.d. = 1.34) for the 41 instructors who did not use the technology. The mean score on the Ease of Use scale was 4.28 (s.d. = 1.34) for the 64 instructors who did use the technology. A one-tailed t test was used to determine if Ease of Use is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Ease of Use scale ($t = -3.22, p < .01$). Thus, Hypothesis Six is supported. See Table 4.13.

Table 4.13 Ease of Use and Actual Use, T-Test, Information Distribution Technology

| | Ease of Use | |
|--------------------|-------------|-------|
| | Non-Users | Users |
| Mean | 3.41 | 4.28 |
| Standard Deviation | 1.34 | 1.34 |
| Sample Size | 41 | 64 |

$$t = -3.22; df = 103; p < .01$$

The Ease of Use measure was gathered for the Assignment Turn-in technology for 90 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Ease of Use scale than those who do not. The mean score on the Ease of Use scale was 3.67 (s.d. = 1.20) for the 80 instructors who did not use the technology. The mean score on the Ease of Use scale was 4.83 (s.d. = 1.48) for the 10 instructors who did use the technology. A one-tailed t test was used to determine if Ease of Use is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Ease of Use scale ($t = -2.82, p < .01$). Thus, Hypothesis Six is supported. See Table 4.14.

Table 4.14 Ease of Use and Actual Use, T-Test, Assignment Turn-in Technology

| | Ease of Use | |
|--------------------|-------------|-------|
| | Non-Users | Users |
| Mean | 3.67 | 4.83 |
| Standard Deviation | 1.20 | 1.48 |
| Sample Size | 80 | 10 |

$$t = -2.82; df = 88; p < .01$$

Analysis of Hypothesis Seven

H7a: There is a positive relationship between Trialability and Intention to Use.

H7b: There is not a positive relationship between Trialability and Intention to Use.

Trialability and Intention to Use measures for the Information Distribution technology were gathered for 105 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Trialability and Intention to Use. The mean Intention to Use was 4.08 (s.d. = 1.55). Mean Trialability was 4.16 (s.d. = 1.44). The results of the correlation indicate that there is a significant positive relationship between Trialability and Intention to Use ($r = .40$; $p < .01$). Thus, Hypothesis Seven is supported. See Table 4.15.

Table 4.15 Trialability and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 4.08 | 1.55 | |
| Trialability | 4.16 | 1.44 | .40** |

*** $p < .01$; $n = 105$*

Trialability and Intention to Use measures for the Assignment Turn-In technology were gathered for 91 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Trialability and Intention to Use. The mean Intention to Use was 3.88 (s.d. = 1.32). Mean Trialability was 4.04 (s.d. = 1.44). The results of the correlation indicate that there is a significant positive relationship between Trialability and Intention to Use ($r = .55$; $p < .01$). Thus, Hypothesis Seven is supported. See Table 4.16.

Table 4.16 Trialability and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 3.88 | 1.32 | |
| Trialability | 4.04 | 1.44 | .55** |

***p < .01; n = 91*

Analysis of Hypothesis Eight

H8a: Instructors who actually use a technology will score higher on the Trialability scale than instructors who do not actually use the technology.

H8o: Instructors who actually use a technology will not score higher on the Trialability scale than instructors who do not actually use the technology.

The Trialability measure was gathered for the Information Distribution technology for 104 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Trialability scale than those who do not. The mean score on the Trialability scale was 3.65 (s.d. = 1.42) for the 40 instructors who did not use the technology. The mean score on the Trialability scale was 4.47 (s.d. = 1.37) for the 64 instructors who did use the technology. A one-tailed t test was used to determine if Trialability is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Trialability scale ($t = -2.95, p < .01$). Thus, Hypothesis Eight is supported. See Table 4.17.

Table 4.17 Trialability and Actual Use, T-Test, Information Distribution Technology

| | Trialability | |
|--------------------|--------------|-------|
| | Non-Users | Users |
| Mean | 3.65 | 4.47 |
| Standard Deviation | 1.42 | 1.37 |
| Sample Size | 40 | 64 |

$$t = -2.95; df = 103; p < .01$$

The Trialability measure was gathered for the Assignment Turn-in technology for 91 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Trialability scale than those who do not. The mean score on the Trialability scale was 3.95 (s.d. = 1.38) for the 81 instructors who did not use the technology. The mean score on the Trialability scale was 4.77 (s.d. = 1.72) for the 10 instructors who did use the technology. A one-tailed t test was used to determine if Trialability is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Trialability scale ($t = -1.71, p = .05$). Thus, Hypothesis Eight is supported. See Table 4.18.

Table 4.18 Trialability and Actual Use, T-Test, Assignment Turn-in Technology

| | Trialability | |
|--------------------|--------------|-------|
| | Non-Users | Users |
| Mean | 3.95 | 4.78 |
| Standard Deviation | 1.38 | 1.72 |
| Sample Size | 81 | 10 |

$$t = -1.71; df = 89; p = .05$$

Analysis of Hypothesis Nine

H9a: There is a positive relationship between Results Demonstrability and Intention to Use.

H9o: There is not a positive relationship between Relative Results Demonstrability and Intention to Use.

Results Demonstrability and Intention to Use measures for the Information Distribution technology were gathered for 107 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Results Demonstrability and Intention to Use. The mean Intention to Use was 4.08 (s.d. = 1.55). Mean Results Demonstrability was 4.43 (s.d. = 1.45). The results of the correlation indicate that there is a significant positive relationship between Results Demonstrability and Intention to Use ($r = .64$; $p < .01$). Thus, Hypothesis Nine is supported. See Table 4.19.

Table 4.19 Results Demonstrability and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|-------------------------|------|--------------------|---------------------------------|
| Intention to Use | 4.08 | 1.55 | |
| Results Demonstrability | 4.43 | 1.45 | .64** |

*** $p < .01$; $n = 107$*

Results Demonstrability and Intention to Use measures for the Assignment Turn-In technology were gathered for 92 respondents who were instructors of classes with at

least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Results Demonstrability and Intention to Use. The mean Intention to Use was 3.88 (s.d. = 1.32). Mean Results Demonstrability was 4.17 (s.d. = 1.50). The results of the correlation indicate that there is a significant positive relationship between Results Demonstrability and Intention to Use ($r = .76$; $p < .01$). Thus, Hypothesis Nine is supported. See Table 4.20.

Table 4.20 Results Demonstrability and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|----------------------------|------|--------------------|---------------------------------|
| Intention to Use | 3.88 | 1.32 | |
| Results Demonstrability | 4.17 | 1.50 | .76** |

** $p < .01$; $n = 92$

Analysis of Hypothesis Ten

H10a: Instructors who actually use a technology will score higher on the Results Demonstrability scale than instructors who do not actually use the technology.

H10o: Instructors who actually use a technology will not score higher on the Results Demonstrability scale than instructors who do not actually use the technology.

The Results Demonstrability measure was gathered for the Information Distribution technology for 105 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Results Demonstrability scale than those who do not. The mean score on

the Results Demonstrability scale was 3.77 (s.d. = 1.41) for the 41 instructors who did not use the technology. The mean score on the Results Demonstrability scale was 4.83 (s.d. = 1.34) for the 66 instructors who did use the technology. A one-tailed t test was used to determine if Results Demonstrability is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Results Demonstrability scale ($t = -3.91, p < .01$). Thus, Hypothesis Ten is supported. See Table 4.21.

Table 4.21 Results Demonstrability and Actual Use, T-Test, Information Distribution Technology

| | Results Demonstrability | |
|--------------------|-------------------------|-------|
| | Non-Users | Users |
| Mean | 3.77 | 4.83 |
| Standard Deviation | 1.41 | 1.33 |
| Sample Size | 41 | 66 |

$t = -3.91; df = 105; p < .01$

The Results Demonstrability measure was gathered for the Assignment Turn-in technology for 92 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Results Demonstrability scale than those who do not. The mean score on the Results Demonstrability scale was 4.00 (s.d. = 1.42) for the 82 instructors who did not use the technology. The mean score on the Results Demonstrability scale was 5.73 (s.d. = 1.27) for the 10 instructors who did use the technology. A one-tailed t test was used to determine if Results Demonstrability is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually

use the technology score significantly higher on the Results Demonstrability scale ($t = -3.71, p < .01$). Thus, Hypothesis Ten is supported. See Table 4.22.

