1999

Effectiveness of Web-Based Virtual Learning Environments in Business Education: Focusing on Basic Skills Training for Information Technology.

Rami Mahmoud Ahmad
Louisiana State University and Agricultural & Mechanical College

EFFECTIVENESS OF WEB-BASED VIRTUAL LEARNING ENVIRONMENTS IN BUSINESS EDUCATION: FOCUSING ON BASIC SKILLS TRAINING FOR INFORMATION TECHNOLOGY

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University
and Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Interdepartmental Program in
Business Administration
(Information Systems and Decision Sciences)

By
Rami Ahmad
B.S. in Electrical Engineering, Louisiana State University, 1987
M.S. in Systems Science, Louisiana State University, 1991
May, 1999

UMI Number: 9925523

With my deepest gratitude and love ...

To My Father ...

Who did not live long enough to see me finish

And To My Children ...

Who I hope, one day, will understand what I went through

ACKNOWLEDGMENTS

I thank God the Almighty for giving me the strength and the perseverance to endure throughout this humbling experience. It was for his blessing and his mercy that I was able to overcome the overwhelming challenges I faced in my life.

I would like to thank my advisor, Dr. Blake Ives, who made a big difference. He treated me as a colleague rather than a student and allowed me to learn and grow under his guidance and supervision. I would like to also thank my committee members for their support through out the years: Dr. S. Kundu, Dr. Y. Chen, Dr. K. Tang, Dr. K. Walsh and Dr. P. Fitzgerald. I would like to acknowledge Gabriele Piccoli, not only a supportive colleague but also a friend, who always inspired me with ideas and words of encouragement. I also thank the faculty, staff and graduate students of the ISDS department, in particular, Dr. Lisa Murphy who helped me sharpen the presentation of my research. My sincere thanks extend to all my friends and colleagues from all over the world, who supported me and kept in touch; in particular, my local support system-- the wonderful people I met at Highland Coffees.

Last but not least, all the members in my family. I start with my mother who traveled across the globe to be beside me. I was blessed to have her prayers and her support. I also thank my brothers Mohammed, Rashed and Yahya, who always believed in me; my in-laws, in particular Mr. and Mrs. Aboud, whose support in taking care of my kids was indispensable; and my wife, Reem, whose understanding and support made it possible for this dream to become a reality. To her I say- this success is not only for me, but also for you and for our children.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Calls for transforming the learning industries and revolutionizing business education are being answered by a proliferation of virtual learning environments, capitalizing on ever-growing and universal Internet-related technologies. This dissertation describes research investigating the effectiveness of web-based virtual environments by comparing traditional and information technology enhanced learning environments. A conceptual framework is proposed contrasting the effectiveness of these two environments across two learning models -- the objectivist and the constructivist. Although technology may serve as a moderator that enhances the implementation of certain features of a learning model, there is a consensus that the learning model- not the technology- is the primary cause of learning. Theory predicts that higher levels of "learner control" will lead to more effective learning. Control and flexibility, among other advantages offered to the learner in virtual environments, lead us to propose that such environments are more effective than traditional environments regardless of the learning model employed. Furthermore, it is proposed that virtual environments are even more effective with the constructivist model, because of the better match between the characteristics of the virtual environments and the assumptions of the constructivist model, as compared to the objectivist model.

The effectiveness of the learning environment is measured in terms of self-efficacy, performance and satisfaction. A field experiment was set up to test the components of the proposed research model with 192 business undergraduate students in an introductory Information Technology course. In this research, several hypotheses comparing students' performance, satisfaction and self-efficacy in both

traditional and virtual learning environments were evaluated. The results of hypotheses testing indicated that subjects in the virtual environment have reported higher levels of self-efficacy in both learning models. However, there was no statistically significant difference in performance between the two environments. Another interesting result was that subjects in the virtual environment, despite showing higher levels of self-efficacy, were less satisfied with the learning environment. The findings of this study may improve our understanding of the implications when virtual environments are implemented. As we prepare to enter the third millennium, web-based virtual learning environments present great and exciting opportunities for both academia and business communities.

1. INTRODUCTION

This chapter starts with an articulation of the challenges facing business schools in keeping abreast with developments in IT. Examples of what is being done to meet those challenges follow. The definition of virtual learning environments is presented along with their perceived advantages and disadvantages. The dilemma of the continuous debate on the effectiveness of learning environments is also addressed leading to a discussion of the research questions followed by the objective of this study and its implications for education and business communities.

1.1 The Problem Area

Calls for transforming the learning industries and revolutionizing business education are being answered by a proliferation of virtual learning environments. Virtual universities are emerging and more and more universities are developing and offering virtual classes capitalizing on ever-growing and ubiquitous Internet related technologies. Ives and Jarvenpaa (1996) warn that: "...nothing will protect the business school from being swept into the current of technologically driven change" and they call upon business schools to seek an alternative vision built around environments that foster virtual learning communities.

Although members of both the Information Systems (IS) and the Education communities intuitively feel that the virtual learning environments will enhance learning and the students' ability to apply knowledge and skills, pedagogic practice (as put by Alavi, 1994) has not yet fully integrated information technology (IT) into the curriculum and classroom activity. Computers and other related technologies remain greatly under-utilized in this context. According to Wellburn (1996): "It is fairly obvious that education has not turned to technology to the same degree as has the

business community and it can be argued that the education system has not done an exemplary job of evaluating the impact of the technology it has implemented." D'Ignazio (1993) described the frustrating gap between the business communities and the educational communities: "businesses have been building electronic highways while education has been creating an electronic dirt road. And sometimes on a dirt road, it's just as easy to get out and walk."

Traditional classrooms seem unlikely to be the environments for operationalizing the underlying assumptions of emerging new paradigms about education such as Lifelong Learning and Just-in-Time vs. Just-in-Case Education. Lin et al. (1996) cited a number of theorists (e.g. Hmelo, 1993; J.S. Brown et al., 1989), who argued that the structure of typical classrooms discourages the kinds of learning necessary for the twenty-first century. Furthermore, the "basics" required for success in our increasingly changing society are no longer simply reading, writing, and arithmetic, but the ability to think critically and reason about important content, plus the ability and the motivation to learn independently throughout one's life (e.g. Bruer, 1993; Resnick & Klopfer, 1989). It is time to reengineer the educational field by adopting new and innovative ways of creating effective and efficient environments that will better prepare us to enter the third millennium.

1.2 Effective Learning Environments

In March 1987, the American Association for Higher Education (AAHE) Bulletin first published "Seven Principles for Good Practice in Undergraduate Education." The Principles, created by Art Chickering and Zelda Gamson with help from higher education colleagues, AAHE, and the Education Commission of the States, with

support from the Johnson Foundation, distilled findings from decades of research on the undergraduate experience. Several hundred thousand copies of the Principles and Inventories have been distributed to two- and four-year campuses in the United States and Canada. These principles are summarized as follows:

- Contacts Between Students and Faculty
- Reciprocity and Cooperation Among Students
- Active Learning Techniques
- Prompt Feedback
- Emphasizes Time on Task
- Communicates High Expectations
- Respects Diverse Talents and Ways of Learning

As to the role of technology in learning environments, there has been a rather vigorous debate between the pros and the cons. Over the years, perhaps since the incorporation of radio and television in the classroom, many studies showed a "Significant Difference" in the outcomes of the learning process. Still, many other studies showed "No Significant Difference." However, in the educational literature, there is a consensus that the implementation of effective instructional strategies is the primary cause of improved learning, not the technology. But for any given instructional strategy, some technologies are better than others are. As the saying goes: Better to turn a screw with a screwdriver than a hammer.

1.3 The Virtual Learning Environments

What is "Virtuality"? Turoff (1997) defines virtuality as the property of a computer system with the potential for enabling a virtual system to become a real one

by encouraging the real world to behave according to the template dictated by the virtual system. Once these virtual systems are actually used in the world of physical reality, they become part of that world and in effect modify existing social systems. The concepts of virtuality have made their way into many disciplines, to name a few: the virtual organization (Mowshowitz, 1997); virtual classrooms (Hiltz, 1993); virtual universities (Chellappa, Barua et al. 1997); virtual museums (Mannoni, 1997); medical applications of virtuality (Zajtchuk and Satava, 1997); virtual teams (Lipnack and Stamps, 1997), virtual casinos (Lewis, 1997); virtual fashion shows, etc.

In this research, the focus is virtual learning environments. But is it virtual learning, or learning in virtual environments? Although it has become a common terminology, "virtual learning" might seem misleading. The learning is real, but the environment is what has changed (Schank, 1997). Almost any metaphor of a learning environment includes at the outset the elements of "time," "place," and "space" where the learning actually occurs. The learning space refers to the range of resources available such as books, notes, etc. The incorporation of technology in educational environments has mostly remained within the traditional boundaries of those elements until the recent explosion in Internet-related technologies. Today, technology allows the student and both the instructor and other students to be decoupled in any of the elements of time, place, and space. Wilson (1996) classified the emerging technology-enabled learning environments into three categories: First, *computer microworlds*, where the students enter a self-contained computer-based environment to learn. Second, *classroom-based learning environments*, in which various technologies may function as tools in support of classroom activities. Third, *Virtual learning*

environments, which are defined as computer-based environments that are relatively open systems, allowing interactions with other participants and providing access to a wide range of resources. Such environments foster an "Any time / Any place" learning model that is not only a different way of delivering knowledge, but also a powerful means of creating knowledge. These new ways potentially have a wide range of advantages over traditional environments such as: convenience, flexibility, currency of material, increasing retention, lowering education costs, transcending geographical barriers, etc.

According to Massy and Zemsky (1995) "IT enables self-paced learning with sensitivity to different learning styles and continuous assessment of student progress. The areas that can profit most from IT-based strategies are those subjects that have a high volume of students, a standardized curriculum, and over whose content faculty is less possessive. IT enables students to work at their own pace with continuous assessment, in contrast to the traditional post-secondary education method, which can be described as batch processing with episodic assessment. Continuous assessment allows teachers to pinpoint the areas where students falter- and in the case of some multimedia programs, those areas trigger further practice automatically so that students receive more instruction - just in time - when they need it most."

1.4 Research Questions

The Commissioner for Higher Education in Virginia, in an address to Educom's National Learning Infrastructure Initiative, stated that for technology to address the "big problems" of higher education it must respond to three questions: Does it make learning more accessible? Does it promote improved learning? Does it accomplish

the above while containing, if not reducing, the per-unit costs of education? Schools and higher education administrators, governments, and the public are demanding answers to these kinds of questions (Owston 1997). Some might say that the use of the World Wide Web is inevitable, so there is no need to justify it. However, if the Web is to be worthy of the attention and the investments involved, it must meet the challenges that these questions bring. Related questions have been articulated in other platforms. The important questions related to virtual learning environments can be classified into four categories of issues:

- **Effectiveness issues** - Do they work? For whom? And when?
- **Financial issues** - What are the cost implications? What are the implications for college professors and course developers? Do they require different business models for making investment decisions or generating revenues?
- **Technical issues** - What are the technical constraints for full exploitation of the advantages of virtual learning environments?
- **Societal issues** - What are the implications for society?

The following is a collection of critical questions dealing with web-based virtual learning environments in general. When does virtual learning work and when it does not? What is the impact of these new environments on traditional teaching and training? What are the costs involved? What are the technical constraints for full exploitation of the advantages of virtual learning environments? Do these environments require different business models for making investment decisions or generating revenues for training organizations? What are the implications for faculty who develop the courses the first time? How should they be paid?

The focus in this research is on the effectiveness issue. While several previous studies have incorporated technology in advanced courses that required critical analysis, higher-order thinking and interaction with other participants (e.g. Alavi, 1994; Leidner & Jarvanpaa, 1993), this research instead, specifically investigates the effectiveness of web-based virtual learning environments in a college course focused on basic IT skills for business majors. The outcome of this study could have several implications for business schools who are considering the migration of some, or all, of their basic skill business courses to the Internet. Also, the results of the study would be interesting to training organizations and business corporations as they continue to look for efficient and effective methods to keep up with the ever-growing need to upgrade the skills of their workforce.

This dissertation addresses the following specific research questions in the context of IT basic skills learning:

- How effective are web-based virtual environments when compared to traditional learning environments? Do they lead to higher levels of performance, self-efficacy and satisfaction?
- Are web-based virtual environments more effective than traditional environments regardless of the learning model employed? Do they lend themselves to a particular learning model?

1.5 Organization of This Document

In the second chapter of this dissertation, a theoretical framework is established and some related previous studies are reviewed. This chapter starts with a brief introduction to research in the educational technology area, which leads to a

discussion on the Theory of Learning. The major assumptions of the "Objectivist" and "Constructivist" learning models are compared. To set the stage for discussing the implications of learning theory on instructional design, an overview of the Component Display Theory (CDT) of instructional design is presented. The "Learner Control" feature of the CDT is emphasized because of its relevance to virtual learning environments. Then, the salient features of the Social Cognitive Theory are presented; in particular, the features related to self-efficacy as a predictor of the actual ability to use the learned skills. The chapter concludes with a review of previous related studies. The third chapter presents the research methodology. The research hypotheses, design of the experiment and validity issues are also discussed. Chapter 4 discusses data collection and data analysis. Chapter 5 includes detailed discussion of the research findings. Finally, the conclusion chapter presents a summary of the contribution and limitations of this study along with suggestions for future research and concluding remarks.

2. LITERATURE REVIEW

In this chapter, a theoretical framework is established and related previous studies are reviewed. This chapter starts with a brief introduction to research in the educational technology area, which leads to a discussion on the Theory of Learning. The major assumptions of the "Objectivist" and "Constructivist" learning models are compared. To set the stage for discussing the implications of the learning theory on instructional design, an overview of the Component Display Theory (CDT) of instructional design is presented. The "Learner Control" feature of the CDT is discussed in more details because of its relevance to virtual learning environments. Then, the salient features of the Social Cognitive Theory are presented; in particular, the features related to self-efficacy as a predictor of the actual ability to use the learned skills. Finally, the chapter concludes with a review of recent related studies.

2.1 Exploration of the Learning Theory

At the heart of any learning activity is a learning model that is either implicitly or explicitly employed. As early as the end of the last century, researchers began studying and refining the underlying models of the learning process. These efforts evolved into learning theories. In general, these theories belong to one of two schools of thought: *behavioral* and *cognitive* learning theories. The behavioral theory was initially the dominant source of conceptions of learning, but in the late 1950's the prevailing paradigm shifted towards the cognitive theories. The traditional approach to schooling has reflected a view of "knowledge" as entities existing independently of the learner or the context and therefore learning can be objective, absolute and unconditional. On the other hand, the cognitive approach argues that knowledge is not acquired as a collection of abstract entities but rather is constructed in the context of the environment it encounters, and learners construct knowledge socially through

collaboration and discussion (Duffy, Lowych et al. 1993). The two major competing models are the "objectivist" and the "constructivist" models representing the behavioral theory and the cognitive theory respectively.

2.1.1 Objectivism vs. Constructivism

The objectivism and constructivism models are different in their philosophical assumptions. The objectivist model holds that learning is a process for representing and mirroring reality, while the constructivist model holds that it is a process of actively interpreting and constructing individual knowledge representations (Jonassen 1993). These two models differ in their basic premise, goals and implications for instruction. The major assumption of objectivism is that the instructor is the source of knowledge to be transferred to the learner for uncritical absorption of facts. The instructor is in control of the material and the pace. On the other hand, constructivism assumes that individuals learn better when they discover things themselves and when they control the pace of learning utilizing the instructor for support rather than direction.

The table on the next page (compiled from Jonassen,1991; Leidner & Jarvenpaa, 1995; and Mory 1996) compares the salient features of the two models. Since learning entails constructivistic and objectivistic activities, the most realistic model of learning lies somewhere between the two positions (Jonassen 1991).

2.1.2 Implications on Instructional Design

Each model has its implications for instructional design. In the objectivist model, the goal of instruction is the transfer of knowledge in an efficient manner. Instructional designers use their objective tools to determine the objective

reality; which they then try to map onto learners by employing instructional strategies that control the learning behavior. On the other hand, the implications of the constructivist model on the instruction design are not as straight forward.

Table 1 - Objectivism vs. Constructivism

(Adapted from Jonassen,1991; Leidner & Jarvenpaa,1995; and Mory,1996)

	Objectivism	**Constructivism**
Reality	External to the learner Structure determined by entities, properties and relations	Determined by the learner Product of mind Structure relies on experiences and interpretations
Mind	Processor of symbols Mirror of nature Abstract machine for manipulating symbols	Builder of symbols Interpreter of nature Conceptual System for constructing reality
Thought	Disembodied: Independent of human experience Governed by external reality Reflects external reality Classification What machines do (Algorithmic)	Embodied: Grows out of bodily experience Grounded in construction Grows out of physical and social experience Building of cognitive models More than machines are capable of
Meaning	Corresponds to entities in the world Independent of understanding External to the learner	Does rely on correspondence to world Dependent upon understanding Determined by the learner
Symbols	Represent reality Internal representations of external reality	Tools for constructing reality Representations of internal reality
Instructional Goal	Transfer of knowledge from instructor to learner	Formation of abstract concepts to represent reality
Implications for Instruction	Instructor houses knowledge, provides stimulus, and controls the content and the pace of learning.	Learner-centered active learning. Learner controls pace. Instructor for support rather than direction.
Feedback	Feedback is based on response match to external reality.	Feedback provides generative, mental construction "tool kits".

Winn (1993) discussed an interesting argument about the contradictions and the problems that arise in this regard. He notes that the extreme claims of constructivists are disturbing to anyone who believes that it is possible to design instruction that leads to predictable outcomes. If there is no objective reality and knowledge is to be entirely constructed by the learners, then there is nothing that instructional designers can do to affect the learner understanding and behavior. Instructional design is based on the assumption that certain prescriptions will result in certain predictable outcomes if employed appropriately. If constructivists are right and this assumption does not hold, then it is pointless to try to design instruction.

However, this is not the view of the majority of scholars in this field. Many others believe that it is feasible to design instruction to facilitate for the implementation of the constructivist model. Jonassen (1991) suggests that in order for the instructional designers to accommodate the constructivist assumptions the following implications need to be considered:

- Instructional goals and objectives would be negotiated, not imposed.
- Providing learners with mental construction tool-kits is more important than implementing instructional strategies to lead learners to specific learning behavior.
- Promoting multiple interpretations of reality is more important than prescribing a single, best sequence for learning.
- Evaluation of learning would become less of a control tool and more of a self-analysis tool.

It is evident that instructional designers must build their design with some learning model in mind. The success of their designs is gauged by how they cater to the

assumptions of a given learning model. Reigeluth (1983) states that instructional design is a prescriptive theory based upon descriptive theories of learning.

2.2 The Component Display Theory of Instruction Design

The Component Display Theory (CDT) of instructional design, proposed by Merrill (1983), provides a set of concepts that describes the conditions, methods, and outcomes of instruction. It also offers guidance to instructional designers and teachers as to what model is most likely to optimize achievement of desired outcomes under specified conditions.

CDT consists of a descriptive theory and a prescriptive theory. The descriptive CDT is the identification of the classification system for instructional outcomes, presentation forms and inter-display relationships. The prescriptive CDT consists of a set of propositions about relationships among components of the descriptive theory that can be empirically tested. Merrill (1994) summarized these propositions as follows:

- **Presentation Forms.** A segment of instruction should include all three primary presentation forms: rule, example and practice. These primary presentation forms should be sequenced in some variation of rule-example-practice, but they should be self-contained allowing the learner to easily locate, skip or review a given form.
- **Learner Control.** Learner should be able to alter the sequence of the primary presentation forms by returning at will to previously presented forms; i.e., returning to the rule after studying an example or skipping to a practice before studying the rule.

- **Generality Representation.** The rule should be restated in other than verbal form and/or elaborated on via a mnemonic or an algorithm.
- **Attention-Focusing Help.** Example and practice displays should include attention-focusing devices or simplified representation.
- **Attribute Matching.** Example displays should include matched non-examples.
- **Instance Sampling and Difficulty.** Instances in both example and practice displays should be divergent

CDT predicts that the implementation of these propositions should result in better student performance, as defined in less number of errors on test; and a more positive student affect, as described by self report of satisfaction. Merrill (1994) reviewed over seventy relevant studies and found a considerable body of empirical support for the propositions of CDT. He found that in every instance where the data reached statistical significance, it has supported some aspect of the propositions. Further, he found that in almost all the cases where data failed to reach statistical significance, the direction of the means was as predicted by the propositions. There was not a single instance in the studies reported where the data contradicted or refuted any propositions.

2.3 Learner Control

"Learner Control" is a very significant feature of CDT. CDT prescribes formulating instruction in such a way as to make it easy for learners to control pace, content, and presentation display. Some of the basic empowerment characteristics of virtual learning environments are the control and flexibility they offer to the learner. A learner in the virtual environment often can control what content to select, how

much time to spend on what, and when to involve him or herself in the learning activity. Furthermore, physical presence in the learning environment is no longer a requirement. Fast-learners are no longer time constrained as with traditional environments, where the needs of slower and less experienced individuals often control the pace of everyone's learning. Technology has been shown to enable students to learn at their own pace (Barron and Orwig 1997). Thus, virtual learning environments seem to be conducive for successful implementation of learning theories that advocate a larger share of learner control in the learning process.

It is beyond the scope of this dissertation to isolate the "learner-control" feature for the purpose of hypotheses testing. However, because of the fact that web-based virtual environments intrinsically offer a great degree of learner control, the following paragraphs present a brief discussion of this feature and the rationale for incorporating it in instructional designs.

2.3.1 Definition of Learner Control

The learner control proposition of CDT states that the learner should be able to alter the primary presentation forms (i.e. the rule, the example and the practice) sequence at will to previously presented forms after having studied subsequent displays. This basically means that the learner could study the example display before going to the rule display, or could return to rule display after going through the practice display. It is also in line with this proposition to expand the notion of control to cover control over the number of examples and practice displays studied and control over the types of help provided (Merrill 1994).

Simons (1993) in the context of self-regulated learning, argues that only learners themselves can achieve the goals of the learning process, which entails an extremely high degree of learner control, not only over content and pace but also over content preparation and feedback mechanisms. Another variation of the "learner control" is "learner ownership" as was called by (Honebein, Duffy et al. 1993) in their description of authentic activities for learning. For the sake of consistency, "learner control" as defined by Merrill in CDT (section 2.2) will be used through out this document.

Learner control, regardless of the instructional delivery system employed, refers to situations where learners are allowed to make decisions about the "path", "flow", or "events" of the learning process (Williams 1996). Several instructional theories cater for the provision of learner control (e.g. Gagne, Briggs et al. (1988), Merrill (1983)). These theories serve as guidelines for designers to incorporate learner control on the different components that comprise these theories.