Table 4.22 Results Demonstrability and Actual Use, T-Test, Assignment Turn-in Technology

| | Results Demonstrability | |
|--------------------|-------------------------|-------|
| | Non-Users | Users |
| Mean | 4.00 | 1.42 |
| Standard Deviation | 5.73 | 1.27 |
| Sample Size | 82 | 10 |

t = -3.71; df = 90; p < .01

Analysis of Hypothesis Eleven

H11a: There is a positive relationship between Voluntariness and Intention to Use.

H11o: There is not a positive relationship between Voluntariness and Intention to Use.

Voluntariness and Intention to Use measures for the Information Distribution technology were gathered for 107 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Voluntariness and Intention to Use. The mean Intention to Use was 4.08 (s.d. = 1.55). Mean Voluntariness was 5.18 (s.d. = 1.76). The results of the correlation indicate that there is not a significant positive relationship between Voluntariness and Intention to Use ($r = .02; p = .82$). Thus, Hypothesis Eleven is not supported. See Table 4.23.

Table 4.23 Voluntariness and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 4.08 | 1.55 | |
| Voluntariness | 5.18 | 1.76 | .02 |

p = .82; n = 107

Voluntariness and Intention to Use measures for the Assignment Turn-In technology were gathered for 92 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Voluntariness and Intention to Use. The mean Intention to Use was 3.88 (s.d. = 1.32). Mean Voluntariness was 5.24 (s.d. = 1.61). The results of the correlation indicate that there is not a significant positive relationship between Voluntariness and Intention to Use ($r = .09$; $p = .42$). Thus, Hypothesis Eleven is not supported. See Table 4.24.

Table 4.24 Voluntariness and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 3.88 | 1.32 | |
| Voluntariness | 5.24 | 1.61 | .09 |

p = .42; n = 92

Analysis of Hypothesis Twelve

H12a: Instructors who actually use a technology will score higher on the Voluntariness scale than instructors who do not actually use the technology.

H120: Instructors who actually use a technology will not score higher on the Voluntariness scale than instructors who do not actually use the technology.

The Voluntariness measure was gathered for the Information Distribution technology for 105 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Results Demonstrability scale than those who do not. The mean score on the Voluntariness scale was 5.23 (s.d. = 1.73) for the 41 instructors who did not use the technology. The mean score on the Voluntariness scale was 5.14 (s.d. = 1.79) for the 64 instructors who did use the technology. A one-tailed t test was used to determine if Voluntariness is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology do not score significantly higher on the Voluntariness scale ($t = .25, p = .40$). Thus, Hypothesis Twelve is not supported. See Table 4.25.

Table 4.25 Voluntariness and Actual Use, T-Test, Information Distribution Technology

| | Voluntariness | |
|--------------------|---------------|-------|
| | Non-Users | Users |
| Mean | 5.23 | 5.14 |
| Standard Deviation | 1.73 | 1.79 |
| Sample Size | 41 | 64 |

$$t = -.25; df = 105; p = .40$$

The Voluntariness measure was gathered for the Assignment Turn-in technology for 92 respondents who were instructors of classes with at least six students during the

Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Results Demonstrability scale than those who do not. The mean score on the Voluntariness scale was 5.19 (s.d. = 1.65) for the 82 instructors who did not use the technology. The mean score on the Voluntariness scale was 5.65 (s.d. = 1.56) for the 10 instructors who did use the technology. A one-tailed t test was used to determine Voluntariness is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology do not score significantly higher on the Voluntariness scale ($t = -.86, p = .20$). Thus, Hypothesis Twelve is not supported. See Table 4.26.

Table 4.26 Voluntariness and Actual Use, T-Test, Assignment Turn-in Technology

| | Voluntariness | |
|--------------------|---------------|-------|
| | Non-Users | Users |
| Mean | 5.19 | 5.65 |
| Standard Deviation | 1.65 | 1.56 |
| Sample Size | 82 | 10 |

$t = -.86; df = 90; p = .20$

Analysis of Hypothesis Thirteen

H13a: Instructors who participate in Intervention Participation will score higher on Intention to Use than instructors who did not participate in Intervention Participation.

H13b: Instructors who participate in Intervention Participation will not score higher on Intention to Use than instructors who did not participate in Intervention Participation.

The Intention to Use measure was gathered for the Information Distribution technology for 107 instructors of classes with at least six students during the Fall 2006

semester and their WebCT course Websites were inspected, to determine if those who were involved with Intervention Participation score significantly higher on the Intention to Use scale than those who do not. The mean score on the Intention to Use scale was 4.00 (s.d. = 1.51) for the 90 instructors who did not participate in intervention. The mean score on the Intention to Use scale was 4.69 (s.d. = 1.62) for the 17 instructors who did participate in intervention. A one-tailed t test was used to determine if Intention to Use is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who participated in intervention score significantly higher on the Intention to Use scale ($t = -1.79, p = .04$). Thus, Hypothesis Thirteen is supported. See Table 4.27.

Table 4.27 Intention to Use and Intervention Participation, T-Test, Information Distribution Technology

| | Intention to Use | |
|--------------------|------------------|-------|
| | Non-Users | Users |
| Mean | 4.00 | 4.69 |
| Standard Deviation | 1.52 | 1.62 |
| Sample Size | 90 | 17 |

$t = -1.79; df = 105; p = .04$

The Intention to Use measure was gathered for the Assignment Turn-in technology for 92 instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who were involved with Intervention Participation score significantly higher on the Intention to Use scale than those who do not. The mean score on the Intention to Use scale was 3.78 (s.d. = 1.28) for the 78 instructors who did not participate in intervention. The mean score on the Intention to Use scale was 4.41 (s.d. = 1.51) for the 14 instructors who did

participate in intervention. A one-tailed t test was used to determine if Intention to Use is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who participated in intervention score significantly higher on the Intention to Use scale ($t = -1.65, p = .051$). Thus, Hypothesis Thirteen is almost supported just fails. See Table 4.28.

Table 4.28 Intention to Use and Intervention Participation, T-Test, Assignment Turn-in Technology

| | Intention to Use | |
|--------------------|------------------|-------|
| | Non-Users | Users |
| Mean | 3.78 | 4.41 |
| Standard Deviation | 1.28 | 1.51 |
| Sample Size | 78 | 14 |

$$t = -1.65; df = 90; p = .051$$

Analysis of Hypothesis Fourteen

H14a: There is a positive relationship between Intervention Participation and Actual Use.

H14o: There is not a positive relationship between Intervention Participation and Actual Use.

Records of participation by 175 instructors were obtained from the department supporting WebCT, and the corresponding WebCT course Websites were inspected for evidence of Actual Use of the Information Distribution technology. The results of the chi-square statistic indicate that significantly ($X^2 = 17.36; p < .01$) more instructors participating in the intervention actually used the technology than would be expected if

Intervention Participation and Actual Use were unrelated. Thus, Hypothesis Fourteen is supported. See Table 4.29.

Table 4.29 Intervention Participation and Actual Use, Cross Tabulation and Chi-Squared, Information Distribution Technology

| Intervention Participation | Actual Use – Information Distribution | | Total |
|----------------------------|---------------------------------------|------|-------|
| | not used | used | |
| no participation | 92 | 2 | 94 |
| participation | 63 | 18 | 81 |
| Total | 155 | 20 | 175 |

$\chi^2 = 17.36; df = 1; p < .01$

Records of participation by 175 instructors in Intervention Participation were obtained from the department supporting WebCT, and the corresponding WebCT course Websites were inspected for evidence of Actual Use of the Assignment Turn-in technology. The results of the chi-square statistic indicate that the number of instructors participating in the intervention was not significantly ($\chi^2 = .933; p = .33$) larger than would be expected if Intervention Participation and Actual Use were unrelated. Thus, Hypothesis Fourteen is not supported. See Table 4.30.