But what is it to be controlled? Basically, there are three types of control that might be relented to the learner: control of pace, control of sequence and control of content (Milheim and Martin 1991). *Control of pace* refers to the speed of presenting the materials; *control of sequence* refers to the order that different units of the materials are presented; *control of content* refers to ability of the learners to omit certain content component which they feel that they already know.

Learner control is contrasted to teacher control in the traditional learning environments, where the teacher primarily controls the content and the basic learning task. In the context of computer-base instruction (CBI), program control is the

alternative to learner control. In program control, the meaning of control is far more pervasive in that the computer takes over even the minute decision making. Virtual learning environments, however, are capable of offering the learners a wide range of degrees of control. In accordance with the instructional objectives, the designer of these virtual environments would determine the degree of control to be granted to the learner.

2.3.2 The Dilemma of Inconclusive Evidence

Research on the effectiveness of learner control has not been conclusive in every aspect of learner control. Merrill (1994) in his review of research on CDT, cited eleven different studies investigating various aspects of learner control. He found that several studies indicated a positive effect on the effectiveness and efficiency of the learning environment when learners were granted control over all components; i.e. the sequence of primary presentation forms, and number of examples and help facilities (e.g. Wilcox et al., 1978). However, he cited others studies (e.g. Callahan et al., 1979) which showed only marginal support for learner control.

In his review of learner control literature, Choi (1995) found reasonable support for one variation of learner control; that is, learner control with advisement. In this variation of learner control, the learner is provided with some opportunities to render some decisions concerning content, timing, difficulty level and so on. He cited several studies (e.g. Arnone and Grabowski, 1992) concluding that students in learner control with advisement performed significantly better than did either students in strictly learner control or students in program control environments.

Reeves (1993) suggested that the lack of conclusive findings is simply due to bad research. He presented a very critical assessment of the body of research on learner control. He argued that many researchers failed to provide adequate operational definition of their learner control treatments, leading to unsound experimental design. He also discussed the lack of theoretical foundation for many studies. Furthermore, he points out some methodological problems (e.g. poor instrumentation, bad sampling, etc.) and analytical shortcomings, such as using improper quantitative techniques when qualitative approaches made more sense.

Most recently, Williams (1996) conducted a very extensive update of the literature on the effectiveness of learner control considering the three most common dependent variables, namely: Performance; Time-on-Task; and Attitudes and Affect.

Given the intuitive appeal of learner control, the research findings were disappointing. Duchastel (1986) sums up the frustrating ambiguity of learner control as follows: "...the research leads one to be cautious about the general learner control hypothesis, namely, that the student is the best judge of the instructional strategy to be adopted. Some results in instructional research indicate that not all students are capable of making appropriate educational decisions. Other results, however, indicate the tremendous benefits of learner control in particular situations. The sophistication of the learner and type of objectives pursued, and the particular context of the system will probably impact on the nature and effectiveness in given situations." (p.391)

2.3.3 Rationale for Learner Control

Regardless of the empirical research findings, many prominent theorists in the field of instructional design found the notion of learner control very appealing for a

variety of reasons. For example, Reigeluth and Stein (1983) in their instructional design theory hypothesized that: "... instruction generally increases in effectiveness, efficiency, and appeal to the extent that it permits informed learner control by motivated learners." From the perspective of learner preferences, Penland (1979) found that the top four reasons why adults prefer learning on their own were expressed as desires to "set my own learning pace," "use my own style of learning," "keep the learning strategy," and "put my own structure on the learning project." Intuitively, it seems that learner control feature of any instructional design is a way for learners to develop their own cognitive abilities.

Disappointing empirical research has lead researches to doubt the possibility of developing a comprehensive, integrative, deductive, prescriptive, and testable theory of learner control (e.g. Williams, 1996). However, that does not mean that instructional prescriptions, that are pragmatic and grounded in some reasonable psychological and educational principles, could not be developed for certain learning situations. For example, Chung and Reigeluth (1992) have provided an empirically supported set of do's and don'ts for deciding when to relent more control to the learner.

For control of content, they recommend that learners should be granted control over content when they have significant prior knowledge of the subject matter. Another suitable situation for content control is when the learning objectives are of higher-order type, as opposed to factual information. As for control of sequence, they recommend granting control to learners when the instructional program is quite lengthy. Keeping the learner interested and motivated is the intended benefit. However, it would be unwise to relinquish control over the sequence if the objectives

have a clear prerequisite order. Their recommendations constitute a list of "if-then" conditions for incorporating learner control in the instructional design. Williams (1996) states that it would be interesting to develop some sort of an expert system based on the "mix and match" combinations of instructional strategies, outcomes and conditions suggested by Chung and Reigeluth. Such a prescriptive system still needs to be validated with research across a wide range of learning situations.

2.3.4 Constructivism and Learner Control

The objectivistic research on learner control suggests that learners are often unable or unwilling to assume greater personal responsibility for learning, so learning should be externally mediated by instructional intervention (Jonassen 1991). However, constructivistic research suggests otherwise. For example, Jonassen, et al. (1993) state that: "The more learner-controlled the instructional systems are, the more generative they are; that is, they require learners to generate or construct their own knowledge" (p.87). Considering that the basic premise of the constructivist model that calls for learners to construct models of reality in their minds, it seems that a higher degree of learner control will be associated with any constructivist learning environment.

2.3.5 The Bottom Line on Learner Control

In conclusion, it has not been established that learner control is right for every one in every situation. The empirical research has been inconclusive; however, its potential for improving learning and its intuitive appeal should not be ignored. Control should be given to learners under two assumptions: First, learners know what is best for them; and second, they are capable of acting appropriately on that

knowledge (Ross and Morrison 1989). If these two assumptions are not applicable, granting full and unconditional control to learners will prove counter-productive. Williams (1996) notes that: "learner control is a way of allowing individual differences to exert a positive influence without trainer control or intervention based on these differences. However, great care needs to be exercised by designers in constructing their learner-controlled lesson to optimize effectiveness for all types of learners" (p.977).

2.4 Educational Technology

It appears that the explosive growth in IT is increasingly playing a role in the continuous debate between the learning models and their implications for instructional design. These developments in technology and their applications in education have shaped the field of educational technology, which is becoming a significant specialty within the larger discipline of education. Educational technology is a multi-dimensional concept that consists of a process and its products. It is a systematic process involving application of knowledge in the search for replicable solutions to problems inherent in teaching and learning. The products of this process could be programmed texts, video programs, computer programs, web-based materials or any combination of those (Hackbarth 1996).

According to Winn and Snyder (1996), the field of educational technology has gone through three "ages" summarized as follows: First came *the age of instructional design*, where the behavioral model was dominant and where it was assumed that the learner's response is predictable for given stimuli. Second came *the age of message design*, where the emphasis shifted from instructional content to instructional format;

here there was an assumption that the format determined the way information was encoded in the memory of the learner. Third, came *the age of environment design*, where the emphasis was on providing information from which the students could construct their understanding through the interaction with the environment. Here, the success of a learning environment is deemed contingent upon the interaction, rather than the content or the format.

These developments had profound implications on the instructional design field. For example, Merrill (1992) implies that the instructional designer's focus will be to prescribe instructions to foster the interactions between the learner and the environment. Hackbarth (1996) in his discussion of the scope and promise of technology elaborates on how educational technology has enriched instruction and made it more individualized, valid, accessible and economical. Jonassen, Mayes et al. (1993) argue that modern technology should support advanced knowledge acquisition in open learning environments, which are need driven, learner-initiated and intellectually engaging.

2.5 Technology Fit with Learning Models

Leidner and Jarvenpaa (1995) proposed four different visions for technology fit with the learning models: "Automate," "Informate-up," "Informate-down," and "Transform." These visions were adapted from organizational research on IT (Zuboff 1988). The principle pedagogical assumptions of these four visions with some examples of supportive technologies are briefly discussed in the following paragraphs.

First, the vision to automate is basically the perception that IT is a means of replacing the instructor with more efficient information technology to do basically the

same thing, that is transferring knowledge to the students. The major assumptions are that the instructor is still the center of the classroom activities; however, presentation technologies can make the delivery of information more interesting. In this vision, learning is computer-assisted allowing learners to emulate what the instructor is doing on the computer. This vision fits well with the objectivist learning model. Information technologies that can facilitate such a vision include: Instructor consoles equipped with presentation software and display control; instructor consoles and stand alone computers; and computer assisted instruction allowing for drill and practice activities.

Second, the vision to "informate up" would entail giving the instructor feedback about the learners' progress in a timely fashion allowing for clarifications of misunderstanding and misinterpretations. Electronic mail is an appropriate example of IT facilitating this vision. Feedback is important, and better late than never.

Third, the vision of "informate down" would entail providing means to students to allow them to critically analyze information and discuss related issues among each other. Unlike the vision to automate where the goal is a more efficient means of transferring information, in "informating down" the goal is to create new information of better quality utilizing powerful methods in doing so. Basically, two categories of information technology would help facilitate this vision: technologies for provision of information to learners and technologies for providing communication facilities. Learning networks, hypermedia, the Internet, search engines and virtual reality are examples of technologies that could support such a vision.

Finally, the vision to "transform" is basically a call to revolutionize the learning environments. It would involve using IT (1) to redraw the physical boundaries of the classroom, (2) to enable more teamwork, (3) to allow learning to be continuous time-independent process, and (4) to enable multi-level, multi-speed knowledge creation. The assumption here is learning is an on-going process unconstrained by time or place.

The web-based virtual learning environments (discussed in section 1.3 above) are the environments that foster the operationalizing of the assumptions of the "vision to transform allowing for "any time/any place", self-paced and collaborative learning. However, it should be noted that some of the assumptions of the other visions could also be served in virtual learning environments, such as: feedback in the vision to "informate up," and efficient delivery in the vision to "automate."

2.6 Self-Efficacy

In the context of skill teaching and training, it is very important to gauge the ability of learners to actually apply what they have learned. Performance on objective tests, although an important and desirable measure of the learning process outcomes, does not seem to be a sufficient indicator of the actual behavior that learners will exert when they are required to apply what they learned. Thus, some kind of measurement of what these learners think of their own ability to perform is helpful in understanding the effectiveness of any skill training environments. This later concept is referred to as "self-efficacy," which is defined as "People's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with skills one has but with judgments of what one

can do with whatever one possesses" (Bandura 1986, p.391). This concept is different from the concept of self-esteem, which is a more general concept considering feelings of adequacy, self-confidence and self-acceptance.

Self-efficacy has been found to influence the actual performance attainments in a wide variety of behaviors. Compeau and Higgins (1995) have cited several studies supporting that self-efficacy has influenced decisions about the choice of behavior to undertake, the effort exerted, and persistence in attempting those behaviors. However, very few studies addressed self-efficacy in the context of computer usage (e.g. Compeau and Higgins (1995), Compeau and Higgins (1995a), and Gist, Schwoerer et al. (1989), Hill, Smith et al. (1987)).

In line with the aim of this dissertation (i.e. investigating the effectiveness of virtual learning environments focusing on developing basic skills), self-efficacy seems to be a very important indicator. Hill, Smith et al. (1987) reported that computer self-efficacy of college students was a factor in determining their decisions to use computers. Gist, Schwoerer et al. (1989) extrapolates from these findings to argue that trainees with high self-efficacy may experience greater success in training than those low in self-efficacy.

2.6.1 Self-Efficacy in the Social Cognitive Theory

The Social Cognitive Theory is a widely accepted and empirically validated model of individual behavior. The theory was proposed by Albert Bandura (e.g. Bandura 1986). The basic premise of this theory is a three-way relationship between "the individual," "the behavior" and "the environment." Bandura calls this relationship a "Triadic Receiprocality" or "Reciprocal Determinism," which basically

suggests three relationships: First, individuals choose and shape the environments they exist in, and in turn these environments influence the individuals. Second, behavior in a given situation is influenced by environmental factors, which are in turn affected by behavior. And third, behavior is influenced by personal and cognitive factors and in turn affects these same factors.

The cognitive personal factors are the most relevant in investigating the effectiveness of learning environments. The Social Cognitive Theory proposes two types of expectations influencing the behavior of individuals: First, "outcome expectations," individuals tend to engage in behaviors that will result in some benefit to them eventually. Second, "Self-efficacy," which refers to the individual's own belief in his of her ability to undertake a certain behavior. According to Compeau and Higgins (1995), outcome expectations have been considered in many IS studies, but self-efficacy did not receive the same attention; only a handful of studies were reported (e.g. Hill, Smith et al. (1987), Gist, Schwoerer et al. (1989), and Webster and Martocchio (1992)).

In this research, the focus is on self-efficacy, as it seems more relevant than outcome expectations for an introductory college level course- the context for this study. However, in organizational training settings, learners are presumably better informed about the benefits of the training (e.g. career advancement, etc.); and therefore, their outcome expectations are more relevant than college students who might not think beyond the grade they expect to get in the course. In the following paragraphs, the concept of self-efficacy will be explored in some detail.

The concept of self-efficacy could be applied to various disciplines and fields. In the field of information technology, some might like to distinguish between computer self-efficacy and software self-efficacy. But with the proliferation of personal computers, the distinction is no longer that relevant. The learner is expected to use the computers, peripherals, and software that are necessary to accomplish certain tasks. Given the integrative nature of information technology, "IT self-efficacy" seems more descriptive than "computer self-efficacy." However, for the sake of consistency with the literature, computer self-efficacy will be used through out this research.

2.6.2 Computer Self-efficacy

Based on the earlier definition of self-efficacy, computer self-efficacy is defined as one's judgement of his or her ability to complete a task using computers. This definition has nothing to do with what individual's previous accomplishments were, but rather, with judgements of what he or she could do in the future. Furthermore, computer self-efficacy is not concerned with component sub-skills (e.g. like entering data) but rather with the judgment of how these component sub-skills could be used to complete a useful task (e.g. conducting a financial analysis).

2.6.3 Measurement of self-efficacy

Compeau and Higgins (1995) in their effort to develop an instrument for the measurement of self-efficacy, conducted a thorough literature review on the subject. They analyzed, criticized and benefited from several studies (e.g. Hill, Smith et al. (1987), Gist, Schwoerer et al. (1989), and Webster and Martocchio (1992)) to develop and validate a ten-item measure of computer self-efficacy. This instrument is focused

on the learners' perception of his or her ability to complete a task (such as producing a report or conducting a data analysis) rather than to master a simple component skill (such as saving a file or formatting a disk). The instrument was pre-tested with both academics and practitioners, and then was validated with 1020 (50%) responses from 2000 surveys mailed out.

The questionnaire is shown in Appendix (C). The developers of this instrument intended to lay the foundation for future research concerning the Social Cognitive Theory perspective on computing behavior and the unique influence of learners' perceptions of their own abilities. In line with the recommendations of Jarvenpaa, Dickson et al. (1985), who encouraged the use of previously validated instruments in the IS field, the same instrument mentioned above was used in this research to measure the self-efficacy of the subjects. Such an approach is advantageous in theory building and validation in general.

2.7 Prior Related Research

A primary goal in studying a new medium of communication for educational delivery must be the identification of its effectiveness (Hiltz 1993). Effectiveness of technology in the classroom has been the subject of some lively debates over the years. The evidence has been anything but conclusive. While many studies showed a "Significant Difference" on the learning outcomes, the number of studies concluding "No Significant Difference" can not be ignored. Historically hundreds of studies considered different types of technologies; for example, Russell (1997) of North Carolina State University cited 248 research reports and papers that found "No Significant Difference." These studies span the years from 1928 till 1996, and cover a

wide range of technologies (radio, tapes, videotapes, telephones, computers, CD's, video-conferencing, etc.). On the other hand, "A Significant Difference" had been shown in many other studies. Perhaps old technologies did not have the significant difference it was hoped for. Orr (1997) of Auburn University, claims that more contemporary research suggest that recent powerful technologies have different characteristics and implications from the old technologies which might have little or no significant difference. He cited over 70 recent studies that concluded "A significant difference" in response to the list compiled by Russell.

As was discussed earlier (section 2.4), we are in the third age of educational technology- the age of environment design. In this age the emphasis has shifted towards empowering the learners in the learning environments through utilizing technology. Perhaps this is the reason behind the fact that more recent studies are concluding a significant difference on the learning effectiveness when technology is incorporated in the classroom.

A recent report, commissioned by the Software Publishers Association and conducted by an independent educational technology consulting firm, Interactive Educational Systems Design, Inc., summarizes educational technology research conducted from 1990 through 1995. Based on 176 research reviews and reports, this report concluded that technology is making a significant positive impact in education (Cradler 1997). The following are some of the important findings in these studies:

- Educational technology has demonstrated a significant positive effect on achievement.

- Educational technology has been found to have positive effects on student attitudes toward learning and on student self-concept. This was particularly true when the technology allowed learners to control their own learning.
- The type of students, the software design, the teacher's role, how the students are grouped, and the level of student access to technology; all influence the level of effectiveness of educational technology.
- Students trained in collaborative learning had higher self-esteem and achievement. Introducing technology into the learning environment has been shown to make learning more student-centered, encourage cooperative learning, and stimulate increased teacher/student interaction.

Recent Relevant studies

The current study is anchored in theory, as well as drawings on the findings of recent related studies. The following recent studies lay important ground for this research. The common denominator among them is that the focus was on learning effectiveness when some sort of a technology-enhanced environment was compared with the traditional classroom. The objectives, findings and limitations of these studies are discussed briefly in this section.

Hiltz (1993), a pioneer of research in this area, accumulated her experiences over the years at the New Jersey Institute of Technology over the years in her book: "The Virtual Classroom: Learning Without Limits via Computer Networks." She experimented with different limits on class size and tested many hypotheses on performance and satisfaction in the virtual classroom ™. Although the findings supported some aspects such as the utility of feedback and student participation, no

conclusive evidence on the superiority (or inferiority) of the virtual classroom was reached. However, it is important to keep in mind that the state of technology when most of these experiments took place (mid-eighties) was neither as advanced nor as accessible as they are today. Thus, it may be advisable to replicate most of these experiments considering the powerful technologies available in the late 1990's. More recently, in studying the impact of college-level courses via Asynchronous Learning Networks (ALN), Hiltz (1995) calls for more research on different technologies and class settings. She emphasized that despite the lack of conclusive quantitative evidence (i.e. higher grades) in many instances, virtual classrooms still have many advantages that will impact society in positive ways. Virtual classrooms still allow students to exchange emotional support, information, and a sense of belonging (Hiltz and Wellman 1997).

Leidner and Jarvenpaa (1993) conducted a descriptive study examining the use and outcomes of computer-based instructional technology in the context of graduate business education. They found that the use of computer-based teaching methods appear to offer an advantage over traditional methods (and over computer-based methods not requiring hands-on student use) in providing a forum for exploratory analysis during class and for acquiring technical procedural knowledge. In 1995, they proposed a taxonomy for incorporating technology in the learning environments (section 2.5 of this document).

Alavi (1994) conducted an empirical evaluation of computer-mediated Collaborative Learning. This study investigated the effectiveness of computer mediated collaborative learning (CMCL) in terms of student learning and evaluation

of the classroom experience. The findings of this study indicated that GDSS-supported collaborative learning led to higher levels of perceived skill development, self-reported learning, grades on exams and evaluation of classroom experience in comparison with non-GDSS supported collaborative learning. This study, however, might have suffered from a researcher-bias effect, as the researcher herself was also the instructor for both groups. Another limitation was that the subjects from the two groups might have interacted, indirectly influencing the self-perception of the learning process. Because the classroom setting for the GDSS group had computers and other equipment, perhaps making it more appealing, the author also does not rule out a novelty effect of the teaching theater.

Alavi, Wheeler et al. (1995) investigated the efficacy of collaborative telelearning environments by considering three groups: Fact-to-Face (FTF), Local Collaborative telelearning (LCT) and Distance Collaborative Telelearning (DCT). They hypothesized that the learning effectiveness of students who collaborate face to face will be greater than the learning effectiveness of those who collaborate via desktop videoconferencing. They also hypothesized that the learning effectiveness for students who collaborate via DCT is greater than in LCT. The study found that the three environments are equally effective in terms of student knowledge acquisition; however, critical thinking skills were found higher to be in the DCT environment. It was also found that three groups were equal in satisfaction, but subjects in DCT were more committed and attracted to their groups compared with the LCT of FTF.

Brandt (1995) conducted a field study to investigate the effectiveness of Electronic Meeting Systems (EMS) in high school classrooms. She argues that EMS

technology had a positive effect on the learning environment in several ways. First, students worked together and were task-focused. Second, students tackled more and bigger problems than was permitted in the traditional classroom. And third, the EMS technology provided more opportunities for immediate and more frequent feedback. However, it seems that the findings of this study may not be generalized because of two reasons: First, the subjects were high school students, who are generally less mature and less consistent in their learning behaviors. And second, it would be difficult to generalize to other subject matters since the educational context of this study was English writing skills. Another extraneous factor is the fact the researcher collaborated with and helped the instructor in the treatment group through out the year; instructors in the control groups did not get that extra help. The extra attention awarded to the students in the treatment group might have caused the better performance. The author herself pointed out several limitations in her study such as the use of only one objective quantitative dependent measure. Additional measures would have provided for potential triangulation of quantitative results. She also states that external validity of the study was threatened due to the fact that the class that served as the "case" volunteered for the study and was not randomly selected.

Bordia (1997) synthesized the findings of eighteen published experimental studies comparing face-to-face (FTF) and computer-mediated communication (CMC). He reported that, in general, discussions on CMC take longer, produce more ideas, and have greater equality of participation. However, there is reduced normative pressure and poorer comprehension of the discussion in CMC. Findings regarding quality of performance, attitude change and evaluation of communication partner are not

definitive. He reported three major items limiting the internal and external validity of these studies: a) characteristics of the subjects, b) problems associated with limiting the amount of time available to complete a task, and c) miscellaneous design considerations. He states that characteristics of the subjects curtailed the external validity of the studies. He, among others, argues that results from experiments conducted with inexperienced student subjects may be of limited or no relevance in other settings.

In one of the first attempts to apply the Social Cognitive Theory in the area of information technology, Compeau and Higgins (1995) applied the concept of self-efficacy to end-user computer training. The context of the study was Lotus 1-2-3 and WordPerfect training for professionals who had little or no knowledge about computers. Based on the Social Cognitive Theory premise that behavior modeling influences the observers' perception of their own ability to perform a task, the study basically compared behavior modeling versus non-modeling (lecture-based) training methods. The modeling method manipulation consisted of videotapes demonstrating the steps necessary to achieve certain tasks in Lotus 1-2-3 and WordPerfect.

They found that self-efficacy had a positive effect on performance in both models. They also found that behavior modeling was more effective than the traditional lecture-based model for training in Lotus 1-2-3, resulting in higher self-efficacy and higher performance. However, this was not the case for training in WordPerfect. The internal validity of these findings might have been affected by the fact that different actors were used in the videotapes and the fact that there was a practice session after measuring self-efficacy and before the performance test. The

external validity may have been also threatened by the fact that the subjects were professionals in small organizations, and generalization to all types of organizations may be limited.

Schutte's paper (1997) " Virtual Teaching in Higher Education: The New Intellectual Superhighway or Just Another Traffic Jam?" has generated a lot of interest and stirred a great deal of discussion in the educational community, despite its many apparent flaws. It gained a lot of attention in several electronic discussion forums (e.g. American Association for Higher Education- Special Group on Information Technology (AAHESGIT)). This experiment was carried out during the Fall, 1996 in which 33 students in a Social Statistics course at California State University, Northridge were randomly divided into two groups, one taught in a traditional classroom and the other taught virtually on the World Wide Web. The study reported that the virtual class scored an average of 20% higher than the traditional class on the examinations. Furthermore, post-test results indicated that the virtual class had significantly higher perceived peer contact, more flexibility, and greater affect toward learning than did the traditional class. However, time spent on class work was higher in the virtual class. The sample size was very small in this study. It appears that many extraneous factors were not taken care of, such as the learning model employed and the lack of standardized teaching procedures and exams for both groups. Thus, the findings must be regarded with some caution.

In the next chapter the research design of this study is presented. Many of the limitations in the previous studies discussed above were considered and their threats eliminated or reduced. The research model and the hypotheses are also presented.

3. RESEARCH METHODOLOGY

In this chapter, the research model and propositions are outlined, followed by a description of the experiment design. This includes a description of the course, the subjects, the manipulation of the independent variables and the measurement of the dependent variables. The chapter concludes with a discussion of the validity issues.

3.1 Research Model and Hypotheses

Previous research has produced mixed results with no conclusive evidence demonstrating the effectiveness of technology in the classroom. One reason for this conflicting evidence is that some studies are not controlling for the learning model when comparing a technologically enhanced environment with a traditional one. Recent studies (e.g. Leidner and Jarvenpaa 1995) have called upon IS researchers to compare the effectiveness of information technology incorporated into a particular model of learning vs. that same model without technology. This is rather than comparing one model of learning with technology to a different model of learning with or without technology. In general, the learning content is another dimension in any proposed framework to investigate the effectiveness of learning environments. In this research, the learning content is focused on developing basic IT skills. Future research is encouraged to replicate this study considering different types of content (e.g. advanced technical skill, problem-solving skills, etc.)

3.1.1 Research Proposition 1

A necessary goal in studying any new medium of communication for educational delivery is the demonstration of its effectiveness (Hiltz 1993). Guided by the theoretical foundation established in the previous chapter, and given the research

needs articulated by several studies (e.g. Leidner (1995), Brandt (1995), Alavi (1994)), the objective of this research is to investigate the effectiveness of web-based virtual learning environments when employing the two different learning models and where the content of the course is basic IT skills. The first proposition of this study is:

<u>Proposition 1:</u> Virtual Learning environments are more effective than traditional learning environments regardless of the learning model employed.

In measuring learning effectiveness, IS investigators are encouraged to build on previous work using variables that are well-established in the education research community such as: self-efficacy, performance, satisfaction, motivation, learning style, thinking level, attention and participation. In this study three dependent variables are considered for the purpose of hypotheses testing: performance, self-efficacy and satisfaction. Merrill (1994) in illustrating the scientific method of instruction, notes that the primary outcome of concern is increased instructional effectiveness, defined as fewer errors on the achievement test following instruction. Thus, with respect to student performance on the exams given after the instruction, it is hypothesized that:

<u>H1:</u> Virtual Learning environments will result in higher performance scores than will the traditional learning environments, regardless of the learning model employed.

Since the subject matter is basic skills, a desirable outcome would seem to be higher levels of self-efficacy in addition to the performance outcome. Ultimately, it is hoped that the learner will apply the skills learned to real life situations. Self-efficacy is defined as the belief that one has about his/her capability to perform a particular

performance. Social Cognitive Theory implies that higher levels of self-efficacy have an important influence on the individual's behavior. In this regard, self-efficacy is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses (Bandura 1986). Hill, Smith et al. (1987) reported that computer self-efficacy of college students was a factor in determining their decisions to use computers. Thus it is hypothesized that:

H2: Virtual Learning environments will lead to higher levels of self-efficacy than will the traditional learning environments, regardless of the learning model employed.

Many universities and corporations are using satisfaction with the learning process as an indication of the training program (Wolfram, 1994). The reaction and feelings of the students when exposed to a new medium (particularly if they did not have a choice) might have an influence on the effectiveness of the learning environment. Thus, the third hypothesis is:

H3: Subjects in the Virtual Learning environments will be more satisfied with the learning process than those in traditional learning environments, regardless of the learning model employed.

3.1.2 Research Proposition 2

The focus of the second proposition of this study is to contrast the two learning models regardless of the learning environment. It appears that educational technologists have accepted cognitive learning theory as the prominent theory in this field. Viadro (1997) believes that educators, inspired by the research of cognitive scientists, began favoring classroom environments in which students take charge of their own learning, learn to think critically and analytically, work collaboratively, and

create products to demonstrate what they have learned. By putting learning in the hands of students, the "constructivist" model drastically upsets the old style of schooling in which a teacher stands up in front students in a classroom and lectures. Thus, it is proposed that:

Proposition 2: The constructivist model is more effective that the objectivist model, regardless of the learning environment.

To investigate the above proposition, three hypotheses similar to those of the first proposition are formulated. The hypotheses are formulated to test if the constructivist model leads to higher levels of performance, self-efficacy and satisfaction than did the objectivist model regardless of the learning environment.

H4: Employing the constructivist learning model will result in higher performance scores than will the objectivist learning model, regardless of the learning environment.

H5: Employing the constructivist learning models will lead to higher levels of self-efficacy than will the objectivist learning models, regardless of the learning environment.

H6: Subjects will be more satisfied with the learning process when the constructivist model is employed than they will be when the objectivist model is employed, regardless of the learning environment.

3.1.3 Research Proposition 3

The consensus among scholars in this field is that technology does not cause learning - learning and teaching behaviors do. Technology comes in to enhance certain behaviors or methods. Almost any learning behavior makes use of one or more old or new technologies: chalk, pens, classrooms, books, overhead projectors, computers, and now the World Wide Web.

It seems that virtual environments lend themselves to supporting the constructivist model more than the objectivist model. This because of the control and flexibility features they offer to the learner. Considering that we are in the third age - the age of environment design- of the three "ages" of scholarship in educational technology (mentioned in section 2.4), it seems appropriate to propose that virtual learning environments would be more effective when cognitive learning models are employed. The proposed taxonomy for technology fit with learning models, by Leidner & Jarvenpaa (1995) supports this assertion. They argue that incorporating technology with the objectivist model is a matter of automation only; however, incorporating technology with the constructivist model would create the potential for long-term effect on the self-variables (e.g. performance, self-efficacy, etc.) since the control has been shifted to the learner. Part of the problem is that the trend toward constructivist learning is relatively new, and technology has been used to support it only in the past few years. As reported by Viadro (1997), "There hasn't been enough time to accumulate a huge amount of evidence," says Christopher Dede, a senior program director for the National Science Foundation. "The literature is positive. There's just less of it." Thus, it is proposed that:

Proposition 3: Virtual learning environments are more effective with the constructivist model than they are with the objectivist model.

To investigate this proposition, we examine the difference in performance, self-efficacy and satisfaction between the two environments for each learning model. The following three hypotheses are formulated to test that this difference is greater for the constructivist model than it is for the objectivist model.

H7: **The difference in performance between the virtual and the traditional environments is greater when the constructivist model is employed than it is when the objectivist model is employed.**

H8 **The difference in self-efficacy between the virtual and the traditional environments is greater when the constructivist model is employed than it is when the objectivist model is employed.**

H9: **The difference in satisfaction between the virtual and the traditional environments is greater when the constructivist model is employed than it is when the objectivist model is employed.**

The proposed model is depicted in Figure (1). The upper diagram presents a high-level depiction of the research model. The lower diagram shows the variables considered in this experiment.

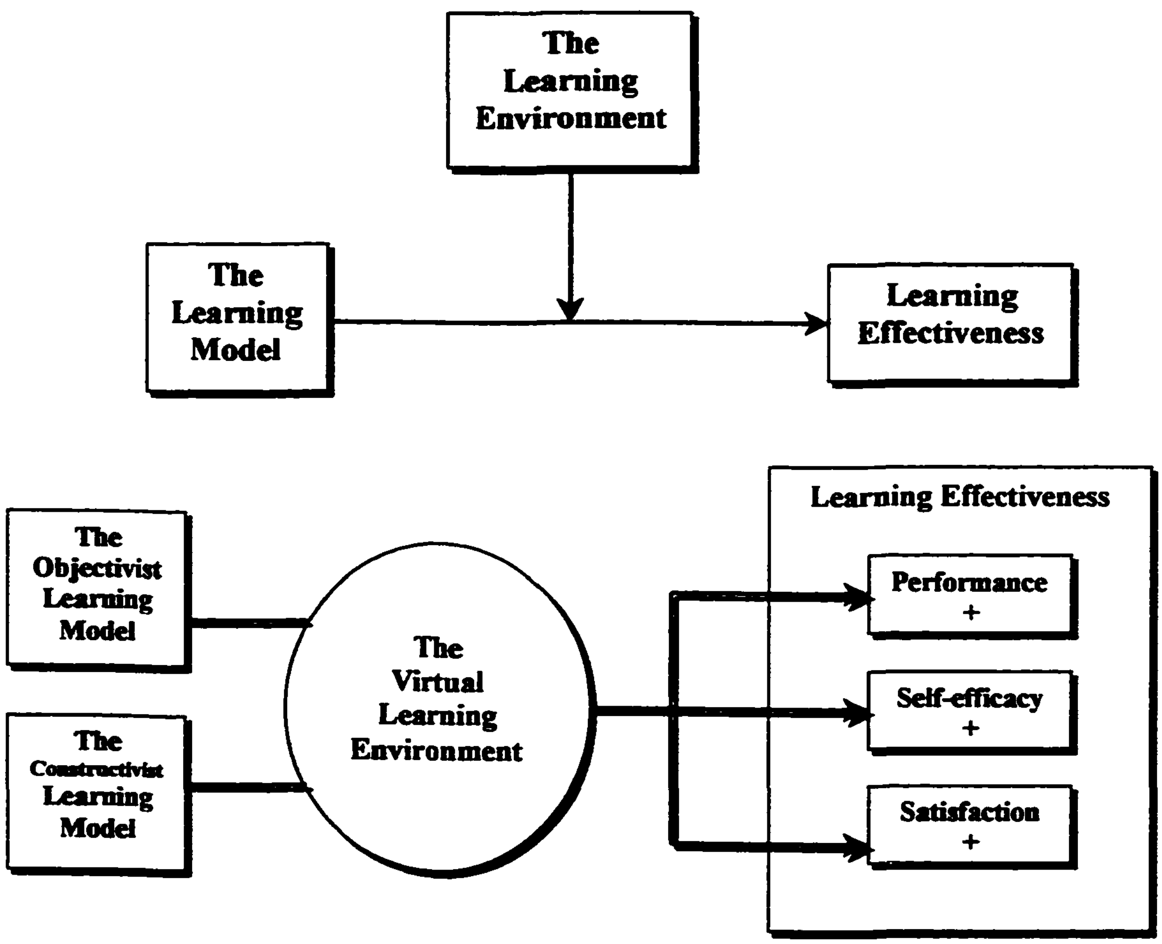


Figure 1 - The Research Model

3.2 Research Design

A field experiment was set up to investigate the propositions presented in the above section. It is a true experiment (as opposed to quasi-experiment) due to the fact that the randomization element was present when selecting the subjects and when assigning them to both the treatment and the control groups (Cook and Campbell, 1976; and Shavelson, 1988). Some might argue that only quasi experiments are possible for such type of research. For example, Hiltz (1993) argues that it is unpractical and unfair to randomly select students to participate in virtual classes. This is understandable, considering the fact that most of the early experiments on virtual classrooms were conducted in the mid and late 1980's. Only those students who were capable of dialing-in to the university network could participate back then; and therefore, the samples were not considered representative of the student population. However in the late 1990's, limitations of access and cost are no longer a significant factor. Personal computers and connections to the Internet are increasingly becoming common place. In fact, the sample in this experiment had no major complaints about access to computer resources (81% of subjects had a computer at home and 65% had access to the Internet from home). In the worst case scenario, students were able to use the widely available campus computing facilities to engage in the classroom activities. Thus, it is reasonable to use a randomly selected group of students to participate in the experiment. Of course, students who still did not want to be part of this experiment had the choice to drop and register in other sections. The salient features of this experiment are highlighted below.

3.2.1 The Course

The course is an introductory course in IT offered by the Information Systems and Decision Science Department at Louisiana State University. All undergraduate business students are required to take the course. It covers a brief introduction to computers. Microsoft Office 97 is then used to introduce the basic concepts of word processing, presentation software, spreadsheets and database management systems.

3.2.2 The Subjects

Four sections were randomly selected out of seventeen sections offered during the spring semester of 1998. Every section of the seventeen had an equal chance of being selected. Initially, the total number of students in four sections was 192 (48 students each). Two of the four sections were randomly assigned to be conducted in a virtual learning environment and the other two sections to be conducted in a traditional classroom to serve as control groups. Anyone of the four sections had an equal chance of being selected for treatment or control. Students in the first two sections did not have prior knowledge that their sections were selected to be receiving the virtual treatment; and signed up based on fit with their particular schedule; we therefore assume the subjects were selected in a manner we can describe as random. All subjects were surveyed in the first week of the class to establish a base line on some demographic information (age, sex, etc.) as well as their attitude towards using computers, accessibility to the web, and previous self-perceived knowledge about the software packages that will be taught in the course. An objective skill assessment was also conducted. The survey and assessment results are discussed in the data analysis chapter of this document.

3.2.3 The Independent Variables

The two independent variables are the learning environment (Virtual / Traditional) and the learning model (Objectivist / Constructivist).

3.2.4 The Dependent Variables

The dependent variables are (1) student performance, which will be measured by student grades on two exams given at the end of first half and at the end of the semester; (2) self-efficacy, which was measured by a survey instrument developed by Compeau and Higgins (1995b); (3) satisfaction, which was measured by a survey instrument developed by Green and Taber and (1980).

Table 2 - Independent & Dependent Variables

Independent Variables	Dependent Variables
• Learning Environment (Virtual/Traditional) • Learning Model (Objectivist/Constructivist)	• Performance • Self-Efficacy • Satisfaction

3.2.5 The Design Layout

The design of this experiment is a repeated measures design. Repeated measures will be taken on the Learning Model. Repeated measures designs are widely used in behavioral sciences. A principle advantage of such designs is that they provide good precision for comparing treatments because all sources of variability between subjects are excluded from the experimental error (Neter, 1990). Since two treatments can be compared directly for each subjects, only the variation within the subjects will be considered in the experimental error. Economizing on the subjects is another advantage of the repeated measures designs, since the subjects are serving as their own controls when comparing the repeated measures. In this research, this was

particularly helpful because of the difficulty in getting more instructors to cooperate with the research activities. Table (3) shows a general design layout. The repeated measures are taken on the same subjects for both learning models. (i.e. the same subjects "n_1" in the virtual environment and same subjects "n_2" in the traditional environment).

Table 3 - Design General Layout

Learning Environment (A)	Subjects	Learning Model (B)	
		Objectivist Model $k = 1$	***Constructivist Model*** $k = 2$
Virtual $j = 1$	n_1	A_1B_1	A_1B_2
Traditional $j = 2$	n_2	A_2B_1	A_2B_2

This general design however does not take into consideration the instructor factor. It is imperative to keep in mind the variations among instructors in almost any educational undertaking. Although, not a major focus of this research, controlling for the instructor effect would add more insight to the investigation of the effectiveness of the learning environment. Accounting for the instructor variations will slightly change the picture. The modified design layout and the statistical model will be discussed in details in the data analysis chapter.

3.2.6 The Manipulation

Two sections received the virtual learning treatment while the other two were conducted in the traditional classroom setting. The semester is divided into two halves: the "Objectivist" learning model was employed in the first half, and the "Constructivist" model in the second. For the sections receiving the treatment, after a brief introduction to computers and the facilities offered by the virtual environments,

the class was completely conducted over the Internet except for midterm and final examinations. Students accessed the virtual learning environment via the web, where they could check the class schedule, the materials, the assignments, their grades and interact with the instructor and other students. The two learning environments were based on the same learning model and followed exactly the same procedures. Assignments and exams were standardized as were the deadlines. Strict teaching procedures were enforced and the instructors were briefed and observed by the researcher. The researcher attended the traditional class lectures and observed the activities in the virtual environment on a regular basis. He monitored the instructor's behavior for consistency, and constantly offered suggestions and directions to ensure the implementation of the learning models.

The Virtual Environment

The virtual environment was developed in Lotus Learning Space environment. Learning Space is an application that allows instructors to quickly create and administer on-line courses through a Lotus Notes client or the World Wide Web. Learning Space offers four "virtual" areas to conduct the classroom activities:

- **The Schedule**: where student can access the course materials and assignments organized by date.
- **The Media Center**: where students can access general information, multimedia material, grades, etc.
- **The Course Room**: where students can interact with each other and with the instructor in a threaded discussion.

- **The Profiles**: where students can post information about themselves and check out information about each other.

The online materials were developed as modules grouped into tutorials. The modules utilize JavaScript routines to present the material in a form that allows students to apply concepts and practice skills without ever leaving the virtual environment. Such an arrangement allows learners to practice as they learn new skills. The students logged in to the virtual environment by using any browser to access the following URL: (http://isds.bus.lsu.edu/cvs/learn/introit/).

Two separate navigation schemes were provided for the students: sequential and random, facilitating for learner control. The sequential pattern allowed the students to follow the path that was prepared by the instructor. Such a scheme is targeted to learners that prefer to have guidance during the learning process. More independent students can take advantage of the random navigation scheme. A number of links connect related modules and allow the students to follow paths that best fit their interest. Each tutorial includes a descriptive index of all the modules that it contains. Such modules can be accessed directly from the index page providing students with a relatively high degree of control over what they want to learn. Learners who prefer visual aids in the learning process could also take advantage of animations provided by the course. Each module is linked to animations that visually show how to accomplish a particular task. Also, by interacting with each other in the discussion area (i.e. the Course-Room), students can ask questions, enhance the discussion, and help each other achieve a better understanding of the materials.

Students in the virtual environment were presented with a detailed schedule of lessons. A new lesson is scheduled every week. Each lesson is composed of one *practice assignment*, one *graded assignment* and two tutorials. Each lesson begins with a practice assignment that presents the students with the teaching objectives of the lesson. The students are required to print out the practice assignment and complete it. The required steps to be completed in each practice assignment are in synch with the teaching modules contained in the lesson's tutorials. The students were instructed to resize the application window (e.g. Microsoft Word 97) to fit on the screen along with the teaching modules. Figure (2) shows a screen shot example, where the teaching model is on the right side of the screen and the application window on the left. In doing so, they can apply each skill as they learn it.

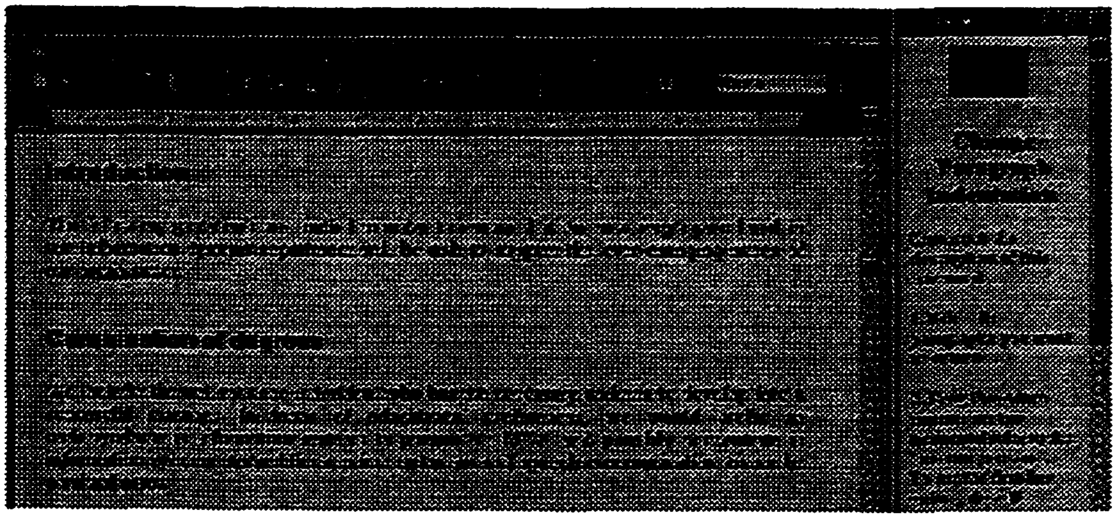


Figure 2 -The Application and the Tutorial on One Screen

Once the practice assignment is complete, the students can complete the "graded assignment" and turn it in to the instructor for feedback and grading. The

graded assignments are structured in such a way that students can not passively follow the tutorials, but they have to actively apply the skills learned. Nevertheless, if they do not remember how to perform a specific task, they can access the on-line materials in a "just-in-time" fashion. Interaction between students and with the instructor takes place through the *Course-Room* facility. While students are completing the lessons, they can easily post questions and comments to the discussion area. The instructor or other students would answer the posted questions. The discussion area allowed the instructor to implement the assumptions of different learning models, manipulating the participation rules.

3.3 Validity Issues

This study is a field experiment that is conducted in the normal setting of college classrooms with typical undergraduate business students. No special criteria were established to admit students in the sections under consideration. The major problem with lab experiments is the fact that they are not conducted under realistic conditions; thus, external validity is threatened. On the other hand, true field experiments are more vulnerable to extraneous factors that present a threat to internal validity (Cook and Campbell 1976). As it is very difficult to eliminate all threats to validity, some middle ground should be targeted. Some sort of a tradeoff between optimizing internal validity and external validity could exist.

Shavelson (1988) states that to counteract the threats to internal validity the designer should adopt one or more of the following: 1) one or more appropriate control groups, 2) random assignment of subjects to groups, and 3) pretests in order to equate groups statistically. In this design, threats to validity were eliminated or

reduced by incorporating control groups, eliminating the researcher bias, exerting best efforts to control for extraneous factors and randomizing the selection and the assignments of subjects. The following are some of the design features:

- Four sections, out of seventeen, were selected for this study. The only consideration was that these sections are during the day, to rule out any bias that might exist due to early morning or late evening classes. Thus, the sample is considered representative of the targeted population (i.e. undergraduate business students).
- The students in these four sections did not have any prior knowledge that their classes were the subject of a research study.
- Furthermore, the students did not have the choice to be in either the treatment groups or the control groups. Each subject had an equal chance of being in either group. Thus, it is random assignments of subjects.
- Instructors also did not select their students or their sections. The department assigned them to these sections during the preparation of the class schedule with no prior knowledge that those particular sections will be the subject of a research study. Each instructor taught one traditional section and one section in the virtual environment to control for instructor quality variations.
- In order to control for potential researcher bias, the researcher did not teach, but monitored the teaching activities. The instructors were kept partially blind with respect to the research goals and hypotheses. They agreed to cooperate with the researcher to study differences among the two learning environments, but they were not informed of the details (hypothesis, variables, instruments, etc.)