Table 4.30 Intervention Participation and Actual Use, Cross Tabulation and Chi-Squared, Assignment Turn-in Technology

| Intervention Participation | Actual Use – Information Distribution | | Total |
|----------------------------|---------------------------------------|------|-------|
| | not used | used | |
| no participation | 142 | 17 | 159 |
| participation | 13 | 13 | 16 |
| Total | 155 | 20 | 175 |

$\chi^2 = .933; df = 1; p = .33$

Analysis of Hypothesis Fifteen

H15_a: There is a positive relationship between the size of classes and Intention to Use.

H15₀: There is not a positive relationship between the Size of Classes and Intention to Use.

The Intention to Use measure for the Information Distribution technology was gathered for 107 respondents who were instructors of classes with at least six students during the Fall 2006 semester and institutional records were inspected for class size, to determine if there is a significant positive relationship between Size of Classes and Intention to Use. The mean Intention to Use was 4.08 (s.d. = 1.55). Mean Size of Classes was 32.95 (s.d. = 22.74). The results of the correlation indicate that there is not a significant positive relationship between size of classes and Intention to Use ($r = -.04$; $p = .34$). Thus, Hypothesis Fifteen is not supported. See Table 4.31.

Table 4.31 Size of classes and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|-------|--------------------|---------------------------------|
| Intention to Use | 4.08 | 1.55 | |
| size of classes | 32.95 | 22.74 | .042 |

$p = .34$; $n = 107$

The Intention to Use measure for the Assignment Turn-in technology was gathered for 107 respondents who were instructors of classes with at least six students during the Fall 2006 semester and institutional records were inspected for class size, to determine if there is a significant positive relationship between Size of Classes and Intention to Use. The mean Intention to Use was 3.88 (s.d. = 1.32). Mean Size of Classes

was 32.95 (s.d. = 22.74). The results of the correlation indicate that there is a not significant positive relationship between size of classes and Intention to Use ($r = .02$; $p = .02$). Thus, Hypothesis Fifteen is not supported. See Table 4.32.

Table 4.32 Size of classes and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|-------|--------------------|---------------------------------|
| Intention to Use | 3.88 | 1.32 | |
| size of classes | 32.95 | 32.95 | .02* |

* $p = .02$; $n = 92$

Analysis of Hypothesis Sixteen

H16_a: Instructors who actually use the technology will have larger class size than instructors who did not actually use the technology.

H16₀: Instructors who actually use the technology will not have larger Class Size than instructors who did not actually use the technology.

The teaching loads of 175 instructors were inspected to determine their Class Size and their WebCT course Websites were inspected to determine if those who actually use the technology for Information Distribution have significantly higher Class Size than those who do not. The mean Class Size was 28.14 (s.d. = 17.31) for the 94 instructors who did not use the technology. The mean Class Size was 38.53 (s.d. = 26.79) for the 81 instructors who did use the technology. A one-tailed t test was used to determine if Class Size is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score have

significantly larger Class Size ($t = -3.00$ $p < .01$). Thus, Hypothesis Sixteen is supported. See Table 4.33.

Table 4.33 Class Size and Actual Use, T-Test, Information Distribution Technology

| | Class Size | |
|--------------------|------------|-------|
| | Non-Users | Users |
| Mean | 28.14 | 38.53 |
| Standard Deviation | 17.31 | 26.79 |
| Sample Size | 94 | 81 |

$t = -3.00; df = 133.13; p < .01$

The teaching loads of 175 instructors were inspected to determine their Class Size and their WebCT course Websites were inspected to determine if those who actually use the Assignment Turn-in technology have significantly higher Class Size than those who do not. The mean Class Size was 32.03 (s.d. = 21.22) for the 159 instructors who did not use the technology. The mean Class Size was 42.13 (s.d. = 34.00) for the 16 instructors who did use the technology. A one-tailed t test was used to determine if Class Size is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score do not have significantly larger Class Size ($t = -1.17$, $p = .13$). Thus, Hypothesis Sixteen is not supported. See Table 4.34.

Table 4.34 Class Size and Actual Use, T-Test, Assignment Turn-in Technology

| | Class Size | |
|--------------------|------------|-------|
| | Non-Users | Users |
| Mean | 32.03 | 42.13 |
| Standard Deviation | 21.22 | 34.00 |
| Sample Size | 159 | 16 |

$t = -1.17; df = 16.20; p = .13$

Analysis of Hypothesis Seventeen

H17_a: There is a positive relationship between Visibility and Intention to Use.

H17₀: There is not a positive relationship between Visibility and Intention to Use.

Visibility and Intention to Use measures for the Information Distribution technology were gathered for 107 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Visibility and Intention to Use. The mean Intention to Use was 4.08 (s.d. = 1.55). Mean Visibility was 4.24 (s.d. = 1.33). The results of the correlation indicate that there is not a significant positive relationship between Visibility and Intention to Use ($r = .14$; $p = .07$). Thus, Hypothesis Seventeen is not supported. See Table 4.35.

Table 4.35 Visibility and Intention to Use, Correlation and Descriptive Statistics, Information Distribution Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 4.08 | 1.55 | |
| Visibility | 4.24 | 1.33 | .14 |

$p = .07$; $n = 107$

Visibility and Intention to Use measures for the Assignment Turn-in technology were gathered for 92 respondents who were instructors of classes with at least six students during the Fall 2006 semester to determine if there is a significant positive relationship between Visibility and Intention to Use. The mean Intention to Use was 3.88

(s.d. = 1.32). Mean Visibility was 3.70 (s.d. = 1.15). The results of the correlation indicate that there is a significant positive relationship between Visibility and Intention to Use ($r = .20$; $p = .03$). Thus, Hypothesis Seventeen is supported. See Table 4.36.

Table 4.36 Visibility and Intention to Use, Correlation and Descriptive Statistics, Assignment Turn-in Technology

| | Mean | Standard Deviation | Correlation Intention to Use |
|------------------|------|--------------------|---------------------------------|
| Intention to Use | 3.88 | 1.32 | |
| Visibility | 3.70 | 1.15 | .20* |

* $p = .03$; $n = 92$

Analysis of Hypothesis Eighteen

H18_a: There is a positive relationship between Visibility and Actual Use.

H18₀: There is not a positive relationship between Visibility and Actual Use.

The Visibility measure was gathered for the Information Distribution technology for 107 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Visibility scale than those who do not. The mean score on the Visibility scale was 3.91 (s.d. = 1.39) for the 41 instructors who did not use the technology. The mean score on the Visibility scale was 4.44 (s.d. = 1.25) for the 66 instructors who did use the technology. A one-tailed t test was used to determine if Visibility is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Visibility scale ($t = -1.98$, $p = .03$). Thus, Hypothesis Eighteen is supported. See Table 4.37.

Table 4.37 Visibility and Actual Use, T-Test, Information Distribution Technology

| | Visibility | |
|--------------------|------------|-------|
| | Non-Users | Users |
| Mean | 3.91 | 4.44 |
| Standard Deviation | 1.39 | 1.25 |
| Sample Size | 41 | 66 |

t = -2.026; df = 105; p = .02

The Visibility measure was gathered for the Assignment Turn-in technology for 92 respondents who were instructors of classes with at least six students during the Fall 2006 semester and their WebCT course Websites were inspected, to determine if those who actually use the technology score significantly higher on the Visibility scale than those who do not. The mean score on the Visibility scale was 3.78 (s.d. = 1.17) for the 82 instructors who did not use the technology. The mean score on the Visibility scale was 3.08 (s.d. = 0.77) for the 10 instructors who did use the technology. A one-tailed t test was used to determine if Visibility is higher for instructors who actually use the technology than those who do not. The results indicate that the instructors who actually use the technology score significantly higher on the Visibility scale ($t = 1.85, p = .04$). Thus, Hypothesis Eighteen is supported. See Table 4.38.

Table 4.38 Visibility and Actual Use, T-Test, Assignment Turn-in Technology

| | Visibility | |
|--------------------|------------|-------|
| | Non-Users | Users |
| Mean | 3.78 | 1.17 |
| Standard Deviation | 3.08 | 0.77 |
| Sample Size | 82 | 10 |

t = 2.55; df = 14.61; p = .04

Conclusion

In this chapter the sample data were presented. The basis for determining reliability and validity of the instrument used to collect the sample data was shown. The results for each of the hypotheses described in the research design were reported and analyzed.