- The duration of the experiment was one full semester, compared to a single-day or single-session, as it was the case in many other studies. This allowed a reasonable time for the implementation and the establishment of the characteristics of different learning environments and models. And perhaps ensured that students were suitably motivated.
- To further reduce the impact of any potential bias introduced in the measures of performance, a pool of four independent graders- who were totally unaware of the research in progress- were involved in the grading process in addition to the two instructors. Instructors developed strict grading guidelines and held regular meetings with graders to ensure the implementation of those guidelines. Graders were systematically rotated among the various sections.
- A pre-test was also used to establish a base line and to ensure that the groups started the experiment on an equal footing. This was intended to weaken the counter-interpretation that the differences between the two groups at the post-test might be attributed to existing differences before the treatment rather than to the treatment effect.
- To ensure that the transition from the objectivist model (1^{st} half) to the constructivist model (2^{nd} half) was achieved, the researcher monitored the learning activities. Periodic meetings with the instructors were held for guidance, direction and evaluation.
- As an additional measure, several students were interviewed to get their comments and perceptions of the implementation of the learning models. Students also were asked on the final survey if they have recognized a different learning model in

action in the second half (i.e. if the switch was successfully achieved). Results indicated such a switch took place, as will be discussed in the discussion chapter of this dissertation.

Considerable effort was exerted to eliminate any selection biases and extraneous factors. However, in behavioral studies, it is very difficult to account for all possible extraneous factors. For example, students might have their own reasons for being in one section or another. Such reasons may not be known to the researcher (e.g. want to be with friends, heard about the instructor, better fit with their class schedule, etc.). Similarly, learning outcomes might have been affected by some cognitive or personal factors that were not accounted for in this research (e.g. student personal problems, other demanding courses on the student schedule, etc.). It's my belief that threats to validity were reasonably reduced and the findings of this research could be generalized to IT basic skills classes in business schools. Furthermore, an extrapolation to any IT basic skills training program could be useful, if peculiarities of the subjects are carefully considered.

4. DATA COLLECTION AND ANALYSIS

In this chapter the collected data will be presented in a summarized form. The results of the statistical analysis will also be presented. A detailed discussion, however, will follow in the next chapter.

The quantitative data in this experiment were collected at three different times: The first week of the course, before the midterm and before the final exam. The following is a timeline of the research activities:

O1	X1	O2	X2	O3	The Virtual Group
O1	Y1	O2	Y2	O3	The Traditional Group

O1: Initial survey and basic skill assessment to establish a base line
X1: Virtual treatment employing the objectivist learning model
Y1: Traditional classroom employing the objectivist learning model
O2: Measuring variables at the end of the first half
X2: Virtual treatment employing the constructivist learning model
Y2: Traditional classroom employing the constructivist learning model
O3: Measuring variables at the end of the second half

The researcher administrated the surveys in an identical fashion in all four sections. The instructors introduced the researcher and then left the room. The researcher explained the questions to students and asked for their cooperation in filling out the surveys. The importance of carefully filling out the questionnaires was emphasized and sufficient time was allowed. The students were assured that the information they provided would remain strictly confidential and that their grades would not be affected in any way. However, as an incentive, two extra points on the first assignment were given to each student who turned in a complete preliminary survey form. Similarly, two extra points on the midterm and on the final were

awarded for participation. The bonus points were not considered in the evaluation of the performance results for hypotheses testing.

4.1 The Instruments

In this section, the preliminary survey and the instruments used to measure the self-efficacy and satisfaction and other items are discussed. A brief discussion about the reliability of the instruments will follow.

4.1.1 The Preliminary Survey

All subjects were surveyed to establish a baseline on items such as: Demographic information (age, gender), academic information (level, major, GPA), access to the Internet (home, on-campus facilities), attitude towards using IT, previous experience and self-perceived prior knowledge of each of the software packages intended for use during the course. Appendix (A) shows the 16-question survey.

4.1.2 Pre-treatment Skills Assessment

The basic-skill's initial assessment (Appendix - B) was given to all subjects in the first week of the semester. The test covered basic concepts about word processing, presentation, spreadsheets and database management applications.

4.1.3 Measuring Performance

At the end of each half, achievement tests (Midterm and final examinations) were considered as measures of performance. Grades on the assignments were examined, but a decision was made not to incorporate these in the measurement of performance. This is because there was no guarantee that these assignments were the independent work of the student; and thus might not be a good measure of learning effectiveness.

4.1.4 Measuring Self-Efficacy

Researchers are encouraged to use previously developed and validated instruments as much as possible. This allows for consistent comparisons between the findings over time, thus enhancing theory building in the field (Jarvenpaa, Dickson et al. 1985). Appendix (C) shows the instrument used to measure self-efficacy. This instrument was developed and validated by Compeau and Higgins (1995b). It consists of a 10-item questionnaire, asking students if they felt that they could do a task using a software package under various circumstances. Initially the students are asked to react with a "yes" or a "no" answer. If "yes", then they are asked to rank their degree of confidence on scale of 1 to 10.

4.1.5 Miscellaneous Items

Other miscellaneous items were added to the survey. These are intended to shed light and gain better perspective on variables that are not the focus of the research hypotheses, but which might help in describing other aspects of the virtual learning environment.

A 5-item satisfaction instrument developed by Green and Taber (1980) was also used. The instrument evaluates the students' satisfaction with learning environments. Appendix (D) shows the questions comprising this instrument.

In both the midterm and final surveys, other miscellaneous items were added to measure the students' feeling about accessibility to the instructor and the promptness of the feedback. Also one question asked the students if they were able to learn at their own pace. The miscellaneous items given on the midterm and final surveys are shown in Appendix (E).

To assess whether the students felt that the switch to the constructivist model had taken place, four items were added on the final survey. These items asked the students to rate their agreement (on scale of 1 to 5) with statements such as: "I had to be active and involved much more in the second half of the semester", and "I was encouraged to use my imagination and think more in the second half of the semester". The questions related to the switch are shown in Appendix (F).

4.1.6 Reliability Analysis

Reliability analysis gives the properties of measurement scales and the items that make them up. The Reliability Analysis procedure calculates a measure of scale reliability and provides information about the relationships between individual items in the scale. Reliability analysis is used to check if the questionnaire measures the subjects' self-efficacy and satisfaction in a useful way. Using reliability analysis, we can determine the extent to which the items in our questionnaires are related to each other. We can get an overall index of the repeatability or internal consistency of the scale as a whole.

Table 4 - Reliability Analysis

	Number of Items	Alpha
Self-efficacy (1st half)	10 items	.92
Self-efficacy (2nd half)	10 items	.93
Combined - self-efficacy	20 items	.94
Satisfaction (1st half)	5 items	.83
Satisfaction (2nd half)	5 items	.88
Combined - Satisfaction	10 items	.89

Alpha (Cronbach) is a model of internal consistency, based on the average inter-item correlation. Table (4) includes the alpha values for both the self-efficacy and satisfaction instruments as were produced by SPSS. As a rule of thumb, an alpha

value of more than .80 is usually considered acceptable in MIS research (Straub, 1989). Thus, the instruments used in this research are deemed acceptable.

4.2 Data Summary

In this section, the quantitative data will be presented in a summarized form. A brief discussion on handling missing data is presented first, followed by a description of the subjects, results of the preliminary survey, the initial skill assessment and finally a summary of the dependent variables means and the other items.

4.2.1 Valid Cases

A total of 192 students were allowed to pre-register in the four sections (48 each). However, the total number of subjects who participated in the preliminary survey was 181. The midterm and the final surveys included 166 and 152 subjects respectively. Only those who participated in all three surveys are considered for data analysis. Those students were 146 subjects representing 76% of the 192 subjects initially pre-registered, 81% of the 181 subjects participated in the preliminary survey, and 89% of the 164 students who eventually received a grade in the course. Table (5) summarizes the number of responses for each of the surveys.

Table 5 - Responses Statistics

Learning Environment	Section	Instructor	Preliminary	Midterm	Final	Usable *
Virtual	Sec V1	Inst #1	47	38	34	34
	Sec V2	Inst #2	47	43	36	36
Subtotal			**94**	**81**	**70**	**70**
Traditional	Sec T1	Inst #1	46	48	45	42
	Sec T2	Inst #2	41	37	37	34
Subtotal			**87**	**85**	**82**	**76**
Total			**181**	**166**	**152**	**146**

* Usable Subjects who completed all three surveys

4.2.2 The Subjects

The 146 valid cases comprise the virtual group and the traditional group, with 70 subjects in the virtual group and 76 in the traditional group (48% and 52% respectively). The subjects were mostly business majors (72.6%). The academic level distribution of the subjects was as follows: Freshman (18.5%), Sophomore (52.1%), Junior (17.8%) and Senior (11%). The overall GPA of the subjects was self-reported to be as follows: Less than 2.5 (20.5%), 2.5-3.0 (32.2%), 3.0-3.5 (29.5%), and greater than 3.5 (17.8%).

Table 6 - Summary of Data on Personal Attributes

Item	Traditional Group	Virtual Group	Total
Major			
1. Business	81.6 %	62.9 %	72.6 %
2. Non-business	18.4 %	37.1 %	27.4 %
Academic Level			
1. Freshman	21.1%	15.7%	18.5%
2. Sophomore	67.1%	35.7%	52.1%
3. Junior	9.2%	27.1%	17.8%
4. Senior	2.6%	20.0%	11.0%
5. Others	-	1.4%	.7%
Overall GPA			
1. < 2.5	28.9%	11.4%	20.5%
2. 5-3.0	35.5%	28.6%	32.2%
3. 0-3.5	23.7%	35.7%	29.5%
4. >3.5	11.8%	24.3%	17.8%
Age			
1. <19	55.3%	37.1%	46.6%
2. 20-22	42.1%	47.1%	44.5%
3. 22-25	-	4.3%	2.1%
4. >25	2.6%	11.4%	6.8%
Sex			
1. Male	65.8%	47.1%	56.8%
2. Female	34.2%	52.9%	43.2%

The subjects were typical young college students, with 91% of the subjects being 22 years of age of less. Males represented 56.8% and females 43.2% of the valid respondents. Table (6) summarizes the distribution of subjects on the demographic and academic attributes for both the virtual and traditional groups. Details are included in Appendix (G).

4.2.3 The Preliminary Survey

Table (7) shows the means on the items related to the subjects' home access to the Internet, their previous experience, their feelings toward using computers, their expectations of this class, and self-perceived knowledge of the software packages which will be taught in the class. The students were asked to rate their answers on a 1-5 scale.

Differences between the two groups will be analyzed in the data analysis section of this chapter and results will be discussed in more details in the next chapter. By examining the total numbers, it appears that the subjects are not completely new to computers. About 82% have access to computers at home and about 65% have access to the Internet at home. On a scale of 1 to 5, the subjects exceeded the rating of "3" when asked about their previous experience with computer and if they enjoyed working with computers. Moreover, on the question of whether they are threatened by computers, the average rating was below "3" and similarly on the question of whether they expect this class to be difficult. There are no extremes in this data set. With the exception of word processing, the subjects generally rated their knowledge about the software to be used in the class as very low. The high rating on self-perceived knowledge on word processing is understandable. Most of these students had to type

reports and assignments for their other classes and many probably faced similar requirements in high school.

Table 7 - Summary of Data (Preliminary Survey)

Item	Virtual Group	Traditional Group	Total
1. Access to computer at home (Yes)	82.9%	80.3%	81.5%
2. Access to Internet at home (Yes)	67.1%	63.1%	65.1%
3. Previous experience with computers	3.36	3.14	3.25
4. Enjoy working with computers	4.01	3.79	3.90
5. Threatened by computers	2.20	2.30	2.25
6. Expect the course to be difficult	2.40	2.63	2.52
7. Expect to learn a lot from the class	4.21	4.24	4.23
8. Knowledge of Word Processing	3.39	3.25	3.32
9. Knowledge of Presentation software	1.77	1.61	1.68
10. Knowledge of spreadsheets	2.40	1.83	2.10
11. knowledge of Database systems	1.69	1.64	1.66

4.2.4 The Initial Skill Assessment

Table (8) summarizes the results for the subjects in both groups on the initial skill assessment. A statistical analysis of the means will be presented in the next chapter.

Table 8 - Results of Initial Skill Assessment

Learning Environment	Section	Mean	Std. Deviation	N
Virtual	V1	67.94	18.38	34
	V2	58.61	21.92	36
Subtotal		**63.14**	20.68	70
Traditional	T1	59.28	16.43	42
	T2	65.00	18.94	34
Subtotal		**61.84**	17.71	76
Total		62.46	19.18	146

4.2.5 Dependent Variables

The important dependent variables of interest in this study are: performance, self-efficacy and satisfaction measured after the implementation of the objectivist

model in the first half and the constructivist model in the second half in both the virtual and traditional learning environments. Table (9) shows the means of these variables:

Table 9 - Summary on Dependent Variables

Learning Environment	N	Objectivist Model			Constructivist Model		
		Performance	Self-efficacy	Satisfaction	Performance	Self-efficacy	Satisfaction
Virtual	70	84.31	7.15	3.87	80.69	7.28	3.53
Traditional	76	82.71	6.53	4.06	76.07	6.55	3.97
Total	146	83.48	6.83	3.97	78.28	6.90	3.76

Appendix (H) shows the means, standard deviations and other details on the above six dependent variables. By visually inspecting these figures, we notice that the virtual group has outscored the traditional group in both performance and self-efficacy but not in satisfaction. These differences will be statically analyzed thoroughly via Repeated Measure Multivariate Analysis in the next chapter.

4.2.6 Summary of Means on Other Variables

Table (10) presents a summary of means on three miscellaneous variables that shed further light on the discussion. These items pertain to what the students thought of the instructor's availability when they needed him and promptness of the feedback they got. A third item assessed whether the subjects felt that they had control over the pace of the learning process. These items were included in both the midterm and final surveys.

Two issues were unique on the final survey at the end of the second half. The first one assessed whether the students felt that a switch to the constructivist model had taken place. The average of answers to four questions (Appendix- F) was

considered. The overall average was 3.78 (on a scale of 1-5; 5 being the strongest indication). Both groups felt that a switch had occurred, with a rating of 3.83 and 3.74 for the virtual and the traditional group respectively. A t-test revealed no significant difference between the two groups on this measure. Thus, it is reasonable to use this result, along with the qualitative data, to indicate that the switch to the constructivist model had occurred. This item is discussed further in the data analysis section.

Table 10 - Summary of Other variables

Learning Environment	N	Objectivist Model			Constructivist Model		
		Availability of instructor	Feedback promptness	Pace	Availability of instructor	Feedback promptness	Pace
Virtual	70	4.07	3.88	4.37	3.77	3.67	3.61
Traditional	76	3.99	4.30	3.68	3.89	4.00	2.62
Total	146	4.03	4.10	4.02	3.84	3.84	3.10

The second issue comprised only one question checking the students feeling about repeating the experience of this course. When asked if they would take another class like this, 76.4% of the subjects in the traditional group answered with "strongly agree" or "agree", while only 47.1% of the subjects in the virtual group gave the same response. On the other end, however, only 2.6% in the traditional group strongly disagreed with the statement while 17.1% did in the virtual group.

4.3 Establishing A Baseline

The purpose of establishing a base line is to check if the two groups (Virtual and Traditional) started the experiment on an equal footing with regards to several items such as: personal attitude towards using computers, their self-perceived knowledge of the materials that will be taught during the class. One-way ANOVA was used to compare the means on each item in the preliminary survey and to compare

the means of scores on the initial skill assessment. The detailed ANOVA tables are shown in Appendix (I).

Table (11) includes the p-value for each of the comparisons. The results showed that there was no significant difference ($p > .05$) between the means of the two groups on any item except the student's prior self-perceived knowledge of spreadsheets ($p = .002$). A test for homogeneity of variance was also conducted for all items. With the exception of two items (expected difficulty and knowledge of spreadsheets), the results indicated homogeneity of variance.

The analysis indicated that there is no significant difference between the groups with respect to the students' attitudes towards using computers, their expectations and their prior self-perceived knowledge. Also, there is no significant difference between the two groups in the mean scores of the objective skill assessment. Thus, it seems reasonable to assume that there was no significant difference between the virtual and the traditional groups before the treatment started. These conditions are helpful in ruling out the effect of these items on the outcome of the experiment, i.e. reducing threats to external validity.

Table 11- Summary of ANOVA on Preliminary Survey Items

Item	Virtual Group	Traditional Group	Significance p-value	Homogeneity of variance
1. Previous experience with computers	3.36	3.14	.161	Yes
2. Enjoy working with computers	4.01	3.79	.170	Yes
3. Threatened by computers	2.20	2.30	.601	Yes
4. Expect the course to be difficult	2.40	2.63	.070	No
5. Expect to learn a lot from the class	4.21	4.24	.866	Yes
6. Knowledge of Word Processing	3.39	3.25	.478	Yes
7. Knowledge of Presentation software	1.77	1.61	.290	Yes
8. Knowledge of spreadsheets	2.40	1.83	.002	No
9. knowledge of Database systems	1.69	1.64	.787	Yes
10. Initial skill assessment	63.1	61.8	.683	Yes

4.4 Data Analysis

In this section, the statistical technique is described, followed by the updated design layout and statistical model. The hypotheses are then discussed and the analysis results are reported.

4.4.1 The Statistical Technique

As mentioned in the methodology chapter of this dissertation, the design of this experiment is a "repeated measures" design. Repeated measures were taken on the Learning Model. A principle advantage of the repeated measures designs is that they provide good precision for comparing treatments because all sources of variability between subjects are excluded from the experimental error (Neter et. al., 1990). Since two treatments can be compared directly for each subject, only the variation within the subjects will be considered in the experimental error. Economizing on the subjects is another advantage of the repeated measures designs, since the subjects are serving as their own controls when comparing the repeated measures.

The consideration of three dependent variables as a measure of effectiveness allows for the notion of multivariate analysis. Multivariate refers to all statistical methods that simultaneously analyze multiple measurements on each individual or object under investigation (Hair et. al., 1995). A variate is a linear combination of variables. In this research, the dependent variables under consideration: performance, self-efficacy and satisfaction are formed into variates.

Considering the three dependent variables, a Repeated Measure Multivariate Analysis is a suitable method as measurements of the dependent variables were

repeated on the same subjects in the first half (employing the objectivist learning model) and again in the second half (employing the constructivist learning model). Thus, the learning model is the within-subjects variable in this analysis. The learning environment is the between-subjects variable since it is the variable that separates the groups. To account for the effect of the instructor factor, it was also considered as a between-subjects variable.

4.4.1.1 The Design Layout

Although it is not a major focus of this study, considering the variations of the instructor factor is very important. The results would enrich the findings and would account for the variation of an extraneous factor, reducing the unexplained portion of the findings. Table (12) illustrates the three-factor design layout when considering the instructor as an independent variable.

Table 12 - The Design Layout

Learning Environment (A)	Instructor (B)	subjects	Learning Model (C)	
			Objectivist $l = 1$	*Constructivist* $l = 2$
Virtual $j = 1$	*Instructor#1* $k=1$	n_1	$A_1B_1C_1$	$A_1B_1C_2$
	Instructor#2 $k=2$	n_2	$A_1B_2C_1$	$A_1B_2C_2$
Traditional $J = 2$	*Instructor#1* $k=1$	n_3	$A_2B_1C_1$	$A_2B_1C_2$
	Instructor#2 $k=2$	n_4	$A_2B_2C_1$	$A_2B_2C_2$

4.4.1.2 The Statistical Model

The main effects of the variables and the interaction terms between them are considered in developing the statistical model for a three-factor experiment with

repeated measures on one. We let α_j, β_k and γ_l be the main effects of the of factors A, B, and C, respectively, and $\rho_{i(jk)}$ be the subject (block) main effect. In this design the subject effect is nested within the learning environment and the instructor (i.e. every subject belongs to a unique combination within factor A and B). A model that incorporates the above specification is as follows (adapted from (Neter et. al., 1990)):

$$Y_{ijkl} = \mu_{....} + \rho_{i(jk)} + \alpha_j + \beta_k + (\alpha\beta)_{jk} + \gamma_l + (\alpha\gamma)_{jl} + (\beta\gamma)_{kl} + (\alpha\beta\gamma)_{jkl} + \varepsilon_{ijkl}$$

Where:

$\mu_{....}$ The overall effect
α_j The main effect of factor A (*The learning environment)*
β_k The main effect of factor B *(The instructor)*
$(\alpha\beta)_{jk}$ The interaction between factor A and factor B *(environment * instructor)*
γ_l The main effect of factor C *(The learning model)*
$(\alpha\gamma)_{jl}$ The interaction between factor A and factor C *(environment * model)*
$(\beta\gamma)_{kl}$ The interaction between factor B and factor C *(instructor * model)*
$(\alpha\beta\gamma)_{jkl}$ The 3-way interaction *(environment * model * instructor)*
$\rho_{i(jk)}$ The subject (block) main effect
ε_{ijkl} The error term

i = 1, ..., n, the subjects in the experiment;
j = 1 and 2, for virtual and traditional environments;
k = 1 and 2, for instructor #1 and instructor #2; and
l = 1 and 2 for the objectivist and constructivist learning model.

The observations Y_{ijkl} for the repeated measures model outlined above have the following properties:

$$E\{Y_{ijkl}\} = \mu_{....} + \alpha_j + \beta_k + (\alpha\beta)_{jk} + \gamma_l + (\alpha\gamma)_{jl} + (\beta\gamma)_{kl} + (\alpha\beta\gamma)_{jkl}$$

$$\sigma^2\{Y_{ijkl}\} = \sigma^2_Y = \sigma^2_\rho + \sigma^2$$

$$\sigma\{Y_{ijkl}, Y_{ijkl'}\} = \sigma^2_\rho \qquad l \neq l'$$

$$\sigma\{Y_{ijkl}, Y_{i'j'k'l'}\} = 0 \qquad i \neq i', j \neq j' \text{ and/or } k \neq k'$$

All observations are assumed to be normally distributed. Observations for different subjects are independent. Since the two exams are completely independent of each other, any two observations for the same subject are also independent.

4.4.1.3 Hypotheses Testing

To evaluate the propositions of this research, several hypotheses need to be tested. For each of the dependent variables, three hypotheses are set up. The first one to compare the means of the dependent variables between the two learning environments. The second hypothesis to compare the means of the dependent variable between the two learning models. Finally, the third one is to test if there is an interaction between the environment and the learning model for each of the dependent variables.