CHAPTER V

SUMMARY AND CONCLUSIONS

Introduction

This chapter presents the conclusions of our study. It is divided into six sections. The first section summarizes and interprets the results. The second through fourth sections discuss the implications for the case study setting, practice, and the information systems research field respectively. The fifth section suggests future research based on the results of this study. The final section concludes with the meaning of our results and a discussion of reliability, validity, and limitations.

Summary

Our purpose was to test the Rogers (1962, 1971, 1983, 1994, 2003) model of diffusion as it extends to actual use in the case of the upgrade to a Course Management System (CMS). The Moore and Benbasat (1991) instrument was used to collect data regarding Perceived Characteristics of an Innovation (PCIs) and Intent to Use. Class size data was obtained from published records of the institution in which the study was conducted. Actual Use data was obtained by inspecting the CMS Websites of the classes.

This research aimed at showing links between PCIs, Intent to Use, and Actual Use and to answer the following questions: (1) Are PCIs related to Intent to Use and Actual Use after an upgrade for each technology? (2) Do subjects who participate in training seminars show a difference in Intent to Use and Actual Use after an upgrade? (3) Is there a difference in use of these technologies in large versus small classes?

All teachers with classes of at least six students during the Fall semester of 2006 were surveyed regarding their PCIs and Intent to Use two technologies that were part of the CMS. From 175 teachers qualifying, 105 usable questionnaires regarding one of the technologies were returned and 90 usable questionnaires regarding the other technology were returned. Correlation, t-test, and Chi-squared analyses were used to analyze the study's model. Our findings support much of the model as originally developed by Rogers and extended by Agarwal and Prasad (1997).

Interpretations

The study research questions were answered by formulating eighteen hypotheses. Thirteen hypotheses were supported for both technologies, two were supported for neither, and results were split for three. The empirical results of our study indicate a significant relationship between the five original constructs of Rogers and both Intent to Use and Actual Use. These results show an ambivalent relationship between both Voluntariness and Visibility, and Intent to Use. No relationship was found between Voluntariness and Actual Use. Paradoxically, while no relationship was found between Class Size and Intent to Use, a significant relationship was found between Class Size and Actual Use.

The 18 hypotheses were designed in pairs. The Independent Variable (IV) of each pair was the same. The DV of the first of each pair was Intent to Use, while the Dependent Variable (DV) of the second of each pair was Actual Use. An overview of the hypotheses, results of previous research, and this study is shown in Table 5.1.

Table 5.1 Hypotheses Overview

| Hypothesis | Independent Variable | Dependent Variable | Agarwal & Prasad (1997) | Agarwal & Prasad (2000) | Grover (1993) | Hebert & Benbasat (1994) | Plouffe (2001) | Van Slyke et al. (2002) | This Study – Information Distribution | This Study – Assignment Turn-in |
|------------|----------------------------|--------------------|-------------------------|-------------------------|---------------|--------------------------|----------------|-------------------------|---------------------------------------|---------------------------------|
| 1 | Relative Advantage | Intention to Use | ** | ** | | + | ** | ** | ** | ** |
| 2 | Relative Advantage | Actual Use | | | | | | | ** | ** |
| 3 | Compatibility | Intention to Use | ** | ** | ** | + | * | ** | ** | ** |
| 4 | Compatibility | Actual Use | | | | | | | ** | ** |
| 5 | Ease of Use | Intention to Use | ** | ** | | | - | * | ** | ** |
| 6 | Ease of Use | Actual Use | | | | | | | ** | ** |
| 7 | Trialability | Intention to Use | ** | | | | * | - | ** | ** |
| 8 | Trialability | Actual Use | | | | | | | ** | * |
| 9 | Results Demonstrability | Intention to Use | ** | | | + | - | * | ** | ** |
| 10 | Results Demonstrability | Actual Use | | | | | | | ** | ** |
| 11 | Voluntariness | Intention to Use | -- | - | | + | * | | -- | - |
| 12 | Voluntariness | Actual Use | | | | | | | -- | - |
| 13 | Intervention Participation | Intention to Use | | ** | | | | | * | ~ |
| 14 | Intervention Participation | Actual Use | | | | | | | ** | - |
| 15 | Class Size | Intention to Use | | | | | | | -- | - |
| 16 | Class Size | Actual Use | | | | | | | ** | - |
| 17 | Visibility | Intention to Use | -- | | | | * | -- | -- | * |
| 18 | Visibility | Actual Use | | | | | | | * | * |

~ $p = .051$; * $p < .05$; ** $p < .01$; -- Not significant; ++ “Significant” with no p -value given

+ “Marginally Significant” with no p -value given

Although results for the Information Distribution technology and the Assignment Turn-in technology are similar in this study, several hypotheses show more support in the former case than the latter. Two possible reasons may explain this difference:

1. The Assignment Turn-in technology is more complex to use than the Information Distribution technology, resulting in fewer instructors achieving success with it.
2. The Assignment Turn-in technology is not perceived as yielding as much benefit as the Information Distribution technology. The Assignment Turn-in technology does not impart an economy of scale factor to an instructor's workload, and instructors who have actually used it often indicate that it is cumbersome. A typical comment is that it does "not work well at all for me in regard to students turning in assignments."

We will consider these differences in more detail next.

Hypothesis One posits a relationship between Relative Advantage (RA) as the independent variable and Intention to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. The results indicate that instructors who believe that the technology provides greater advantage than alternatives to that technology are more likely to report an intention to use that technology.

This finding is consistent with Rogers (2003, p. 229), who states that previous Diffusion of Innovations (DOI) research identifies RA as "one of the strongest predictors of an innovation's rate of adoption." Previous research in information technology innovations is likewise unanimous in its support of this relation (Agarwal & Prasad,

1997; Agarwal & Prasad, 2000; Hebert & Benbasat, 1994; Plouffe, 2001; Van Slyke et al., 2002).

The implication that RA is associated with ITU, is tantamount to saying that people are more likely to plan usage if they think it is worthwhile to do so. The results of tests for this hypothesis support the notion that people think in a rational manner –they align their *intentions* with the evidence they perceive. It does not, however, imply that they act in a rational manner – that they *act* in accordance with the evidence they perceive.

The negative aspect of this hypothesis is illustrated by selected comments from subjects who chose not to use the innovation:

“My own webpage & class listserves suffice for me” (i.e., improvement in RA perceived.)

“It’s cheaper for students to purchase handouts from the campus book store. Students asked to have handouts placed in the book store. So I decided not to use WebCT for distributing handouts & syllabi.” (i.e., negative RA perceived.)

Comments associated with RA and ITU suggest that instructors surveyed in this study focus on the contribution of the technology to their primary goal. Specifically, comments in this study focus on usefulness of the technology to the overall educational process rather than the instructor experience alone. Thus, the concept of RA is interpreted by subjects in a manner consistent with the culture of the setting. Accordingly, Hypothesis One is supported by this research.

Hypothesis Two posits a relationship between Relative Advantage (RA) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends Hypothesis One beyond intention, to actual use. Actual use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results indicate that instructors who believe that a technology provides greater advantage than alternatives to that technology, are more likely actually to use that technology.

This extension is a significant contribution of this research, since AU measurement in other studies of RA (e.g., Jurison, 2000; Moore & Benbasat, 1990; Moore & Benbasat, 1991) and similar constructs (e.g., Adams et al., 1992; Kettinger & Grover, 1997; Rawstorne et al., 2000; Straub et al., 1995; Szajna, 1996; Taylor & Todd, 1995; Teo et al., 1999; Venkatesh & Davis, 2000) have largely been limited to self-report statistics.

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects' perceptions. Thus, the results of tests for Hypothesis Two clearly show a positive relationship between the perceived characteristic of RA and AU.

Hypothesis Three posits a relationship between Compatibility (CO) as the independent variable and Intention to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. The results indicate that instructors who believe that

the technology is consistent with their values and needs, are more likely to report an intention to use that technology.