Univariate tests

The means for each of the dependant variables (performance, self-efficacy and satisfaction) are organized in a table like the one below (Table-13). The overall means are calculated for the purpose of hypotheses testing. The overall means $\mu_{1.}$ and $\mu_{2.}$ are across the virtual and traditional environments. The overall means $\mu_{.1}$ and $\mu_{.2}$ are across the objectivist and constructivist learning models respectively.

Table 13 -Means of Dependent Variables

	Means for each dependent variables		
	Objectivist	**Constructivist**	**Overall**
Virtual	μ_{11}	μ_{12}	$\mu_{1.}$
Traditional	μ_{21}	μ_{22}	$\mu_{2.}$
Overall	$\mu_{.1}$	$\mu_{.2}$	

Nine hypotheses are tested, three for every one of the three dependent variables. The first hypothesis states that virtual learning environments lead to higher

levels of the dependent variable (performance, self-efficacy and satisfaction) regardless of the learning model employed.

Ho: $\mu_{1.} = \mu_{2.}$
H1: $\mu_{1.} > \mu_{2.}$

The second hypothesis states that the constructivist model leads to higher levels of the dependent variable (performance, self-efficacy and satisfaction) regardless of the learning environment.

Ho: $\mu_{.1} = \mu_{.2}$
H2: $\mu_{.2} > \mu_{.2}$

The third hypothesis states that the difference between performance means (that of the virtual environment and that of the traditional environment) in the constructivist model are higher than it is in the objectivist model.

Ho: $\mu_{12} - \mu_{22} = \mu_{11} - \mu_{21}$
H3: $\mu_{12} - \mu_{22} > \mu_{11} - \mu_{21}$

<u>**Multivariate Test**</u>

The overall effectiveness is measured by the combined outcome of performance, self-efficacy and satisfaction. The dependent variables (x: performance, y: self-efficacy, and z: satisfaction) are formed into a vector for the multivariate tests. The first hypothesis now could state that the virtual learning environments are more effective than the traditional environment regardless of the learning model employed.

$$\text{Ho: } \begin{bmatrix} \mu_1(x) \\ \mu_1(y) \\ \mu_1(z) \end{bmatrix} - \begin{bmatrix} \mu_2(x) \\ \mu_2(y) \\ \mu_2(z) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \qquad \text{H1: } \begin{bmatrix} \mu_1(x) \\ \mu_1(y) \\ \mu_1(z) \end{bmatrix} - \begin{bmatrix} \mu_2(x) \\ \mu_2(y) \\ \mu_2(z) \end{bmatrix} \neq \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

The second hypothesis states that the constructivist model is more effective than the objectivist model regardless of the learning environment it is employed in.

$$\text{Ho: } \begin{bmatrix} \mu_1(x) \\ \mu_1(y) \\ \mu_1(z) \end{bmatrix} - \begin{bmatrix} \mu_2(x) \\ \mu_2(y) \\ \mu_2(z) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \qquad \text{H2: } \begin{bmatrix} \mu_1(x) \\ \mu_1(y) \\ \mu_1(z) \end{bmatrix} \quad \begin{bmatrix} \mu_2(x) \\ \mu_2(y) \\ \mu_2(z) \end{bmatrix} \neq \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

The third hypothesis states that the virtual environment is more effective with the constructivist model than it is with the objectivist model; i.e. the difference between the two environments is higher when the constructivist model is employed than when the objectivist model is employed.

$$\text{Ho: } \begin{bmatrix} \mu_{12(x)} - \mu_{22(x)} \\ \mu_{12(y)} - \mu_{22(y)} \\ \mu_{12(z)} - \mu_{22(z)} \end{bmatrix} = \begin{bmatrix} \mu_{11(x)} - \mu_{21(x)} \\ \mu_{11(y)} - \mu_{21(y)} \\ \mu_{11(z)} - \mu_{21(z)} \end{bmatrix} \qquad \text{H3: } \begin{bmatrix} \mu_{12(x)} - \mu_{22(x)} \\ \mu_{12(y)} - \mu_{22(y)} \\ \mu_{12(z)} - \mu_{22(z)} \end{bmatrix} > \begin{bmatrix} \mu_{11(x)} - \mu_{21(x)} \\ \mu_{11(y)} - \mu_{21(y)} \\ \mu_{11(z)} - \mu_{21(z)} \end{bmatrix}$$

4.4.2 Overview of the Analysis Results

The underlying assumptions have been met. Appendix (J) shows the result of testing for the homogeneity of variance of the error term and normality plot. Table (12) summarizes the results obtained by running GLM-Repeated Measures MANOVA on SPSS. The following table includes the p-value for every variable and for every interaction term. Appendix (K) shows more details on these tests, including descriptive statistics, multivariate tests and univariate tests. Appendix (L) shows plots on the dependent variables. In the following sections the results of the multivariate test and the univariate tests are discussed. We begin with the multivariate as it is the more general test and then the univariate tests are followed.

Table 14 - Summary of Analysis Results

	Effect	Multivariate Test	Univariate Test		
			Performance	Self-Efficacy	Satisfaction
Between-Subjects	Type of Environment	*Significant* * .000	X .116	*Significant* .013	*Significant* .016
	Instructor	*Significant* .015	X .935	X .094	*Significant* .002
	Environment * Instructor	X .755	X .860	X .868	X .388
Within-subject Variables	Learning model	*Significant* .000	*Significant* .000	X .692	*Significant* .006
	Learning model * Environment	X .269	X .287	X 1.000	X .087
	Learning model * Instructor	X .614	X .506	X .339	X .870
	Learning model * Environment * Instructor	X .085	X .258	X .131	*Significant* .036

(* Significant when Alpha < 0.05)

4.4.2.1 Results of the Multivariate Test

Wilks' Lambda is used to determine the significance of a variable or an interaction term. According to the MANOVA analysis, the two independent variables (The Learning Environment and the Learning model) were significant. Also it was found that the instructor is significant. None of the interaction terms was found significant, which allows the statistical conclusions about the independent variables to stand.

<u>**The Learning Environment**</u>

The learning environment is the focus of the first hypothesis. The Repeated Measure MANOVA revealed a significant effect for the learning environment (p = .00). Thus the first null hypothesis could be rejected and we can conclude that for the sample used in this experiment the two groups are not equal in effectiveness.

The Learning Model

The learning model is the focus of the second hypothesis. The analysis revealed a significant effect for the learning model ($p= .000$). Thus the second null hypothesis could be rejected and we can conclude that employing the two learning models will lead to a different level of effectiveness.

4.4.2.2 Results on the Univariate Tests

It is informative to consider the univariate analysis to draw separate conclusions on the effects of the learning environment and the learning model on the individual dependent variables. The findings reported here will be discussed in details in the following chapter.

The Learning Environment

The results of the univariate tests on the dependent variables allow us to conclude that the learning environment is significant for the self-efficacy variable and not for performance. This conclusion was straightforward due to the absence of significant interaction terms in the model for both of these two variables. However, because of the significant interaction term between learning environment and instructor and the learning model, a clear conclusion on the significance of the learning environment effect on satisfaction could not be reached at this point. In the discussion chapter, different plots will be examined in an attempt to interpret the interaction and analyze the effect of the learning environment on satisfaction.

The Learning Model

The results of the univariate tests on the dependent variables allow us to conclude that the learning model is significant for the performance variable and not for

self-efficacy. This conclusion was straightforward due to the absence of significant interaction terms in the model for both of these two variables. However, because of the significant interaction term between learning environment and instructor and learning model, a clear conclusion on the significance of the learning model could not be reached at this point with regard to satisfaction. The interaction term needs to be interpreted before drawing conclusions. In the discussion chapter, different plots will be examined in an attempt to analyze the effect of the learning model on satisfaction.

The Instructor

The instructor was not found to have a significant effect on either the performance or the self-efficacy dependent variables. However, it was found to have a significant effect on satisfaction. But because of the significant 3-way interaction term, further investigation is needed before drawing conclusions on the significance of instructor on the satisfaction variable.

The results reported in this chapter will be discussed thoroughly in the next chapter.

5. DISCUSSION OF RESULTS

The results of the statistical analysis are discussed in this chapter. A summary of the findings is presented, followed by a more detailed discussion on the independent and dependent variables. A separate section is devoted to discussing the significance of the instructor as a factor in this study. The final section will include discussion of miscellaneous findings from both quantitative and qualitative findings.

5.1 Overview of the results

Based on the findings of this research, it was found that there was no statistically significant difference between the virtual and the traditional groups in terms of performance, although the direction of the means might suggest that we would find better performance in the virtual environment. However, it was found that in the virtual environment there was a significantly higher level of self-efficacy than in the traditional environment. The results for satisfaction were just the opposite. There was a statistically significant difference in the level of satisfaction, with scores being higher for the traditional environment. It appears that the subjects in the virtual environment have shown a higher level of self-efficacy, but were less satisfied than were those in the traditional environment. A detailed discussion will be presented in the following sections.

5.2 The Variables

In this section, a detailed discussion is provided on each of the variables of interest in this study. Table (15) summarizes both the independent and dependent variables.

Table 15 - Independent & Dependent Variables

Independent Variables	Dependent Variables
• Learning Environment (Virtual / Traditional) • Learning Model (Objectivist / Constructivist)	• Performance • Self-Efficacy • Satisfaction

5.2.1 The Independent Variables

In he following paragraphs the manipulation of the independent variables is discussed.

5.2.1.1 The Learning Environment

The first independent variable was the learning environment. A description of both environments was presented in the methodology chapter. Activities in the traditional environment went smoothly with no interruptions or problems. Subjects attended the lectures twice every week, typically once in the classroom and once in the lab. On the other hand, in the first two weeks, subjects in the virtual environment were introduced to computers and to necessary skills they need in order to participate in the learning environment. Then, the class met only two other times, at the end of the 1st half (midterm) and at the end of the 2nd half (final examinations).

Controlling the Learning Pace

A basic premise of the virtual learning environment is the shift of control from the instructor to the student. According to the Component Display Theory of instructional design, the higher the level of learner control, the more effective the learning process is. In an effort to gage the perception of subjects about controlling the learning pace, they were asked if they felt that they were able to learn at their own

pace throughout the semester. The students were asked to rate response on a scale of 1 to 5 (5 total control of the learning pace). Table (16) and Figure (3) display a comparison between the two environments for both learning models.

Table 16 - Controlling the Pace of Learning

	1st half	2nd half	Overall
Virtual	4.37	3.61	3.999
Traditional	3.68	2.62	3.146

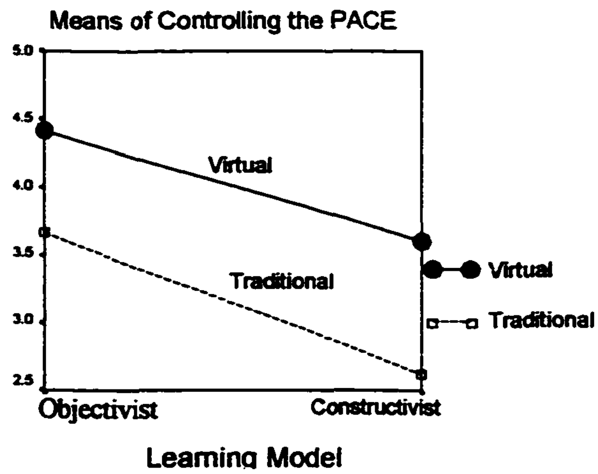


Figure 3 - Control over the Pace of Learning

The virtual environment enabled the subjects to have more control over the pace of learning more than did the traditional environment. The difference was statistically significant (Table -17). Furthermore, qualitative data provide support that the subjects enjoyed a higher degree of control over the pace of learning. For example, one student in the virtual environment commented on the final survey: "What is good is that I can go to class whenever I feel like it." Another student in a euphoric tone: "enjoyed working at own pace/ at own time frame- flexible, I like it!". On the final survey, one student in the virtual environment wrote: "I was extremely happy with this kind of class. My job really cuts into the amount of time I can spend

with schoolwork. This class allowed me to do my work on Sunday nights for example. I feel like I learned more in this class than in any other this semester. I use my computer for more than just playing on the Internet."

Table 17 - F Test Comparing Control of Pace

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	26.414	1	26.414	58.898	.000
Error	64.132	143	.448		

The F tests the effect of Type of the Learning Environment. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

The Drop out Rate

In comparing the two environments it was important to compare the drop out rate and to understand the reasons behind any significant difference in that rate. The total number of students who dropped out of the course was 28 (15%), which is reasonable in similar classes. However, the number was higher in the virtual environment (20%) than it was in the traditional environment (8%). Some of those subjects dropped early in the semester or did not show up at all. Taking these subjects out of consideration would have resulted in lower drop percentages than what is being summarized in the following table:

Table 18 - Drop Out Statistics

Learning Environment	Section	Pre - Registered	Dropped	
			Count	Percentage
Virtual	Sec V1	48	12	25%
	Sec V2	48	8	17%
Subtotal		96	20	20%
Traditional	Sec T1	48	2	4%
	Sec T2	48	6	13%
Subtotal		96	8	8%
Total		192	28	15%

An inquiry was initiated to understand why subjects dropped the class especially those in the virtual environment. A short survey (Appendix-M) was prepared to ask the subjects about the reasons behind their decisions to drop the class. Every effort was made to contact the twenty subjects who dropped (by e-mail and telephone), nine students responded. Two out of the nine stated that because of personal reasons they had to resign from the university that semester, an explanation that has nothing to do with the virtual environment. One of these two students noted that: "The class was great and the idea of teaching over the Internet was great also. I had to resign from the university this semester, so I will have to retake ISDS 1100 this summer. In the future, if I had a chance to take a class like this I would. I would also recommend this class to others."

Two others thought that the class was very time consuming and they had to drop because they had heavy loads that semester (one of the two was a tennis player). The common reason, among the remaining five subjects, was "I can't learn without meeting the instructor face-to-face". Other reasons mentioned were "I simply hate computers", "the class required a lot of computer skills", "the virtual environment is inconvenient" and "the class did not have clear procedures". By examining the responses of those who dropped out of the class, it seems that personal reasons and personal preference regarding the learning environment (like face-to-face interactions) were the two major reasons for dropping.

5.2.1.2 The Learning Model

The transition from the objectivist model in the first half to the constructivist model in the second half required extra attention to details. The instructors had to

prepare the subjects to think differently. Instructors negotiated, rather than imposed, the goals and objectives of the learning process. They provided the subjects with tool-kits to form their own understanding of the subject matter. They promoted the concept that multiple interpretations of reality is more important than prescribing a single best sequence for learning. They encouraged finding different ways of achieving the same task. They emphasized that grades will be given to help the subjects in evaluating their progress, rather than to control their learning behavior. The researcher observed and constantly reminded the instructors to implement the assumptions of the constructivist model. The researcher held periodic meetings with the instructors for guidance, evaluation and debriefing.

Ensuring the switch to the Constructivist Model

To validate the researcher's efforts in ensuring the correct implementation of the two learning models, the subjects were asked on the final survey to identify differences between how the course was taught in the first half and how it was taught in the second half. Appendix (F) shows the four items pertaining to evaluating the switch. The students felt that the switch had occurred as the overall mean of their responses was close to 4 on a scale of 1 to 5 (5 being the highest level of agreement that the switch has taken place). Furthermore, a t-test revealed that there was no statistical difference between the means of the virtual and the traditional groups ($p = .292$). This result, when coupled with the qualitative data supports the claim that the constructivist model was implemented in the second half. For example, one student complained: "the second half was more difficult and it took more effort. Participating in the discussion questions helped a lot to figure out problems." Another student was more elaborate in describing the additional responsibilities he had to take on in the

second half: "I spent between two to three hours on assignments in the first half. In the second half, this time was tripled and not to mention the time spent on e-mails and checking the discussion area looking for answers." However, not all students expressed discontent with the constructivist model. Some actually welcomed the additional responsibility and enjoyed the interaction with the other participants; for example, one student commented on the final survey: "I was able to learn from other people in my section through the discussion area, while also being able to help them in return."

5.2.2 The Dependent Variables

Table (19) summarizes the results of testing the nine hypothesis formulated in methodology chapter of this document to investigate the research propositions.

Table 19 - Summary of Hypotheses Testing

	Hypothesis	Support	Direction of Means	Sig.
H1	Performance is higher in virtual environments	Not Supported	Insignificant in the Same direction	.116
H2	Self-efficacy is higher in virtual environments	Supported	**Significant** in the Same direction	.013
H3	Satisfaction is higher in virtual environments	Not Supported	**Significant** in the Opposite direction	.016
H4	Performance is higher with the constructivist model	Not Supported	**Significant** in the Opposite direction	.000
H5	Self-efficacy is higher with the constructivist model	Not Supported	Insignificant in the Same direction	.692
H6	Satisfaction is higher with the constructivist model	Not Supported	**Significant** in the Opposite direction	.006
H7	Difference in performance between the two environments is higher in the constructivist model	Not Supported	Insignificant in the Same direction	.287
H8	Difference in self-efficacy between the two environments is higher in the constructivist model	Not Supported	Insignificant No Interaction	1.000
H9	Difference in satisfaction between the two environments is higher in the constructivist model	Not Supported	Insignificant in the Opposite direction	.087

5.2.2.1 Performance

Performance is measured in terms of students' achievement on the exams given at the end of the implementation of the learning models in both the virtual and the traditional environments. The statistical analysis has revealed that none of the interaction terms (between the independent variables) has a significant effect on this dependent variable. Thus, we can proceed to draw conclusions on the significance of the independent variables.

The statistical analysis revealed that the first independent variable (The learning environment) does not have a significant effect on performance ($p = .116$). This suggests that it is unlikely that the difference in performance between the two groups is due to the learning environment. Thus, for **(H1)**, the null hypothesis that $Performance_{(virtual)} = Performance_{(traditional)}$ could not rejected; and therefore, the data collected from this sample did not support the first hypothesis that virtual environments lead to higher levels of performance. However, by examining the direction of the means in Figure (4), it is apparent that performance was somewhat higher in the virtual environment regardless of the learning model employed. In any case there is no evidence that the virtual environment was inferior to the traditional environment.

Hypothesis **(H4)** considered a comparison between the two learning models. It was found that the learning model has a significant effect ($p=.000$) on this dependent variable. Thus, the second null hypothesis that $Performance_{(objectivist)} = Performance_{(constructivist)}$ could be rejected and it is concluded that the learning model has a significant effect on the performance of the subjects. But by examining the direction

of the means, we conclude that performance levels associated with the objectivist model were higher than performance levels associated with the constructivist model. Thus, the data did not support the second hypothesis of this study. The interpretation of this result may lie in the fact that, despite its appeal and many advantages, the constructivist model may not be ideal for every situation.

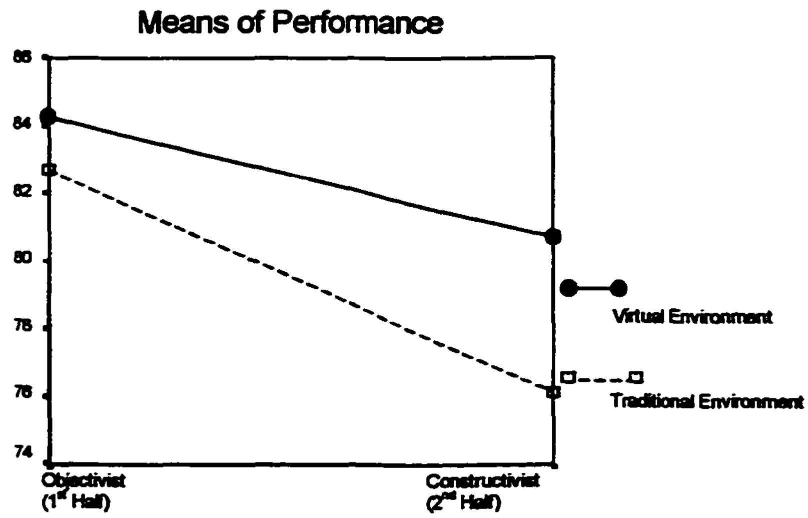


Figure 4 - Performance Means

First, Employing the constructivist model when the content is basic skills might not be effective. Basic skill training is procedural in nature (Olfman et. al. 1994), where it could be argued that there is a limited number of options on how to complete a task; unlike the contents of conceptual nature, where the open-ended issues are quite outweighing. Showing the subjects how to do a task and asking them to absorb this knowledge without critical thinking may be effective enough in such context. Thus, employing the constructivist model may create confusion and disarray in the minds of the subjects and this may be reflected in lower grades on their exams.

A second possibility may be in the fact that the constructivist model shifts a great deal of responsibility from the teacher to the students. Young students (91% of the subjects in this study were less than 22 years of age) are used to the traditional objectivist model where they would simply come to class like other classes, listen to an instructor lecturing for one hour, then go home and do some home work. Perhaps the switch to the constructivist model in the middle of the semester had disrupted their studying routine. One student commented: "I felt that I needed to teach myself everything." The same sentiment was echoed in several comments on the final survey. This may suggest that there may be a learning curve problem. These students are used to behaving and interacting in the objectivist model setting in other courses they are enrolled in. Moreover, things seemed to be as they expected until the switch to constructivist model took place in the middle of the semester. Then, almost at once they were expected to think and act differently, and perhaps they did not have sufficient time to adapt. The students may not have welcomed this additional load, which was reflected in lower grades on the final.

In examining the analysis results with respect to performance, the only significant variable was the learning model. The learning environment and the instructor were not significant. Also none of the interaction terms between these variables was significant. The insignificant interaction between the learning environment and the learning model suggests that the null hypothesis of (H7) can not be rejected. Therefore, the data in this sample does not support the hypothesis that performance will be even higher when the constructivist model is employed in a virtual environment. Although not statistically significant, the interaction does exist in

support of the third hypothesis. This is obvious by examining the graph above (Figure- 4). The difference between the means of virtual and traditional is greater in the constructivist model.

5.2.2.2 Self-efficacy

Self-efficacy is measured twice, at the end of the implementation of each of the learning models in both the virtual and the traditional environments. The statistical analysis has revealed that none of the interaction terms (between the independent variables) has a significant effect on this dependent variable. Thus, we can proceed to draw conclusions on the significance of the independent variables.

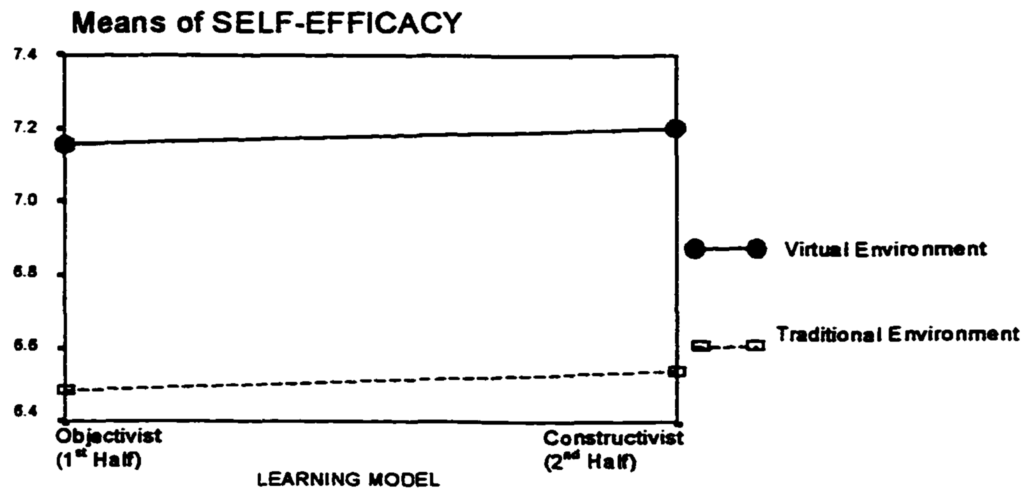


Figure 5 - Means of Self-Efficacy (by Environment)

The statistical analysis revealed that the first independent variable (The learning environment) does have a significant effect on self-efficacy ($p = .013$). The analysis thus suggests that the difference in self-efficacy levels was due to the learning environment. Thus, for **(H2)**, the null hypothesis that Self-efficacy $_{(virtual)}$ = Self-efficacy $_{(traditional)}$ can be rejected; and therefore, the data collected from this sample did support the first hypothesis that virtual environments lead to higher levels of self-

efficacy regardless of the learning model employed. The graph in Figure (5) illustrates this conclusion.

The second hypothesis on self-efficacy (H5) considered a comparison of self-efficacy between the two learning models. It was found that the learning model does not have a significant effect (p=.692) on this dependent variable. Thus, the null hypothesis that Self-efficacy $_{(objectivist)}$ = Self-efficacy $_{(constructivist)}$ can not be rejected and thus there is no evidence that the learning model has an effect on the self-efficacy of the subjects. However, by examining the direction of the means in Figure (6), it is apparent that self-efficacy was somewhat higher when the constructivist model was employed regardless of the learning environment. Thus, there is no evidence in the opposite direction of the hypothesis.

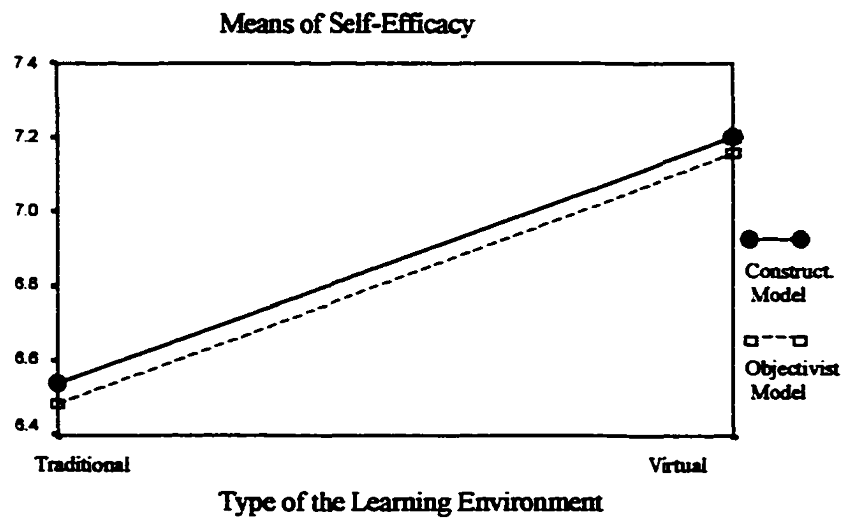


Figure 6- Means on Self-efficacy (by Model)

In examining the analysis results with respect to self-efficacy, the only significant variable was the learning environment. The learning model and the instructor were not significant. Also none of the interaction terms between these variables was significant. The insignificant interaction, between the learning

environment and the learning model, means that the null hypothesis (H8) could not be rejected. Therefore, the data in this sample does not support the proposition that self-efficacy will be even higher when the constructivist model is employed in a virtual environment.

5.2.2.3 Satisfaction

Satisfaction was measured twice, at the end of the implementation of each of the learning models in both the virtual and the traditional environments. The statistical analysis has revealed that both independent variables had a significant effect on the level of satisfaction. The instructor was also found to a have a significant effect on this dependent variable. However, our ability to draw conclusions on those independent variables was hindered due to the fact that the 3-way interaction term (Environment * Model * Instructor) was found to be significant ($p = .036$). This requires additional analysis of the results when drawing conclusions on the significance of the independent variables. Although the analysis shows a significant effect for the learning environment variable and the learning model variable, inferences can not be drawn directly on these main effects.

Because of the existence of the significant interaction term, the plots are examined first. Figure (7) clearly shows that the level of satisfaction of subjects in the virtual environment was lower than that of subjects in the traditional environment, regardless of the learning model employed. Since the learning environment was found to have a statistical significant ($p = .016$), we can conclude, considering the other significant independent variables, that the learning environment has a significant effect on the satisfaction of the subjects with the learning process. This observation serves in

the opposite direction of the hypothesis (H3), which states that virtual environments will lead to higher levels of satisfaction.

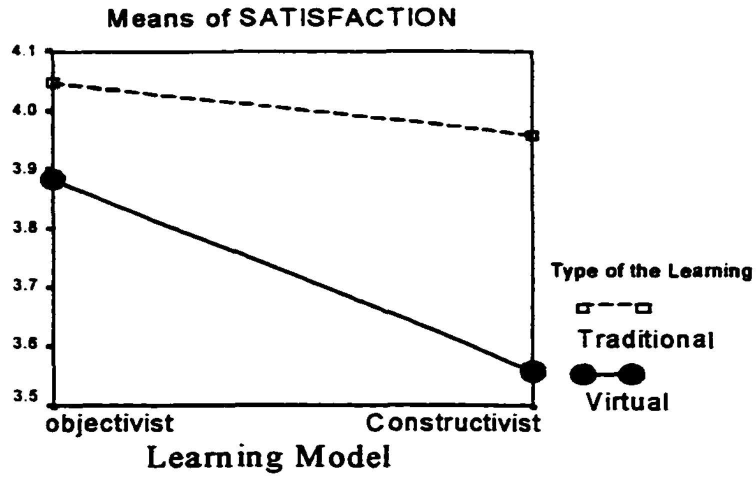


Figure 7 - Means on Satisfaction (by Environment)

The same goes for the hypothesis (H6) on learning model. Although it was found to have a significant effect (p = .006), the means are in the opposite direction to the hypothesis, which states that satisfaction with the constructivist model will be higher than it is with the objectivist model. Figure (8) indicates that satisfaction was lower in the constructivist model regardless of the learning environment.

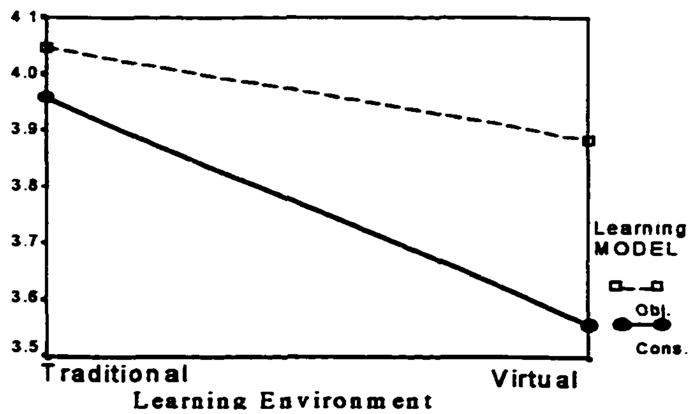


Figure 8- Means on Satisfaction (by Model)

The third hypothesis on satisfaction (H9) states that virtual environments will lead to even higher levels of satisfaction when the constructivist model is employed. The graphs above indicate just the opposite. The difference between the means is even greater in the virtual environment, i.e. employing the constructivist mode in the virtual environment lead to the lowest levels of satisfaction.

In fact the analysis results on satisfaction, supported by the qualitative data collected from the students and the instructors, were surprising as they failed to support any of the hypotheses on satisfaction. An interpretation of these surprising findings is sought by examining the qualitative data and having a closer look at the characteristics of the subjects. One or more of the following line of reasoning could help explain why subjects in the virtual environments were less satisfied.

First, Lack of familiarity creates some feelings of anxiety. Actually any change in the status quo creates uneasy feelings and a certain degree of fear of the "unknown". These subjects are used to going to class, listening to a teacher, doing the homework and turning it in on a due date, and taking an exam and getting a grade. The activities in the virtual environment did in fact upset their expectations of what a learning environment is. They found themselves in control and responsible for decisions that used to be made for them. This probably presented a tremendous pressure for young students who have been largely "Spoon-fed" up to this point in their academic careers. This was reflected in lower satisfaction scores when compared to the students in the traditional environment who did not have to exert extra effort or do anything different from their other classes to manage the learning activities for this class. On student in the virtual environment wrote almost one page expressing her

feeling of disappointment. She says: "...It was quite frustrating , not knowing where to turn for help. Since the class did not meet, I could not look around and find my classmates and ask for help, because I did not know them..."

To use a metaphor, it seems what took place in the virtual environment is similar to throwing somebody in the swimming pool to teach him how to swim. The frustration is expected to be very high but hopefully the procedure is effective in achieving the goal, i.e. acquiring swimming skills. For subjects in the virtual environment, the frustration was reflected in lower satisfaction scores, and achieving the goal was reflected in a significantly higher self-efficacy and slightly, though insignificantly, higher performance scores.

A second factor that might have contributed to lower satisfaction results is what the subjects thought of the promptness of feedback. The repeated measure analysis revealed that the interaction term was significant. Therefore, our ability to draw any conclusion statistically was hindered. However, by examining the plot in Figure (9), it appears that subjects thought that feedback in the virtual environment was not as prompt as it was in the traditional environment and. Moreover, feedback was not as prompt in the second half as it was in the first half for both environments. Furthermore, some students perhaps relied on visual and verbal communication styles that were not catered for in the virtual environment. Compensation needs to be made by the instructor to reduce the loneliness felt by students who can only communicate through verbal cues (Wolfram, 1994). Actually, several studies have blamed the medium for the dissatisfaction of the subjects; for example, Kiesler et. al. (1985) reported that communication in computer-mediated environments was frustrating to

subjects because of the inability of the medium to communicate positive affective information. This might have been a source of frustration for some subjects in this research.

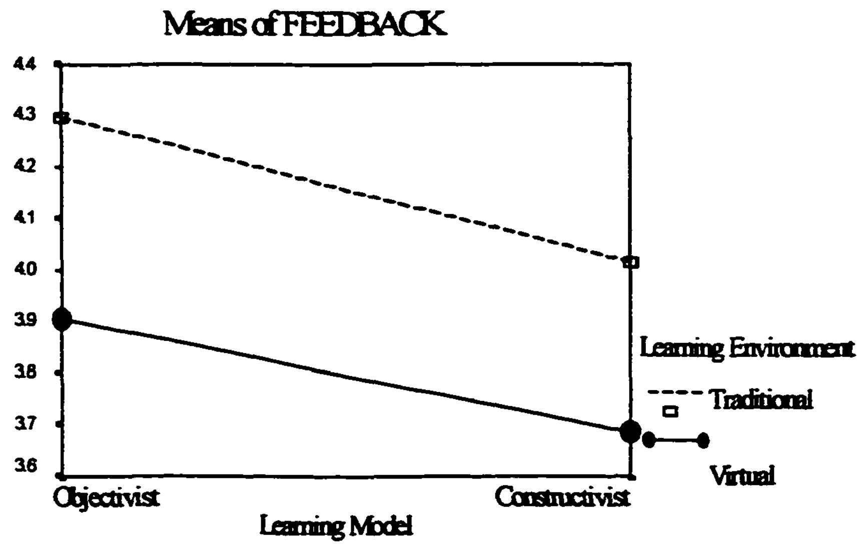


Figure 9 - Feedback levels

Third, technical issues might have contributed to the dissatisfaction of the subjects in the virtual environments. Few subjects complained that logging in to the Lotus Learning Space was slow and at times very frustrating. Other problems had to do with difficulties in getting access to the Internet for those who did not have access at home. Technical difficulties were rare throughout the semester, but perhaps they were a source of frustration for those who happen to log on at the wrong time.

A fourth factor could be the lack of social interaction in the virtual environment. College life is a social and a cultural experience, as well as academic. Virtual environments seem to deprive students from some of the aspects of that social experience. Meeting people with a smile on their face seemed to have a great value of

many of the students asked. The fact that 91% of the subjects were under 22 year of age and mostly single is worthy of consideration in this regard.

In addition to the above mentioned factors, the fact that young college students were used as subjects helps explain the surprising low satisfaction levels in this experiment. Rendering higher degree of control over the learning activities might prove more rewarding for subjects who are self-motivated and know exactly what they are getting out of the learning experience and how to get what they want. Perhaps there are some exceptions, but the majority of young college students do not seem to be equipped with the necessary skills that will allow them to identify what to learn and how to mange the time and effort to achieve the learning objective. The situation is likely to be different with older wiser corporate employees, who probably have better time management skills and can take on more responsibilities. Further, they would appreciate the value of being in control rather than being "spoon-fed" by an instructor. All of the above might have contributed, in some way, to the lower subjects satisfaction with the virtual learning environment.

5.2.3 The Instructor Factor

As with any instructional undertaking, it is imperative to consider the potential influence of the facilitator or the instructor. Whether in a virtual or traditional environment, it seems unavoidable that instructor's personal attributes would play some role. In order to account for the variations caused by the instructors, the instructor was treated in the statistical analysis as an independent variable. The multivariate test revealed a significant effect for the instructor ($p = .015$) along with the learning environment and the learning model. This entails a closer look at the

effect of the instructor on the dependent variables. The univariate tests revealed that the instructor had a significant effect on satisfaction (p = .002), but not on performance (p = .935) nor on self-efficacy (p = .094). Since the 3-way interaction term (Learning model * Learning environment * Instructor) was found to be significant for satisfaction, examining the plots below should help explain the significance of this factor.

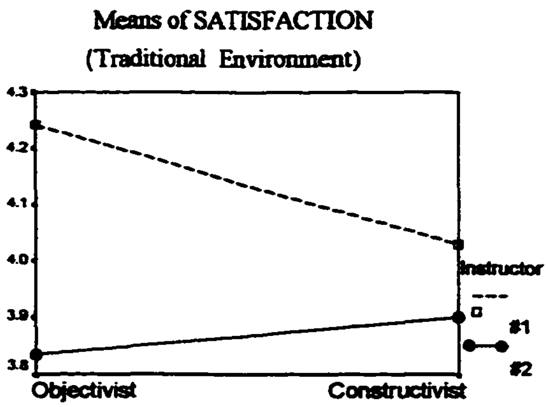


Figure (A)

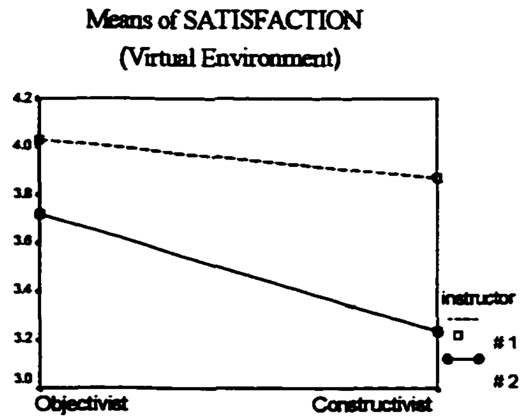


Figure (B)

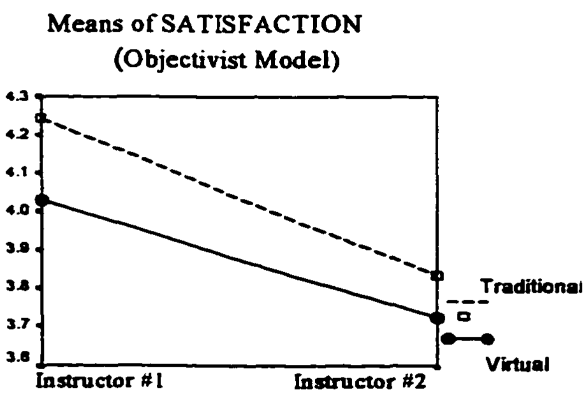


Figure (C)

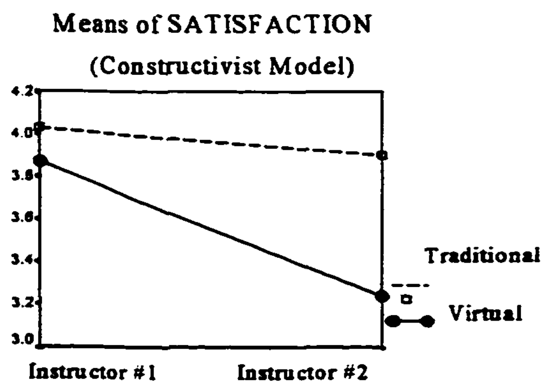


Figure (D)

Figure 10 - Means of Satisfaction (by instructor)

In Figure (10) graphs A&B clearly show that the subjects of the first instructor have reported higher levels of satisfaction regardless of the learning environment or the learning model. Graphs C&D clearly show that satisfaction was lower in the virtual environment regardless of the instructor or the model.

In seeking a better understanding of the instructor's significant effect, two other items are considered: the availability of the instructor and the promptness of feedback as perceived by the subjects.

5.2.3.1 Availability of Instructor

The analysis revealed that there was a significant difference between what the subjects thought of the instructor's availability in the first half and the second half. However, the learning environment was not significant. It is obvious from the plot in Figure (11) that subjects thought that instructors were available more in the first half (the Objectivist Model) than they were in the second half (the Constructivist Model). But there was no advantage of one environment over the other.

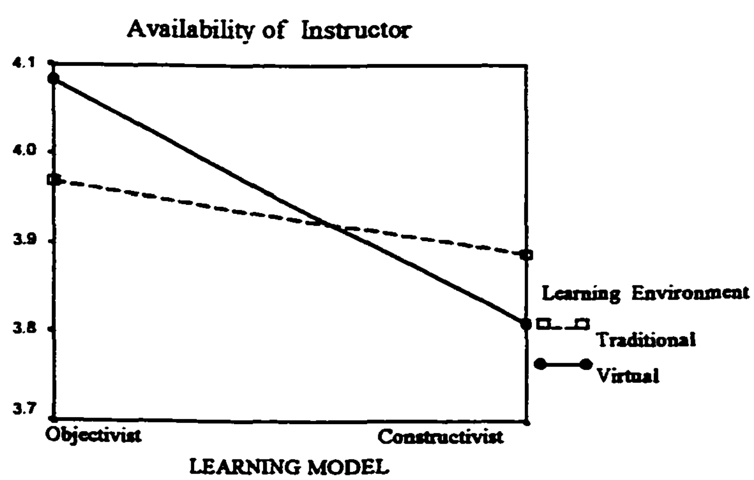


Figure 11- Availability of Instructor

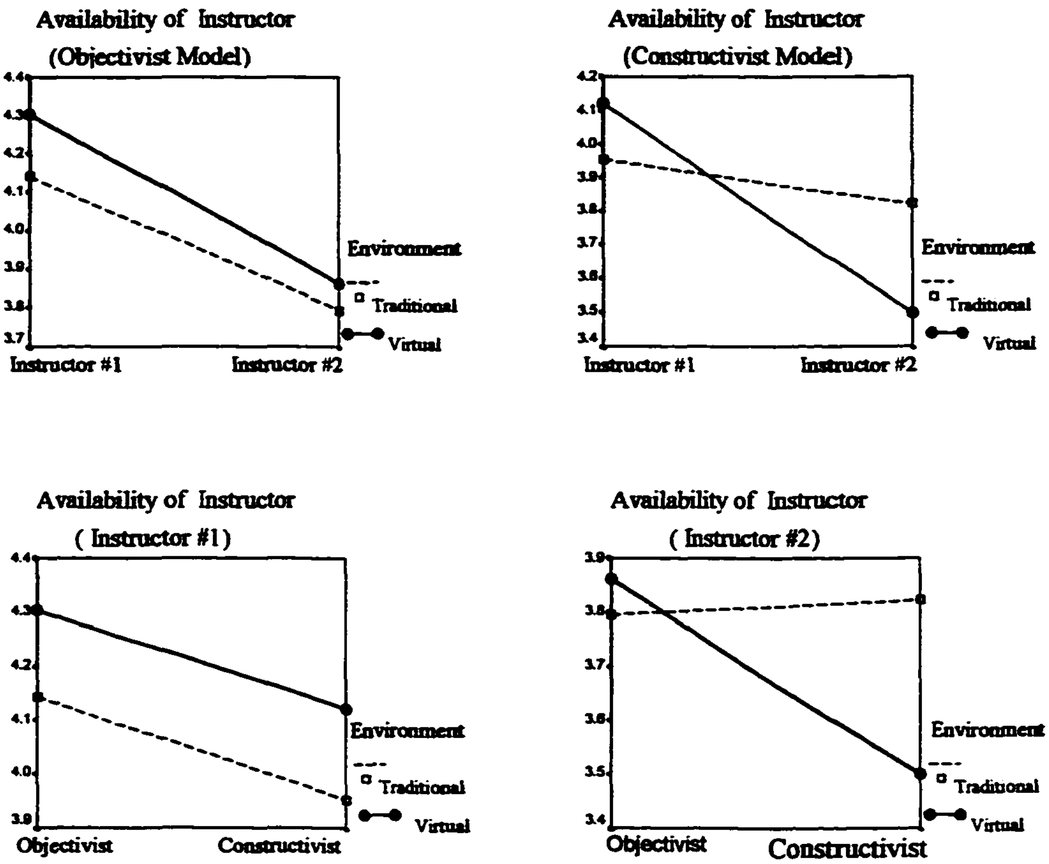


Figure 12 - Availability of Instructor (by Instructor and by Model)

The analysis showed also that the instructor was significant. By a closer examination of the four plots in Figure (12), we see that the subjects of instructor #1 thought that he was more available than those of instructor #2 regardless of the learning model. As far as the learning environment is concerned, the analysis showed it was not significant and the plots do not show any consistent pattern. Except for instructor #1 who was consistently more available in the virtual environment.

5.2.3.2 Promptness of Feedback

By examining the four plots in Figure (13), it is obvious that instructor #1 has received higher rating on the promptness of feedback in virtual environment regardless

of the learning model. Instructor #2, however, received lower ratings on the promptness of feedback regardless of the learning model. In the case of the traditional environment, the case was not as clear. Instructor #1 received higher rating when employing the objectivist model only.