This finding is consistent with Rogers (2003, p. 249), who states that “The compatibility of an innovation...is positively related to its rate of adoption. Past diffusion research suggests that compatibility may be somewhat less important in predicting the rate of adoption than is relative advantage.” Previous research is unanimous in its support of this hypothesis (Agarwal & Prasad, 1997; Agarwal & Prasad, 2000; Grover, 1993; Hebert & Benbasat, 1994; Plouffe, 2001; Van Slyke et al., 2002). Plouffe (2001) shows less support for Hypothesis Three than Hypothesis One, which is in line with Rogers’ statement.

The implication that CO is associated with ITU, is tantamount to saying that people are more likely to plan usage if they think the technology being considered will work well for them. The results of tests for this hypothesis support the notion that people think in a rational manner – they align their *intentions* with the evidence they perceive. It does not, however, imply that they act in a rational manner – that they *act* in accordance with the evidence they perceive.

The negative aspect of this hypothesis is illustrated by selected comments from subjects who chose not to use the innovation:

“Works well if students know how to access & have the appropriate ‘viewers’ to look at the materials.” (i.e., concerned about CO).

“I used WebCT 4.0 without difficulties. Although 6.0 is an upgrade, it has been the biggest pain to work with. Also, I was assured my stuff would be on there by the 1st day of class and it wasn’t. (i.e., negative CO perceived).

Comments associated with CO and ITU suggest that instructors surveyed in this study focus on the compatibility of the technology to their primary goal. Specifically, comments in this study focus on compatibility with the educational process rather than the instructor's processes alone. Thus, the concept of CO is interpreted by subjects in a manner consistent with the culture of the setting. Accordingly, Hypothesis Three is supported by this research.

Hypothesis Four posits a relationship between Compatibility (CO) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends the link of Hypothesis Three beyond intention, to actual use. Actual use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results indicate that instructors who believe that a technology is consistent with their values and needs, are more likely to actually use that technology.

This extension is a significant contribution of this research, since AU measurement in other studies of CO (e.g., Moore & Benbasat, 1990; Moore & Benbasat, 1991; Taylor & Todd) have largely been limited to self-report statistics.

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects' perceptions. The results of tests for Hypothesis Four clearly show a positive relationship between the perceived characteristic of CO and AU.

Hypothesis Five posits a relationship between Ease of Use (EOU) as the independent variable and Intention to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. The results indicate that instructors who believe they can understand how to use the technology are more likely to report an intention to use that technology.

Research is mixed in its support of this hypothesis, with the majority supporting it (Agarwal & Prasad, 1997; Agarwal & Prasad, 2000; Van Slyke et al., 2002) and a minority failing to support it (Plouffe, 2001). The lack of compulsion in this setting may provide an explanation for the positive results in this study as compared to some studies in the research literature. While our results support this hypothesis for both the Information Distribution and Assignment Turn-in technologies, support was stronger in the case of the Information Distribution technology than the Assignment Turn-in technology.

On the surface, this might seem natural because the Assignment Turn-in technology is more difficult for instructors to implement and yields less benefit. But some studies give full support to more complex technologies. The disparity between our results for this hypothesis and those of others may stem from organizational culture, e.g., a technology may actually be preferred if it is considered more difficult to use because it provides a differentiating factor between different worker groups, whereas in the setting of this study no such benefit is conferred.

The implication that EOU is associated ITU, is tantamount to saying that people are more likely to plan usage if they think it is possible to do so. The results of tests for

this hypothesis support the notion that people think in a rational manner – they align their *intentions* with the evidence they perceive. It does not, however, imply that they act in a rational manner –that they *act* in accordance with the evidence they perceive.

The negative aspect of this hypothesis is illustrated by comments from subjects who chose not to use the innovation:

“Technology takes too much time to learn and maintain. The one workshop I attended was way over my head” (i.e., negative EOU perceived).

“Like any software, WebCT is a tool. It has pros and cons – fits some students better than others” (i.e., no EOU improvement perceived).

Comments associated with EOU and ITU suggest that instructors surveyed in this study focus on the ease of use of the technology to their primary goal. Specifically, comments in this study focus on ease of use with the educational process rather than the instructor’s processes alone. Thus, the concept of EOU is interpreted by subjects in a manner consistent with the culture of the setting. Accordingly, Hypothesis Five is supported by this research.

Hypothesis Six posits a relationship between Ease of Use (EOU) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends the link of Hypothesis Five beyond intention, to actual use. Actual use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results indicate that instructors who believe they can understand how to use a technology are more likely to actually use that technology.

This extension is a significant contribution of this research, since AU measurement in other studies of EOU (e.g., Adams et al., 1992; Kettinger & Grover, 1997; Moore & Benbasat, 1990; Moore & Benbasat, 1991; Rawstorne et al., 2000; Straub et al., 1995; Szajna, 1996; Taylor & Todd, 1995; Teo et al., 1999; Venkatesh & Davis, 2000) have largely been limited to self-report statistics.

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects' perceptions. Thus, the results for Hypothesis Six clearly show a positive relationship between the perceived characteristic of EOU and AU.

Hypothesis Seven posits a relationship between Trialability (TR) as the independent variable and Intent to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. The results indicate that instructors who believe that "the innovation may be experimented with on a limited basis" (Rogers, 2003, p. 258) are more likely to report an intention to use that technology. Rogers suggested that other factors such as innate personality and the position of the innovation on the diffusion curve might affect TR. Previous research of this hypothesis in information technology innovations is mixed, with some finding significance (Agarwal and Prasad, 1997) and others not finding significance (Van Slyke, Lou, & Day, 2002).

Given the impact of a Course Management System on an instructor's work, it is reasonable that they should like to test new methods before commitment. The results of tests for this hypothesis support the notion that people think in a rational manner – they align their *intentions* with the evidence they perceive. It does not, however, imply that

they act in a rational manner – that they *act* in accordance with the evidence they perceive.

There were no comments that could be specifically tied to TR. Several comments indicated that instructors felt a need to move into these technologies but had not yet done so.

In view of the significant positive correlation found between TR and ITU, Hypothesis Seven is supported by this research.

Hypothesis Eight posits a relationship between Trialability (TR) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends the link of Hypothesis Seven beyond intention, to actual use. Actual use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results indicate that instructors who believe that “the innovation may be experimented with on a limited basis” (Rogers, 2003, p. 258) are more likely to report an intention to use that technology.

This extension is a significant contribution of this research, since AU measurement in other studies of TR (e.g., Moore & Benbasat, 1990; Moore & Benbasat, 1991) have largely been limited to self-report statistics.

While one should be cautious about the number of cases in the sample, the reduced support in the case of Assignment Turn-in may indicate that it is less valuable or more difficult to implement.

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects' perceptions. Thus, the results of tests for Hypothesis Eight show a positive relationship between the perceived characteristic of TR and AU.

Hypothesis Nine posits a relationship between Results Demonstrability (RD) as the independent variable and Intent to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. The results indicate that instructors who believe that they can observe the results of using the technology are more likely to report an intention to use that technology. This finding is consistent previous research (Agarwal & Prasad, 1997; Van Slyke, Lou, & Day, 2002).

The implication that RD is associated with ITU, is tantamount to saying that people are positively influenced by the perception that they will know if they have succeeded or not. The results of tests for this hypothesis support the notion that people think in a rational manner – they align their *intentions* with the evidence they perceive. It does not, however, imply that they act in a rational manner – that they *act* in accordance with the evidence they perceive.

There were no comments that could be specifically tied to RD. Instructors showed no indications that they were unsure of results, suggesting that in this setting the instructors felt they had accurate knowledge of how the use of the Course Management System affected both themselves and the students. Thus, the concept of RD is interpreted by subjects in a manner consistent with the culture of the setting. Accordingly, Hypothesis Nine is supported by this research.

Hypothesis Ten posits a relationship between Results Demonstrability (RD) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends the link of Hypothesis Nine beyond intention, to actual use. Actual use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results indicate that instructors who believe that they can observe the results of using the technology are more likely to actually use that technology.

This extension is a significant contribution of this research, since AU measurement in other studies of RD (e.g., Moore & Benbasat, 1990; Moore & Benbasat, 1991) has largely been limited to self-report statistics.

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects' perceptions. Thus, the results of tests for Hypothesis Ten show a positive relationship between the perceived characteristic of RD and AU.

Hypothesis Eleven posits a relationship between Voluntariness (VO) as the independent variable and Intent to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. The results do not indicate that instructors who believe that their use is voluntary are more likely to report an intention to use that technology.

Previous research has been mixed, with some (Agarwal & Prasad, 1997; Agarwal & Prasad, 2000) supporting the hypothesis and others (Hebert & Benbasat, 2002; Plouffe, 2001) finding no support.

It is reasonable for this particular link to vary from setting to setting. In the face of little compulsion, one would not expect a connection between the perception of compulsion and ITU.

Only one comment out of a sample of over 100 cited VO as an issue: “Covertly the administration has made its use mandatory (Teaching evaluations: Tool is crafted in a manner where faculty who don’t use WebCT receive a lower overall evaluation.)” This lack of response on the VO issue suggests that there is generally no perceived compulsion, and apparently drove responses which cause Hypothesis Eleven to be rejected by this research.

Hypothesis Twelve posits a relationship between Voluntariness (VO) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends the link of Hypothesis Eleven beyond intention, to actual use. Actual use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results do not indicate that instructors who believe that their use is voluntary are more likely to actually use the technology.

This extension is a significant contribution of this research, since AU measurement in other studies of VO (e.g., Moore & Benbasat, 1990; Moore & Benbasat, 1991) have largely been limited to self-report statistics.

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects' perceptions. Thus, the results of tests for Hypothesis Twelve show a no relationship between the perceived characteristic of VO and AU.

Hypothesis Thirteen posits a relationship between Intervention Participation (IP) as the independent variable and Intent to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. Agarwal and Prasad (2002) support a relation using a similar construct. The results indicate that instructors who participated in seminars designed by management to increase knowledge about the innovation, are more likely to report an intention to use that technology – but only for the less complex Information Distribution technology. Our results support this hypothesis for the Information Distribution technology, but do not support it for the Assignment Turn-in technology.

Frustration with the seminars appeared in some of the comments:

“I do not use WebCT. I have attended 6-8 sessions of instruction.”

“The one workshop I attended was way over my head.”

The disparity between results of the two technologies supports the notion that the Information Distribution technology is becoming routinized (Rogers 2003, p. 428) at this institution, but the Assignment Turn-in technology is still at an earlier stage of diffusion. The department supporting WebCT has responded to comments such as those above by focusing significant attention on tuning these events since the study data was collected.

Given the results of the two tests, Hypothesis Thirteen is supported by this research – for technologies in the routinized stage of diffusion.

Hypothesis Fourteen posits a relationship between Intervention Participation (IV) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends the link of Hypothesis Thirteen beyond intention, to actual Use. Actual Use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results indicate that instructors who participated in seminars designed by management to increase knowledge about the innovation, are more likely to actually use that technology – but only for the less complex Information Distribution technology. This disparity suggests that the Information Distribution technology has become routinized at this institution, but the Assignment Turn-in technology is still at an earlier stage of diffusion.

The difference in support between these two technologies may also reflect the difference in complexity between them. Information Distribution can be comprehended easily and implemented with relatively little learning. Assignment turn-in on the other hand has multiple variables in its necessary configuration and requires far more technology to be brought on-line both on the instructor and the student sides. In addition, the value to be gained from assignment turn-in over alternatives (e.g., handing the instructor a paper at class time or email attachments) is less.

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects’

perceptions. Accordingly, Hypothesis Fourteen is supported by this research – for technologies in the routinized stage of diffusion.

Hypothesis Fifteen posits a relationship between Class Size (CS) as the independent variable and Intent to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. The results indicate that instructors with larger classes are not more likely to report an intention to use that technology.

Our results do not support this hypothesis for either the Information Distribution technology or the Assignment Turn-in technology. The economy of scale may not be recognized by prospective users before implementation. Other reasons may prevail. One response suggested that an instructor may personally lose money if they distribute materials through the CMS instead of selling them through the campus bookstore:

“There is no way a student will be able to buy reports of the specific nature that I require in my classes.”

For the Materials Distribution technology, lack of support for this hypothesis is interesting. WebCT technology enables certain types of materials distribution far better than other means – and some instructors have been quite vocal in meetings about this advantage. But such cases may still be considered “bleeding edge” by the majority of instructors, and thus ignored.

In the case of Assignment Turn-in technology, there is less economy of scale for larger classes because the turn-in process is no less cumbersome when the technology is used, so one might not expect a relation. In fact, the benefit may be negative as suggested by one comment:

“There are items that do not work well at all for me in regard to students turning in assignments. I have the students print out the assignment page, fill it out, and turn it in to me in class.”

Accordingly, this research does not support Hypothesis Fifteen.

Hypothesis Sixteen posits a relationship between Class Size (CS) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends the link of Hypothesis Fifteen beyond intention, to actual Use. Actual Use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results indicate that instructors with larger classes are more likely to actually use that technology – but only for the Information Distribution technology.

The disparity between results of this hypothesis test for the Information Distribution technology and the test of Hypothesis Fifteen is interesting, since it indicates that there is lack of intention yet actual use occurs – the use ratio was actually higher than the intent, when in most of life action falls short of intentions! One possible explanation for this disparity might be that instructors of larger classes do not *like* the technology and wish there was something better-suited to their needs, but they *use* the technology because it is available. It is also possible that instructor attitudes toward the technology degrade once they begin using it, but they feel there is no alternative.

The disparity between results of this hypothesis test for the Information Distribution technology and the same hypothesis test for the Assignment Turn-in

technology is less of a mystery. The Information Distribution technology is less difficult to use and yields more benefit, especially in larger classes; whereas the Assignment Turn-in technology is more difficult to use and yields little benefit in many cases (depending on the complexity of the assignments to be turned in).

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects' perceptions. Given the mixed results and multiple possible explanations for apparent disparities, our research does not provide clear support for Hypothesis Sixteen.

Hypothesis Seventeen posits a relationship between Visibility (VI) as the independent variable and Intent to Use (ITU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. Visibility is roughly equivalent to Rogers' (2003, p. 258) characteristic of "Observability." The results indicate that instructors with who believe their use of a technology is visible to others are not more likely to report an intention to use that technology.

The relationship between VI and ITU has previously been tested with mixed support. While most previous research (Agarwal & Prasad, 1997; Van Slyke, Lou, & Day, 2002) does not support this hypothesis, there was some support (Plouffe, 2001). Our research shows Hypothesis Seventeen was not supported for the Information Distribution technology, but was supported for the Assignment Turn-in technology. We suspect that this results from a difference between the routinized state enjoyed by the Information Distribution technology (in which visibility is no longer a significant factor), and the

early stage at which the Assignment Turn-in technology remains (in which relationships to other teachers are a key factor so visibility is important).

Accordingly, this research provides mixed support for Hypothesis Seventeen – suggesting that there is at least one moderating factor involved.

Hypothesis Eighteen posits a relationship between Visibility (VI) as the independent variable and Actual Use (AU) as the dependent variable. This hypothesis was tested for two technologies: the Information Distribution technology and the Assignment Turn-in technology. This hypothesis extends the link of Hypothesis Seventeen beyond intention, to actual Use. Actual Use was measured by inspecting Websites in the WebCT Course Management System, to determine if instructors were actually using the technologies in question. The results indicate that instructors with who believe their use of a technology is visible to others are more more likely to actually use that technology.

This extension is a significant contribution of this research, since AU measurements in other studies of VI (e.g., Moore & Benbasat, 1990; Moore & Benbasat, 1991) have largely been limited to self-report statistics.

By measuring artifacts of subject behavior, this research obtained AU information without the possibility of contamination by the effect of good intentions on subjects' perceptions. Thus, the results of tests for Hypothesis Eighteen clearly show a positive relationship between the perceived characteristic of VI and AU.

It is interesting to compare results for Hypothesis Seventeen with those for Hypothesis Eighteen with respect to the Information Distribution technology. The former uses Intent to Use as DV, while the latter uses Actual Use. It may be that Information

Distribution has become routinized for those who wish to use it, but routinely resisted by those who do not wish to use it. Yet when faced with serving students, instructors who perceive that their use or non-use is visible will actually use the technology.