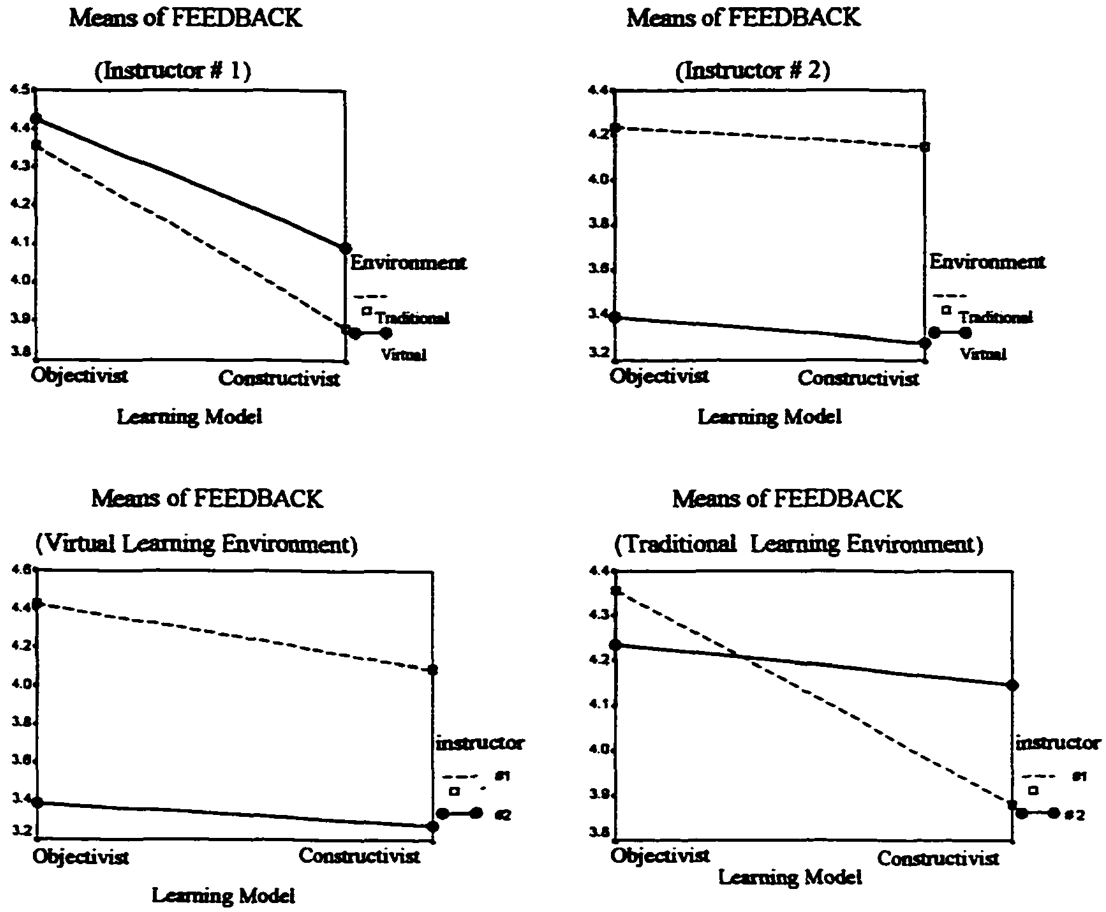


Figure 13 - Feedback of Instructors

In light of the above discussion on the instructor's availability and promptness of feedback, it seems that instructor #1 was a better instructor. The students' comments and the researcher's observation throughout the semester could support this conclusion also. For example, one student wrote complaining about instructor #2: "I

don't feel as though the instructor helped us as a teacher, I feel that the other cyber students helped much more than the instructor did."

5.3 Miscellaneous Findings

The subjects were asked to rate their feeling whether they would take another class like this one. The average response was 3.91 and 3.23 (1-5 scale 5 being I strongly agree) for the traditional group and the virtual group respectively. The ANOVA table indicates a significant difference between the two groups ($p= .001$). This result is consistent with the findings on satisfaction. It seems that the subjects in the virtual group were more frustrated and they seemed less willing to take another course like this. However, it is worth mentioning that this question was asked before they took the final. Perhaps the anxiety level was quite high. Informally, when some students were asked the same question three months after the class, their response was different. For example, one student said: "the more time I had to reflect back on that experience, the more I appreciated it. I was able to help a friend of mine, who is a graduate student in psychology, in writing reports and preparing presentations ... Actually, I talked about the class to many of my friends."

5.3.1 Students' Comments

There were several opportunities to collect students' comments formally and informally. On several occasions the researcher, while attending lectures or monitoring e-mail and posting activities, would ask the students informally about their thoughts about the learning environments. He also conducted a few formal interviews with randomly selected students towards the end of the semester. Most importantly, the students were asked on the final survey to voice their opinions on anything related

to the learning environment. The students' comments were both positive and negative. Appendix (N) includes a selection of students' comments.

The positive comments seem to fall along the following lines:

- ➔ Not having to come to class was attractive to many students.
- ➔ Controlling the pace and timing of learning activities was very appealing.
- ➔ Some experienced students liked the idea of not sitting in a classroom listening to simple explanations for tasks they have already mastered. Controlling the pace of learning was advantageous for such students.
- ➔ Those who worked felt that it was a great saving in time and that it was very convenient.
- ➔ Some enjoyed the virtual environment because they thought it was a modern way to develop the skills they need to deal with new technologies that everybody is talking about. They felt it was a bonus to acquire these skills in addition to learning the usual course content.

The negative comments seem to fall into the following categories:

- ➔ Liked the idea of learning in virtual environments, but were not happy because of technical reasons such as:
  - The interface of Learning Space was cumbersome
  - They had problems connecting to the Internet
  - The navigation through the tutorials was slow
- ➔ Some hated the idea altogether for reasons such as:
  - Lack of feedback: They felt that the feedback was not as prompt in the virtual learning environments.

- Lack of face-to-face interaction with the instructor and other students
- They felt that a huge responsibility was placed on their shoulders, rather than the instructors', and they felt that they had to spend a lot more time than they would for a traditional class
- The lack of routine activities caused problems with time management

Some students went so far as to say that they felt cheated by the virtual learning environment. They paid tuition to the school to have an instructor standing in front of the class and taking the time to provide the students with hand-on experience. One student articulated this point by writing: " I would much rather have my questions answered in-person and when I ask them. I will never take a course taught in this manner again. I paid money to LSU to get a teacher, not an on-line course." Some students also complained that they were not aware of the fact that this class will be held in a virtual environment before registration. They thought that it was unfair and that they should have been given the choice to be in a virtual or traditional environment. Even those who enjoyed the virtual experience felt that the student has the right to choose the environment. One student wrote: "I think this class is a very good idea; however, I suggest that in the class registration form, students should be made aware that this is not a regular in-class, teacher-to-student study, as they would assume."

5.3.2 Researcher's Observations

The researcher monitored the learning activities through out the semester and held regular meetings with the two instructors for guidance, evaluation and debriefing. The following is a summary of observations that were not discussed above:

- The maturity of subjects might have been a factor in two ways: in employing the constructivist model (because of the responsibility it entails) and in benefiting from having more control over the content, sequence and pace of learning.
- It seems that a lot of the subjects liked the idea of not coming to class, but they thought that the price they paid eventually (extra effort) was high.
- Previous experience with computers seemed to be important in getting up to speed interacting and moving around the virtual environment. Lack of familiarity may have been a source of frustration for students.
- Many students compared themselves to other sections of the same course and they felt at a disadvantage because they were not given the choice between taking the class in a virtual or a traditional environment. (For the purpose of randomization, the researcher intentionally did not give the subjects the choice). This raises another issue addressed by Hiltz (1993), in which she thought it is unfair and perhaps unethical to force the students go through the virtual environment.
- Despite the extra effort and the frustration, there was a sense of pride and achievement for many students in the virtual environment.
- The switch to the constructivist model in the second half intimidated some students. They felt that it is a lot easier for them to simply listen and get knowledge form the instructor rather than be involved and active in the learning process as required by the constructivist model. This factor might have had an effect on their performance. A better job of "selling" the constructivist model to the students might have alleviated many fears and ensured a full implementation and exploitation of all the presumed advantages.

- The notion of practical significance as opposed to the statistical significance is perhaps worthy of consideration when evaluating the findings of such research. Offering procedural basic skill courses for large numbers of students in large universities is a major undertaking. Virtual environments present a practical alternative to overcome several problems that have to do with finding enough qualified instructors to prepare the materials and deliver knowledge in a consistent and efficient manner.

6. CONCLUSIONS

In this closing chapter, the contribution of this research will be outlined, followed by a discussion of the limitations of the study. Several suggestions for future research building on the findings of this study will be presented. Some concluding remarks will round up this chapter and this dissertation.

Living in this day and age requires a quite different set of skills. The ability and the motivation to learn independently are very crucial. The IT skills are the enabling tools for that. Reading and writing are no longer sufficient skills to survive and be a contributing member in today's world. There is a great concern about the IT skills across businesses, communities and government organizations. For example, the U.S. Department of Commerce's Technology Administration developed a web site (called "Go for IT" web site -http://www.ta.doc.gov/go4it/welcome.htm) to serve as a public resource with the intent to advocate the development and use of Information Technology. This was in response to the needs expressed by participants in town meetings, and to the flood of inquiries they have received since the release of the Office of Technology Policy report, "America's New Deficit". This report found that the United States will require more than 1.3 million new computer scientists and engineers, systems analysts, and computer programmers in the decade ahead.

In his welcome address on the web site, the Secretary of Commerce, William Daley, states: "The wave of digital technologies sweeping our economy is driving a sharp increase in the demand for workers who can create, apply, and use information technologies (IT). Today, employers across the country report difficulties in recruiting and retaining these skilled workers, and the country's need for their skills is expected

to grow at a rapid rate...Stakeholders across the country are gearing up to meet the IT work force challenge in their communities. They are forming partnerships and pursuing creative solutions to expanding IT skills in their region."

Virtual learning environments present a great potential in this campaign for IT literacy. In fact, many businesses have realized this need and started to introduce measures and policies to deal with it. According to Masi (1997), 81% of fortune 500 companies have an on-line program of some sort going on. Computerworld estimates the web-based market could hit one billion dollars by the year 2000 (Ouellette, 1998). In fact numerous training outfits have established themselves in the market such as DigitalThink. Not only commercial training outfits are capitalizing on the web-based offerings, but also well established universities offering classes or complete degree programs on-line. According to the New York Times (Nov.2, 1998): "No one knows exactly how many colleges operate on the Internet. But what is clear is that the trend is picking up speed nationwide."; and they list a number of universities who started some sort of an on-line program such as: Stanford University, Drexel University, New York University, Penn State, Florida State, University of Phoenix. Colleges could collaborate also to complement each other and develop stronger programs. The California Virtual University is a good example of such collaboration. It is a consortium of nearly 100 California universities and colleges, opened this fall with more than 1600 online courses. This area is too important to be taken for granted. The potential is great, but research is needed in a wide range of disciplines to justify and to find effective ways of implementing such environments. This dissertation propels us further in this direction.

6.1 Contribution of the Study

Although the literature is rich with studies that looked at incorporating technology in the classrooms, only few studies have considered web-based virtual environments (e.g. Schutte, 1997). This area is quite new, and there has not been enough time to conduct thorough research in different disciplines. It is only recently that the technical capabilities of the Internet have allowed for the implementation of a reasonable number of virtual environments' features.

This dissertation is perhaps the first "IS" study to consider the implementation of different learning models in conjunction with web-based virtual environments. This study is unique in the fact that it looked at the effectiveness of web-based learning environments when employing the objectivist and constructivist learning models over a reasonable duration. This is opposed to many studies that were conducted over short periods of time with little or no attention to the learning model employed. Some of the landmark studies were conducted over one or two-day training sessions.

This research builds upon the existing IS literature on learning models (e.g. (Leidner and Jarvenpaa 1993),(Leidner and Jarvenpaa 1995)), on adapting the Social Cognitive Theory to the IS field (e.g. (Compeau and Higgins 1995a),(Compeau and Higgins 1995b),(Gist, Schwoerer et al. 1989)), and on the educational literature on the "learner control" feature of the Component Display theory of instructional Design (Merrill 1983). It also expands on the findings of several studies on virtual classroom in general (e.g. (Hiltz 1993),(Hiltz 1995),(Hiltz and Wellman 1997)) and specifically on web-based studies (e.g (Schutte 1997)). Furthermore, it adds more insight to the lively debate on the significance of enhancing classrooms with technology.

Implications for educational technology

The debate on the significance of the incorporating technology in the classroom has been a lengthy and a very inconclusive one. As was discussed in second chapter of this dissertation, historically hundreds of studies considered different types of technologies and drew different conclusions on the significance of the technology effect on learning effectiveness. For example, Russell (1997) of North Carolina State University cited 248 research reports and papers that found "No Significant Difference". On the other hand, Orr (1997) of Auburn University, claims that more contemporary research suggest that recent powerful technologies are a different ball game and he cites over 70 recent studies that concluded "A significant difference" in response to the list compiled by Russell. More recently, (Cradler 1997) concluded that technology is making a significant positive impact in education, based on 176 research reviews and reports conducted from 1990 through 1995. The findings discussed in this dissertation provide insight in the following way:

- ➔ The findings on performance - although no statistically significant difference was found, the direction of the means supported the hypotheses that virtual environments are more effective. This conclusion is just as important in justifying the implementation of virtual environments to capitalize on other advantages. At least there is no evidence that virtual environments are worse.
- ➔ The findings on self-efficacy - A basic objective of basic skill offerings is to build or enhance the confidence of the subjects in tackling tasks in the real world. The higher levels of self-efficacy in virtual environments are presumably a very welcomed advantage in any basic skills training.

→ The findings on satisfaction- Although, it was hypothesized that satisfaction would be higher in virtual environments, but the findings are just as important in exposing the realities of the implementation of virtual environments. Perhaps designers will take extra precautions to keep this issue in check. Taking measures to alleviate the anticipated frustration will increase the effectiveness of any learning environment.

→ The significance of the learning model also has its implication on selecting what model to implement for what content. The findings of this research suggest that for basic skills of procedural nature (e.g. how to use a word process or a spread sheet software), the constructivist model might end up causing more anxiety and disarray. This is particularly true when the subjects are young college students.

→ The significant effect of the instructor on the satisfaction of the students calls for certain recommendations when selecting instructors in virtual environments. Future research is needed to identify needed traits for effective instructors in virtual learning environment.

Implications for Distance Education

Time is becoming more critical than distance in distance learning. Masie (1998) states that: "The more we listen to users of on-line and distance learning programs, the less it seems to be about distance. In fact, the major element is increasingly 'shifting time'. Learners, even those that are right next to the classroom or campus, are choosing this new delivery in order to allow learning to take place 'when' they want. In conversations with distance learning coordinators at higher education institutions

they are seeing more and more of their learners come from local communities rather than far away. Likewise, on-line training coordinators in corporations are reporting that a large driver is 'time shifting' rather than travel reduction."

Considering the capability of Virtual environments in transcending the barriers of distance and time, they present distance learning programs with more effective and efficient ways when compared to the regular mail system.

This study has some implications for educational institutions in suburban areas as well as developing nations. They can enhance their curricula by incorporating web-based courses. Based on the findings of this and similar research, they can identify some of the basic skill courses that they need to offer (or improve) and make arrangements with reputable educational institutions to facilitate for their students to take those classes. Financial and technical issues need to be considered of course, but as far as the effectiveness of the offering is concerned, virtual environments allow students to attend necessary and current courses offered by the best institutions in the world. This presents a wonderful opportunity for students and educational organizations (who would not have it any other way) to be part of state-of-the-art educational undertakings. Capitalizing on the advantages of such creative environments will hopefully be reflected in a sustainable growth in human resources in those communities.

6.2 Limitations of the Study

As explained in the section on validity issues in the methodology chapter (sec.3.3), this study has taken into consideration many limitations of previous studies. However, it still suffers from other limitations as follows:

➔ The scope of the contents. IT basic skills --

Basic IT skills training is the most common target of virtual environment implementations in this industry today. Massy (1995) argues that such environments are good for high volume of students, standardized curriculum, and over whose content faculty is less possessive. Basic IT skills conform to those characteristics and thus the choice of content for this study is deemed to be appropriate. However, the case may not be the same for other business basic skills content (e.g., accounting business skills). Furthermore, the case is most likely to be different for courses with advanced skill content. This fact poses a threat to the external validity and thus the ability to generalize the findings is hindered.

➔ Students not employees--

Although college students are common targets for such research initiatives, it is quite possible that corporate employees would have different appreciation and perception of the advantages and implications of virtual environments. Again, this might have limited the generalization of the results to all types of learners. Bordia (1997) reviewed 18 studies comparing face-to-face (FTF) with computer mediated communication (CMC) and noticed that the major focus of research in this area is towards application of CMC to organizational and social functions. However, he argues that this aim is jeopardized by the use of student subjects in nearly all the studies he reviewed. He supported his argument by Gorden's review (1986) on studies that had students and non-students as participants. They reported that several authors attributed the differences in results with students and non-students subjects to

differences between the two groups on "experience or familiarity with the experimental task" and "cognitive appraisal of the experimental task".

➔ The age of the subjects -- young undergraduate students

The problem with student subjects is not limited to their lack of experience. The fact that 91% of the subjects were 22 years or less raises a flag as far as the external validity is concerned. As discussed in the chapter 5, different age groups might have reacted differently to the challenges of learning in virtual environments. Sears (1986) reported a wide range of attributes that are unique to late adolescence and early adulthood. Furthermore, Gorden (1986) believes that college students differ from other people their age because of specific cognitive skills. Thus the generalizability of the findings might have been limited.

➔ The instructor factor--

Perhaps the number of sections (2+2) is too few to control for the instructor factor. This research missed an opportunity to study the instructor factor in more details. There were no hypotheses as to what characteristics a teacher should possess in order to be an effective instructor in virtual learning environments. It would have been useful to take advantage of this experiment by hypothesizing on certain characteristics of instructors.

➔ Randomization process--

Although every effort was exerted to fully randomize the selection and the assignment of the sections and the subjects, perhaps the process was not 100% random. Although the subjects chose their sections independently and without prior knowledge that they will be subjects in an experiment, there might have been other

reasons that are not known to the researcher (e.g. they might have registered for this class to be with friends, etc.)

➔ Novelty effect--

Another threat to validity that might have had an influence is the Novelty effect. Although, the researcher tried to play down any possible fascination with virtual environments, students in the virtual environment might have talked to friends about the virtual environment and bragged about it. They might have also thought higher of themselves, which in turn reflected higher self-efficacy levels.

One or more replications would have put many validity issues to rest. The above discussion pointed out a number of limitations that perhaps could be controlled better in future research. The next section includes several suggestions for future research.

6.3 Suggestions for Future Research

As was mentioned in the introduction of this dissertation, the important issues in the area of virtual learning are classified as: effectiveness, technical, financial and social issues. As far as the effectiveness issues, future research will build on the results of this study to further investigate the effectiveness of virtual environments considering the limitations of this experiment, outlined in the previous section. For example, it would be interesting to investigate the effectiveness of virtual environments in business training settings instead of college level courses. The subjects in a business setting would perhaps have a different perception of the value of virtual environments, and they would probably pose different challenges to instructors.

IT basic skills is a very common target for virtual learning offerings. However, content of a different nature could call for other considerations in implementing such environments. Thus a replication of this study in courses where the focus is advanced skills rather than basic skills is thought to be useful.

This study could also be replicated to consider additional measures of effectiveness such as "time on task." From the students' comments we observed that a good number of students thought that learning in virtual environments allowed them to get the maximum output for a given period of time. There was no wastage of time, getting to and back from the classroom and sitting through entire lectures, especially when the instructor is attending to the needs of other students and discussing perhaps familiar topics.

Another item pertaining to the effectiveness of the virtual environment is the learning style of the learner. Several classifications of learning styles have been developed and well established in the educational literature. For example, Merrtit and Marshal (1985) have developed a 40-item questionnaire to classify learners into four types based on Kolb's experiential model of learning (Kolb, 1974). Basically, the model establishes two dimensions; Abstract-Concrete and Active-Reflective. Depending on where they fall on these two dimensions Figure (14), learners are classified into four categories: The Accommodator, the Converger, the Diverger, and the Assimilator.

Table (20) summarizes predominate activities and possible content for every one of the four categories. It would be interesting to know if virtual learning environments are more effective for students who are of a particular learning style.

Such findings could be instrumental in recommending virtual environments for particular types of students.

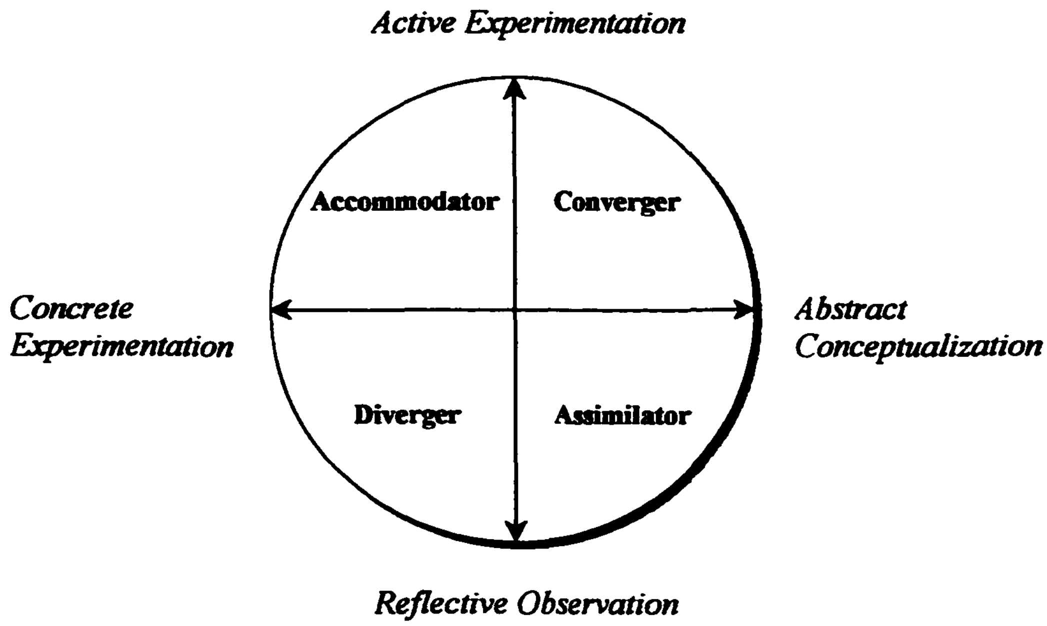


Figure 14 - The Learning Styles

Table 20- Features of Learning Styles

Learning Style	Predominant Activities	Possible Content
The Diverger	Feeling and watching	– Tend to be Good for generating ideas
The Assimilator	Thinking and watching	– Tend to be good for inductive reasoning and abstract conceptualization
The Converger	Thinking and doing	– Tend to focus on practical application of ideas
The Accommodator	Feeling and doing	– Tend to be strong in doing things and carrying out plans

In light of the findings of this study, other research questions present themselves. For example, if there is no difference in performance between the two environments what are the cost implications for educational institutions? Are there

any cost savings? What are the implications for training outfits? Do virtual learning environments present new business models for generating revenues and making investment decisions? Financial questions are worthy of serious research. Analysts estimate that the Web-based training market could hit $1 billion by the year 2000 (Ouellette 1998).