Generalizability

In view of the similar results of this study to studies in other contexts, it is reasonable to assume that the same results of new hypotheses will generalize well to similar settings. Settings where voluntariness is less may result in different results.

Implications for the Case Study Setting

Although the suite of technologies represented by the WebCT Course Management System have been in place for several years, utilization is mixed. Use of the Information Distribution technology is fairly widespread, and well understood by a substantial group of instructors. The Assignment Turn-in is used far less. The question at hand is whether low usage is due to an early position on the diffusion time curve, whether the benefits are outweighed by the costs, or whether the functionality delivered is actually a poor match to needs. The recent acquisition of WebCT by its competition raises the question of the next move for the campus in question: whether continued standardization on a product which may become a dead end or lose its identity as it is merged with another product line, is better than switching to an alternative. It should be noted in this context that actual use of WebCT's technologies after five years in place has been insubstantial in areas not supported by the Moodle, an alternative technology which is free. On the other hand, complaints about WebCT have often centered on its rate of

change (which is considered high by those who complain). Clearly, this institution must soon make a non-structured decision about the future of Course Management System software.

Another question raised repeatedly in survey comments is the targeting of educational events related to the technology. The connection between these events and actual use is tenuous, and several respondents volunteered the suggestion that resources would be better spent on individual rather than group tutorials. Study results support the suggestion that economy of scale is more effective with less-complex technologies. On the other hand, there is great appreciation for ongoing support by the office charged with that responsibility.

Implications for Practice

The support for Intervention Participation's links to Intent to Use and Actual Use is interesting, since it shows support in the case of Information Distribution but not Assignment Turn-in. It would appear that the seminars being held are effective at inducing attitudes and behavior in the case of the former, simpler, technology – but not the latter. This could either be due to less perceived (and achieved) value of the Assignment Turn-in technology, or an earlier placement on the curve of diffusion over time. The amount of time required to use the technology might answer this question, but if the value of the Assignment Turn-in technology is improved by reducing its complexity, a tipping point might be reached for reason of value rather than mere time.

The link between visibility and Intent to Use / Actual Use bears attention by practitioners, who need to recognize where their subjects are in the diffusion cycle because inverse relationships can arise.

Implications for Research

There is a need for more understanding of the interactions between innovations and various groups of people the organization, rather than considering each as unrelated entities. Jasperson, Carter, and Zmud (2005) recognized that for optimal success, the nature of the innovation itself is molded to better align with business needs, and support activities connect from perceived needs of users to the way the innovation is made available. Gallivan (2001) viewed innovation in the context of the firm's politics. A synthesis of these two approaches would be helpful.

In the same line, Agarwal and Prasad (2000) found it useful to consider the effect of user training but failed to connect this with the adoption cycle per se. This study showed some counterintuitive results between training and attitudes, which would bear more investigation.

The relationship between class size and usage of a course management system (CMS) might indicate where, if ever, the tipping point is that triggers effective use of a CMS as opposed to traditional methods. Perceptions about lack of user-friendliness can be eclipsed by the amount of work involved in manual alternatives. Study of the sensitivity of perceptions to the volume of work and ease of use, would be helpful.

The progress of the diffusion process is sometimes depicted as an S-shaped curve (Rogers 2003, p. 273) . While the S-shape may be the mathematical justification for

terming this process “diffusion,” another aspect that may justify study is the role of different players in the drama. To illustrate, consider the first derivative of the diffusion curve, which happens to be a bell curve. The height of the bell curve indicates the amount of change occurring – which simultaneously shows the amount of money changing hands, the non-productivity, and stress being experienced by those implementing the innovation. Meanwhile, the S-curve itself shows contribution to success of the organization or individual, while at the same time showing success of the change agents. This perspective of actors and their motives may yield useful research questions in the future.

Related to this is the relationship between habit, perceived usefulness, and adequate alternatives. One might expect that adequacy of an alternative combined with the inertia of habit would cloud perceptions of perceived usefulness. There appears to be an interesting comparison here: males have traditionally been considered more likely to stick with the first adequate alternative when shopping, yet research in diffusion (Venkatesh & Morris, 2000) shows them to be more willing to try new technologies.

Suggestions for Future Research

More research is needed to determine the relationship between management interventions and attitudes including Intention to Use. Data from this study suggests that the “fit” between management interventions and user maturity play a role, but specific guidelines need to be developed based on research.

In the case of a Course Management System, organization plays a role and should be considered in further research. In some cases the instructor works with the CMS

directly. In others an assistant of some kind performs the CMS interaction. In others a support department does more of the work. Research should be performed to determine the effect of organizational styles on attitudes and success.

A topic unaddressed by this research is the issue of program errors. The constructs Ease of Use and Complexity, as well as complaints of cumbersome procedures, could hide disconnects between specifications and the delivered product. This research does not consider fractured implementation or malfunction from poor design, and how each might affect diffusion. One might expect that poor implementation can often be surmounted by changes in user behavior, but incorrect underlying design is more difficult to surmount and thus may result in permanent impacts on perceptions and usage. While this issue might be considered a limitation, one can argue that the effects program errors are a part of all computer technologies and so they should be included in any research.

Another aspect of the whole malfunction/misdesign issue is that users may actually prefer a poorly-functioning product because this differentiates them from those who have not or cannot adapt to it.

Finally, apparent malfunction or misdesign can be due to poor training – either incorrect training or lack of training. This can happen at multiple levels, depending on where it happens. If misuse of a technology occurs merely in one user's work, the effects are limited to that user. Misuse of a technology at a design level affects all levels of design below the error.

Most importantly, a link should be established between perceived characteristics of innovations and effectiveness of individuals or organizations. Are peoples' perceptions

useful indicators of effectiveness? Do those perceptions, when incorrect, influence effectiveness either positively or negatively?

Reliability and Validity

Although the Cronbach alpha values for this study are in line with research practice, the small number of actual users for the Assignment Turn-in technology suggests that conclusions based on that aspect of the study should be used with caution. Validity of the constructs used was extensively tested by Moore & Benbasat (1991).

Limitations

The most challenging limitation faced by this study is the fact that the entities studied are active. For instance, in the original design one of the technologies studied was use of the WebCT gradebook. After the instrument was developed, however, the department supporting WebCT switched their support to another product out of frustration with WebCT's gradebook. Any knowledge about this on the part of the subjects may taint the results. As a result of this specific problem, testing of hypotheses using the gradebook technology was omitted from our analysis.

A second challenge was the dynamics of innovation itself. Different actors in the process operate on different time-cycles. Several comments on the survey sheets indicated that while the Information Distribution technology itself was worthwhile, it changed at a rate faster than the users could handle. Dynamics inject a dimension of variables that can confound easy explanation of behavior.

A third challenge is that of alternative technologies. As mentioned above, one aspect of the study (Online Gradebooks) was abandoned because the support office switched to an alternative. For some technologies a Course Management System (CMS) cannot provide optimal methods for all users, and some at least will be tempted to use alternatives.

Conclusions

Rogers (1962, 1971, 1983, 1984, 2003) model is clearly supported using the Moore and Benbasat (1991) instrument in this case. Except for the constructs of Voluntariness and Visibility, support is strong. In an environment with high Voluntariness and Visibility, one could reasonably expect little relationship between these variables and either Intention to Use or Actual Use. Support for hypotheses relating Intervention Participation (in this case training seminars) to Intention to Use and Actual Use is less strong, and relates primarily to the less-complex technology. Support for relating Class Size to these DVs is even weaker – possibly because class sizes at this institution are generally smaller than the norm.

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APPENDIX A

SURVEY COVER LETTER



(date)

(name)

(department)

Processing code: (identifier)

Dear Colleague:

Many of you will remember filling out a survey for me during the Winter semester of 2005. This was a great help for my dissertation research. This survey is a follow-up to determine what, if any changes have come in the wake of the many things the Office of Online Learning has done to improve their support for faculty and students.

Your help is needed to maintain the momentum of this project, whether or not you currently use or anticipate using WebCT – and whether or not you completed the earlier survey.

Thank you very much for your help in filling out the survey.

Sincerely,

John Beckett, Associate Professor of Computing

APPENDIX B
SURVEY INSTRUMENT

Distributing Materials

| Please answer the following questions with regard to the use of WebCT for <u>distributing materials</u> such as syllabi and handouts to students. | | | | | | | |
|--|-------------------|--|--|---------|--|--|----------------|
| (Every third row is shaded for your convenience.) | Strongly Disagree | | | Neutral | | | Strongly Agree |
| 1. Using this technology enables me to accomplish tasks more quickly. | | | | | | | |
| 2. Using this technology improves the quality of work I do. | | | | | | | |
| 3. Using this technology makes it easier to do my job. | | | | | | | |
| 4. Using this technology enhances my effectiveness on the job. | | | | | | | |
| 5. Using this technology gives me greater control over my work. | | | | | | | |
| 6. Using this technology is compatible with all aspects of my work. | | | | | | | |
| 7. I think using this technology fits well with the way I like to work. | | | | | | | |
| 8. I believe that it is easy to get this technology to do what I want it to do. | | | | | | | |
| 9. Learning to operate this technology is easy for me. | | | | | | | |
| 10. I would have no difficulty telling others about the results of using this technology | | | | | | | |
| 11. I believe I could communicate to others the consequences of using this technology. | | | | | | | |
| 12. I would have difficulty explaining why using this technology may or may not be beneficial. | | | | | | | |
| 13. I have seen what others do using this technology. | | | | | | | |
| 14. In my organization, one sees this technology being used by many individuals. | | | | | | | |
| 15. This technology is not very visible in my organization. | | | | | | | |
| 16. My interaction with this technology is clear and understandable. | | | | | | | |
| 17. Before deciding whether to use this technology, I was able to properly try it out. | | | | | | | |
| 18. I was permitted to use this technology on a trial basis long enough to see what it could do. | | | | | | | |
| 19. I am able to experiment with this technology as necessary. | | | | | | | |
| 20. My management does not require me to use this technology. | | | | | | | |
| 21. Although it might be helpful, using this technology is certainly not compulsory in my organization. | | | | | | | |
| 22. I would use this technology even if its use were not required. | | | | | | | |
| 23. I would recommend this technology for use in other organizations. | | | | | | | |
| 24. I would recommend the use of this technology to other individuals. | | | | | | | |
| 25. I prefer means other than this technology to interact with others. | | | | | | | |
| 26. Using this technology fits into my work style. | | | | | | | |
| 27. The results of using this technology are apparent to me. | | | | | | | |
| 28. It is easy for me to observe others using this technology in my organization. | | | | | | | |
| Comments regarding the Information Distribution function of WebCT: | | | | | | | |

Gradebooks

| Please answer the following questions with regard to the use of WebCT for communicating grades and scores to students. (Every third row is shaded for your convenience.) | | | | | | | |
|--|-------------------|--|--|---------|--|--|----------------|
| | Strongly Disagree | | | Neutral | | | Strongly Agree |
| 1. Using this technology enables me to accomplish tasks more quickly. | | | | | | | |
| 2. Using this technology improves the quality of work I do. | | | | | | | |
| 3. Using this technology makes it easier to do my job. | | | | | | | |
| 4. Using this technology enhances my effectiveness on the job. | | | | | | | |
| 5. Using this technology gives me greater control over my work. | | | | | | | |
| 6. Using this technology is compatible with all aspects of my work. | | | | | | | |
| 7. I think using this technology fits well with the way I like to work. | | | | | | | |
| 8. I believe that it is easy to get this technology to do what I want it to do. | | | | | | | |
| 9. Learning to operate this technology is easy for me. | | | | | | | |
| 10. I would have no difficulty telling others about the results of using this technology | | | | | | | |
| 11. I believe I could communicate to others the consequences of using this technology. | | | | | | | |
| 12. I would have difficulty explaining why using this technology may or may not be beneficial. | | | | | | | |
| 13. I have seen what others do using this technology. | | | | | | | |
| 14. In my organization, one sees this technology being used by many individuals. | | | | | | | |
| 15. This technology is not very visible in my organization. | | | | | | | |
| 16. My interaction with this technology is clear and understandable. | | | | | | | |
| 17. Before deciding whether to use this technology, I was able to properly try it out. | | | | | | | |
| 18. I was permitted to use this technology on a trial basis long enough to see what it could do. | | | | | | | |
| 19. I am able to experiment with this technology as necessary. | | | | | | | |
| 20. My management does not require me to use this technology. | | | | | | | |
| 21. Although it might be helpful, using this technology is certainly not compulsory in my organization. | | | | | | | |
| 22. I would use this technology even if its use were not required. | | | | | | | |
| 23. I would recommend this technology for use in other organizations. | | | | | | | |
| 24. I would recommend the use of this technology to other individuals. | | | | | | | |
| 25. I prefer means other than this technology to interact with others. | | | | | | | |
| 26. Using this technology fits into my work style. | | | | | | | |
| 27. The results of using this technology are apparent to me. | | | | | | | |
| 28. It is easy for me to observe others using this technology in my organization. | | | | | | | |
| Comments regarding the Gradebook function of WebCT: | | | | | | | |

Assignment Turn-In

| Please answer the following questions with regard to the use of WebCT for <u>students turning in assignments.</u> (Every third row is shaded for your convenience.) | | | | | | | |
|---|-------------------|--|--|---------|--|--|----------------|
| | Strongly Disagree | | | Neutral | | | Strongly Agree |
| 1. Using this technology enables me to accomplish tasks more quickly. | | | | | | | |
| 2. Using this technology improves the quality of work I do. | | | | | | | |
| 3. Using this technology makes it easier to do my job. | | | | | | | |
| 4. Using this technology enhances my effectiveness on the job. | | | | | | | |
| 5. Using this technology gives me greater control over my work. | | | | | | | |
| 6. Using this technology is compatible with all aspects of my work. | | | | | | | |
| 7. I think using this technology fits well with the way I like to work. | | | | | | | |
| 8. I believe that it is easy to get this technology to do what I want it to do. | | | | | | | |
| 9. Learning to operate this technology is easy for me. | | | | | | | |
| 10. I would have no difficulty telling others about the results of using this technology | | | | | | | |
| 11. I believe I could communicate to others the consequences of using this technology. | | | | | | | |
| 12. I would have difficulty explaining why using this technology may or may not be beneficial. | | | | | | | |
| 13. I have seen what others do using this technology. | | | | | | | |
| 14. In my organization, one sees this technology being used by many individuals. | | | | | | | |
| 15. This technology is not very visible in my organization. | | | | | | | |
| 16. My interaction with this technology is clear and understandable. | | | | | | | |
| 17. Before deciding whether to use this technology, I was able to properly try it out. | | | | | | | |
| 18. I was permitted to use this technology on a trial basis long enough to see what it could do. | | | | | | | |
| 19. I am able to experiment with this technology as necessary. | | | | | | | |
| 20. My management does not require me to use this technology. | | | | | | | |
| 21. Although it might be helpful, using this technology is certainly not compulsory in my organization. | | | | | | | |
| 22. I would use this technology even if its use were not required. | | | | | | | |
| 23. I would recommend this technology for use in other organizations. | | | | | | | |
| 24. I would recommend the use of this technology to other individuals. | | | | | | | |
| 25. I prefer means other than this technology to interact with others. | | | | | | | |
| 26. Using this technology fits into my work style. | | | | | | | |
| 27. The results of using this technology are apparent to me. | | | | | | | |
| 28. It is easy for me to observe others using this technology in my organization. | | | | | | | |
| Comments regarding the Assignment Turn-In function of WebCT: | | | | | | | |

Demographic Information

Please enter or correct the following information.

| | |
|---|-------------------------------|
| Name | (name from database) |
| Email address | (email address from database) |
| Year you began teaching at SAU | (year from database) |
| Year you were born (optional) | |
| Status (A=Adjunct, F=Full-time) | (status from database) |
| Department | (department from database) |
| Number of classes for which you use WebCT in a year | |
| If you use WebCT, for which class do you use it most intensively? | |
| What characteristic or feature of WebCT is most likely to <u>discourage</u> you from using it in your classes? | |
| What characteristic or feature of WebCT is most likely to <u>encourage</u> you to use it in your classes? | |