Another set of issues related to the technical requirements of successful implementation of virtual learning environments. These include environment design issues and infrastructure issues. The infrastructure issues may not appear as important as the effectiveness and finical issues because of the recent proliferation of computers and networks. However, these issues are still worthy of investigation in two directions at least- capability and availability. The capability issue is very essential; especially when the virtual courses include a wide range of audio and video materials. Rapid technological improvements are helping in this regard. The availability issue may be less important for advanced educational institutions and for populations in urban areas. But for populations in developing countries, and even for poor and suburban populations in developed nations, the technical infrastructure issues are very essential.

Finally, the social and societal implications are also worthy of the attention of the IS research community. What are the implications for individuals interacting in virtual learning environments regarding matters like trust, cooperation, teamwork, social networking, etc. What are the implications for certain segments of society, who do not have the resources (time, money, family, etc.) to go to traditional educational institutions? For example, a mother who can not afford to spend time away from her kids; or a blue-collar worker, who would like to improve his skills and perhaps purse a

more lucrative and fulfilling career. What opportunities do virtual learning environments present for such individuals, and others who embrace the life-long learning paradigm?

The gap between the developed and the under-developed is widening with every new technological breakthrough. Developing countries have been suffering from a "brain drain" phenomenon, where they have to send their best students to learn abroad and hopefully come back. However, many of these students do not go back, depriving their countries from the much-needed knowledge and experience they attained abroad. Do virtual learning environments present an opportunity to minimize the effects of this "brain drain" phenomenon? How? What are the limitations? How can they be overcome? What are the required resources? International developing organizations (such as The World Bank) are committing resources for research on human resource development projects in developing countries. Capitalizing on virtual learning environments seems to be a suitable area for such research initiatives.

6.4 Concluding Remarks

This research was carried out in the spring semester of 1998. Several limitations of previous studies were considered in the design of this experiment. For example, having individuals other than the researcher teach the course; incorporating control groups in the design; the random selection and assignment of subjects; and a semester-long duration of the experiment, as compared to a single-day or single-session in other experiments. These measures, among others, reduced several threats to validity. This study is anchored in theory, as it draws from the theories of learning and the "Learner Control" proposition of the Component Display Theory of instruction

design. It also benefited from the Social Cognitive Theory in speculating about the implications of self-efficacy on the competency of subjects in applying the skills they learned.

This dissertation was intended to shed light on the effectiveness of the web-based virtual learning environments with a focus on developing basic IT skills in business education. While building on the excitement of what the technology has to offer, this study kept into consideration the well-known educational principles about technology, which basically emphasized that technology per se has "no" predictable effect on educational outcomes, teaching and learning models do. However, technology does play a role in employing these models effectively.

The outcomes of the research could be of particular interest in business education, as institutions begin to migrate some (or all) of the basic skill courses to virtual learning environments. The findings also have some implications for training organizations and business corporations as they seek efficient and effective ways to satisfy their training needs. Furthermore, distance education programs and individuals embracing the "Life-long Learning" concept may also be interested in the findings of such research. After all, a major goal of MIS is to help organizations manage the vital operations necessary to survive and sustain growth. Upgrading the skills of the workforce is increasingly becoming a vital objective of organizations in this day and age.

Although the use of the web is perhaps inevitable, investments in its deployment for education must be justified. I believe that to provide that justification, it must be proven effective through vigorous research under a wide range of learning

situations. The one I have chosen to look at in this dissertation, basic IT skills, is already a common target of online educational offerings. As we prepare to enter the third millennium, web-based virtual learning environments present great and exciting opportunities for both academia and business communities.

REFERENCES

Alavi, M. (1994). "Computer-Mediated Collaborative Learning: An Empirical Evaluation." MIS Quarterly (June 1994): pp. 159-174.

Alavi, M., B. Wheeler, et al. (1995). "Using IT to Reengineer Business Education: An Exploratory Investigation of Collaborative Telelearning." MIS Quarterly 19(3) (September 1995): pp. 293-312.

Bandura, A. (1986). Social Foundation for Thought and Action. Englewood Cliffs, NJ, Prentice Hall.

Barron, A. E. and G. W. Orwig (1997). New technologies for education. A beginner's guide. Englewood, CO, Libraries Unlimited.

Bordia, P. (1997). "Face-to-Face Versus Computer-Mediated Communication: A Synthesis of the Experimental Literature." The Journal of Business Communication 34 (1) (January 1997): pp. 99-120.

Brandt, S. A. (1995). Reengineering the Classroom: A Field Study of Computer-Supported Collaborative Learning. College of Business Administration, University of Arizona: 129.

Brown, J. S., A. Collins, et al. (1989). "Situated cognition and the culture of learning." Educational Researcher 18(1): pp. 32-42.

Bruer, J. (1993). Schools for thought. Cambridge, MA, MIT Press.

Callahan, E., B. F. Richards, et al. (1979). "Extrinsic rewards and strategy training on student optimization of learner control." (Working paper No. 116, NSF Final Report SED 76-01650). Provo: Courseware Inc.

Chellappa, R., A. Barua, et al. (1997). "An Electronic Infrastructure for a Virtual University." Communications of the ACM 40:9(September 1997): pp. 56-58.

Choi, W. (1995). The Effects of Utilization Methods That Increase learner Engagement on Efficiency and Effectiveness of Learning From a Computer-Based Instructional Simulation. School of Education, Indiana University.

Chung, J. and C. M. Reigeluth (1992). "Instructional Prescriptions for Learner Control." Educational Technology Vol. 32(10): pp. 14-20.

Compeau, D. and C. Higgins (1995a). "Application of Social Cognitive Theory to Training for Computer Skills." Information Systems Research Vol.6, No.2 (June 1995): pp. 118-143.

Compeau, D. R. and C. A. Higgins (1995b). "Computer Self-Efficacy: Development of a Measure and Initial Test." MISQ 19(2): pp. 189-211.

Cook, T. and D. Campbell (1976). The Design and Conduct of Quasi-Experiment and True Experiments in Field Settings. Handbook of Industrial and Organizational Psychology. M. Dunnette. Chicago, Rand McNally College Publishing Company.

Cradler, J. (1997). "Summary of Current Research and Evaluation Findings on Technology in Education." http://www.fwl.org/techpolicy/refind.html Far West Laboratory.

D'Ignazio, F. (1993). Electronic Highways and Classrooms of the Future. The Technology Age Classroom. e. b. T. C. a. L. F. Wilsonville. Wilsonville, Ore., Franklin, Beedle, and Associates.

Duchastel, P. (1986). "Intelligent computer assisted instruction systems: the nature of learning control." Journal of Educational Computing Research 2(3): pp. 379-93.

Duffy, T., J. Lowych, et al. (1993). Designing Environments for Constructive Learning. Berlin, Springer-Verlag.

Gagne, R. M., L. J. Briggs, et al. (1988). Principles of instructional Design, 3rd. ed. New York, Holt, Rinehart & Winston.

Gist, M., C. Schwoerer, et al. (1989). "Effects of alternative training methods on self-efficacy and performance in computer software training." Journal of Applied Psychology Vol. 74(No. 6): pp. 884-891.

Green, S. and T. Taber (1980). "The Effects of Three Social Decision Schemes on Decision Group Process." Organizational Behavior and Human Performance (25): pp. 97-106.

Gorden, M. E., L. A. Slade, et al. (1986). "The "science of the sophomore" revisited: From conjecture to empiricism." Academy of Management Review 11: pp.191-207.

Hackbarth, S. (1996). The Educational Technology Handbook: A Comprehensive Guide. Englewood Cliffs, NJ, Educational Technology Publications.

Hill, T., N. Smith, et al. (1987). "Role of efficacy expectations in predicting the decision to use advanced technologies: The case of computers." Journal of Applied Psychology Vol. 72: pp. 307-313.

Hiltz, S. R. (1993). The Virtual Classroom: Learning Without Limits via Computer Networks. Norwood, New Jersey, Ablex Publishing Corporation.

Hiltz, S. R. (1995). "Impacts of college-level courses via Asynchronous Learning Networks: Focus on Students." Sloan Conference on Asynchronous Learning Networks, Philadelphia, OCT 1995.

Hiltz, S. R. and B. Wellman (1997). "Asynchronous Learning Networks as a Virtual Classroom." Communications of the ACM 40:9 (September 1997): pp. 44-49.

Hmelo, C. E. (1993). Learning in school and learning in life: An exploration of issues. Nashville, TN, Vanderbilt University Learning Technology Center.

Honebein, P., T. Duffy, et al. (1993). Constructivism and the Design of Learning Environment: Context and Authentic Activities for Learning. Designing Environments for Constructive Learning. T. Duffy, J. Lowych and D. Jonassen. Berlin, Springer-Verlag.

Ives, B. and S. L. Jarvenpaa (1996). "Will the Internet revolutionize business education and research?" Sloan Management Review 37 (Spring 96): pp. 33-41.

Jarvenpaa, S. L., G. Dickson, et al. (1985). "Methodological Issues in Experimental IS Research: Experiences and Recommendations." MIS Quarterly 9(2) (June 1985): pp. 141-156.

Jonassen, D. (1991). "Objectivism versus Constructivism: Do We Need a New Philosophical Paradigm." Educational Technology, Research and Development Vol.39, No.3: pp. 5-14.

Jonassen, D., T. Mayes, et al. (1993). A Manifesto for a Constructivist Approach to Uses of Technology in Higher Education. Designing Environments for Constructive Learning. M. Duffy, J. Lowyck and D. Jonassen. Berlin, Springer-Verlag: pp. 231-247.

Jonassen, D. H., B. G. Wilson, et al. (1993). "Constructivist uses of expert systems to support learning." Journal of Computer-Based Instruction Vol. 20(3): pp. 86-94.

Leidner, D. and S. Jarvenpaa (1993). "The information age confronts education: case studies on electronic classrooms." Information Systems Research 4:1(March 1993): pp. 24-54.

Leidner, D. E. and S. L. Jarvenpaa (1995). "The Use of Information to Enhance Management School Education: A Theoretical View." MIS Quarterly 19(3) (September 1995): pp.265-291.

Lewis, P. (1997). Lawmakers gear up to try to control the surging on-line gambling industry. The New York Times. New York. 9/22/97

Lin, X., J. Bransford, et al. (1996). Instructional Design and Development of Learning Communities: An Invitation to a Dialogue. Constructivist Learning Environments: Case Studies in Instructional Design. B. Wilson. Englewood Cliffs, NJ, Educational Technology Publications: pp. 203-220.

Mannoni, B. (1997). "A Virtual Museum." Communications of the ACM 40:9 (September 1997): pp. 61-62.

Masie, E. (1998). "Time Shifting More Critical Than Distance in Distance Learning." TechLearn Trends — Technology & Learning Updates http://www.masie.com , The MASIE Center(#68 -Sept. 14,1998).

Massy, W. F. and R. Zemsky (1995). Using Information Technology to Enhance Academic Productivity, Inter-university Communications Council, Inc.

Merrill, M. D. (1983). Component Display Theory. Instructional Design Theories and Models. C. M. Reigeluth. Hillsdale, NJ, Lawrence Erlbaum Associates.

Merrill, M. D. (1992). Constructivism and instructional design. Constructivism and the technology of instruction. T. Duffy and D. Jonassen. Hillsdale, NJ, Erlbaum.

Merrill, M. D. (1994). Instructional Design Theory. Englewood Cliffs, NJ, Educational Technology Publications.

Milheim, W. D. and B. L. Martin (1991). "Theoretical bases for the use of learner control: three different perspectives." Journal of Computer-Based Instruction Vol. 18(3): pp. 99-105.

Mory, E. H. (1996). Feedback Research. Handbook of Research for Educational Communications and Technology. D. H. Jonassen. New York, Simon & Schuster Macmillan: pp. 919-956.

Mowshowitz, A. (1997). "Virtual Organization." Communications of the ACM 40:9 (September 1997): pp. 30-37.

Neter, J., M. Kutner, et al. (1990). Applied Linear Statistical Models. Chicago, IRWIN.

Orr, B. (1997). "A Significant Difference." http://teleeducation.nb.ca/anygood/asigdiff.shtml.

Ouellette, T. (1998). "Does online training work? Maybe." Computer World Vol.32 (No.6): p. 45.

Owston, R. D. (1997). " The World Wide Web: A Technology to Enhance Teaching and Learning?" Educational Researcher Vol. 26, No. 2 (March 1997): pp. 27-33.

Penland, P. (1979). "Self-initiated learning." Adult Education 29(3): pp. 170-179.

Ragan, T. J. and P. L. Smith (1996). Conditions-based models for designing instruction. Handbook of Research for Educational Communications and Technology. D. H. Jonassen. New York, Simon & Schuster Macmillan: pp. 541-569.

Reeves, T. C. (1993). "Pseudoscience in computer based instruction: the case of learner control research." Journal of Computer-Based Instruction 20(2): pp. 39-46.

Reigeluth, C. M. (1983). Introduction. Instructional-design theories and models: The current state of the art. C. M. Reigeluth. Hillsdale, NJ, Lawrence Erlbaum.

Reigeluth, C. M. and F. S. Stein (1983). The Elaboration Theory of instruction. Instructional-design theories and models. C. M. Reigeluth. Hillsdale, NJ, Erlbaum: pp. 335-382.

Resnick, L. B. and L. E. Klopfer (1989). Towards the thinking curriculum: Current cognitive research. Alexandria, VA, ASCD.

Ross, S. and G. Morrison (1989). "In search of happy medium in instructional technology research: issues concerning external validity, media replications, and learner control." Educational Technology Research and Development 37: pp. 19-33.

Russell, T. L. (1997). "No Significant Difference." http://teleeducation.nb.ca/phenom/.

Schank, R. (1997). Virtual Learning, A Revolutionary Approach to Building A Highly Skilled Workforce. New York, McGraw- Hill.

Schutte, J. G. (1997). "Virtual Teaching in Higher Education: The New Intellectual Superhighway or Just Another Traffic Jam?" http://www.csun.edu/sociology/virexp.htm.

Sears, D. O. (1986). "College sophomores in the laboratory: Influences of a narrow data base on social psychology's view of human nature." Journal of Personality and Social Psychology 51: pp. 515-530.

Shavelson, R. J. (1988). Statistical Reasoning for the Behavioral Sciences. Boston, Allyn and Bacon, Inc.

Simons, P. (1993). Constructive Learning: The Role of the Learner. Designing Environments for Constructive Learning. T. Duffy, J. Lowych and D. Jonassen. Berlin, Springer-Verlag.

Straub, D. (1989). " Validating instruments in MIS Research." MISQ 13(2): pp. 147-165.

Turoff, M. (1997). "Virtuality." Communications of the ACM, 40:9(September 1997): pp. 38-43.

Viadro (1997), D. Education Week on the Web <http://www.edweek.org/sreports/tc/class/cl-n.htm>.

Webster, J. and J. Martocchio (1992). "Microcomputer playfulness: Development of a measure with workforce implications." MIS Quarterly 15:1 (June 1992): pp. 201-226.

Wellburn, E. (1996). "The Status of Technology in the Education System: A Literature Review." Technology and Distance Education Branch, Ministry of Education, Skills and Training, British Columbia, Canada,(May, 1996).

Wilcox, W. C., B. F. Richards, et al. (1978). "Learner Control of number of instances in rule-using tasks." (Working paper No.94). Provo: Courseware Inc.

Williams, M. D. (1996). Learner-Control and Instructional Technologies. Handbook of Research for Educational Communications and Technology. D. H. Jonassen. New York, Simon & Schuster Macmillan: pp. 957-983.

Wilson, B. G. (1996). Constructivist Learning Environments: Case Studies in Instructional Design. Englewood Cliffs, NJ, Educational Technology Publications.

Winn, W. (1993). A Constructivist Critique of the Assumptions of Instructional Design. Designing Environments for Constructive Learning. T. Duffy, J. Lowych and D. Jonassen. Berlin, Springer-Verlag: pp. 189-212.

Winn, W. and D. Snyder (1996). Cognitive Perspectives in Psychology. Handbook of Research for Educational Communications and Technology. D. H. Jonassen. New York, NY, Macmillan: pp. 112-142.

Wolfram, D. (1994). "Audio-graphics for distance education: A case study in students attitudes and perceptions." Journal of Education for Library and Information Science 35(3): pp. 179-186

Zajtchuk, R. and R. Satava (1997). "Medical Applications of Virtual Reality." Communications of the ACM 40:9 (September 1997): pp. 63-64.

Zuboff, S. (1988). In the Age of the Smart Machine: The Future of Work and Power. New York, Basic Books, Inc.

APPENDIX A - PRELIMINARY SURVEY

Name: ______________________ **ISDS 1100 -Sec:___**

Please answer the following questions to the best of your knowledge. The information provided in this questionnaire will remain strictly confidential and will not affect your grade in this course.

1. Major	Business	Non-Business		
2. Academic Level	Freshman	Sophomore	Junior	Senior
3. Overall GPA	< 2.5	2.5-3.0	3.0-3.5	> 3.5
4. Age	<19	20-22	23-25	> 25 years
5. Sex	Male	Female		

6. Do have access to a computer at home?	Yes	No
7. Do have access to an Internet connection at home?	Yes	No

8. How would you describe your previous experience with computers? (1=No experience 2=Somewhat 3=Occasional 4=Frequent user 5=Professional user)	1	2	3	4	5
9. Do you enjoy working with computers? ("1" =Not at all & "5" = Very much)	1	2	3	4	5
10. Do you feel threatened by computers? ("1" =Not at all & "5" = Very much)	1	2	3	4	5
11. Do expect this course to be difficult or easy? ("1"= very easy & "5"= very difficult)	1	2	3	4	5
12. Do you expect to learn a lot out of this course? ("1" =Nothing & "5" = High expectation)	1	2	3	4	5

13. How do you rate your knowledge of the following software:
(A rating of "1" indicating no knowledge at all and "5" excellent knowledge)

- Word Processing Software(e.g. MS Word)	1	2	3	4	5
- Presentation Software (e.g. MS PowerPoint)	1	2	3	4	5
- Spread Sheets Software (e.g. MS Excel)	1	2	3	4	5
- Database Management Systems (e.g. Access)	1	2	3	4	5

APPENDIX B - INITIAL BASIC-SKILLS ASSESSMENT

This is a basic-skills assessment. Please answer to the best of your knowledge. This assessment will not affect your grade in the course in any way.

1. The software that is best suited for creating an address book of the customers of a company is:

   a. Word Processor
   b. Spreadsheet Software
   c. Database management System
   d. Presentation Software

2. In Word you can create all of the following EXCEPT:

   a. Tables
   b. Index
   c. Slides
   d. Paragraphs of text

3. You would use Excel to:

   a. Write a letter
   b. Create a telephone directory
   c. Prepare a financial statement.
   d. Create images

4. When asked to prepare some slides for a project presentation, which one of the following would you use:

   a. MS Word
   b. MS Excel
   c. MS Power Point
   d. MS Access

5. What does NOT belong to Microsoft Access terminology:

   a. Table
   b. Field
   c. Query
   d. Paragraph

6. What software package would you use to create a graph of USA population growth trend for the next 2 years based on historical data.

   a. Microsoft Word
   b. Microsoft Power Point
   c. Microsoft Excel
   d. Microsoft Access

7. What character is used to start a formula in Excel

   a. =
   b. $
   c. f
   d. %

8. When you save a file in MS Word, it is saved with one of the following file extension types:

   a. .XLS
   b. .DOC
   c. .EXE
   d. .HTM

9. To retrieve certain records from an Access Database you would write a:

   a. Table
   b. Field
   c. Query
   d. Paragraph

10. Is it possible to incorporate sounds in a Power Point file?

   a. Yes
   b. No

APPENDIX C - SELF-EFFICACY INSTRUMENT

Name:____________________ **ISDS 1100 - Sec:**_____

Please take your time and answer to the best of your judgment. The information you give on this survey will remain strictly confidential and will not affect your grades in anyway.

Often in the real work environments we are told about software packages that are available to make wok easier. For the following questions, imagine that you were given a new software package for some aspect of your work. It doesn't matter specifically what this software does, only that it is intended to make your job easier and that you have never used it before.

The first ten questions ask you to indicate whether you could use this unfamiliar software package under a variety of conditions. For each condition, please indicate whether you think you would be able to complete the job using the software package. Then, for each condition that you answer "yes," please rate your confidence about your first judgment, by circling a number from 1 to 10, where 1 indicates "Not at all confidant," 5 indicates "Moderately confidant," and 10 indicates "Totally confidant."

For example, consider the following sample item:

I COULD COMPLETE THE JOB USING THE SOFTWARE PACKAGE...		**Not Confident**				**Moderately Confident**					**Totally Confident**
1....if there was no one around to tell me what to do as I go.	(YES). NO	1	2	3	4	(5)	6	7	8	9	10

The questionnaire is on the next page...

I COULD COMPLETE THE JOB USING THE SOFTWARE PACKAGE ...		**Not Confident**				**Moderately Confident**					**Totally Confident**
1. ...if there was no one around to tell me what to do as I go.	YES... NO	1	2	3	4	5	6	7	8	9	10
2. ...if I had never used a package like it before.	YES... NO	1	2	3	4	5	6	7	8	9	10
3. ...if I had only the software manuals for reference.	YES... NO	1	2	3	4	5	6	7	8	9	10
4. ...if I had seen someone else using it before trying it myself.	YES... NO	1	2	3	4	5	6	7	8	9	10
5. ...if I could call someone for help if I got stuck.	YES... NO	1	2	3	4	5	6	7	8	9	10
6. ...if someone else had helped me get started.	YES... NO	1	2	3	4	5	6	7	8	9	10
7. ...if I had a lot of time to complete the job for which the software was provided.	YES... NO	1	2	3	4	5	6	7	8	9	10
8. ...if I had just the built-in help facility for assistance.	YES... NO	1	2	3	4	5	6	7	8	9	10
9. ...if someone showed me how to do it first.	YES... NO	1	2	3	4	5	6	7	8	9	10
10. ...if I had used similar packages before this one to do the same job	YES... NO	1	2	3	4	5	6	7	8	9	10

APPENDIX D - SATISFACTION MEASUREMENT INSTRUMENT

How would you describe the learning process in this course?

1.	1 Very Inefficient	2 Somewhat Inefficient	3 Undecided	4 Somewhat Efficient	5 Very Efficient
2.	1 Very Uncoordinated	2 Somewhat Uncoordinated	3 Undecided	4 Somewhat Coordinated	5 Very Coordinated
3.	1 Very Unfair	2 Somewhat Unfair	3 Undecided	4 Somewhat Fair	5 Very Fair
4.	1 Very Confusing	2 Somewhat Confusing	3 Undecided	4 Somewhat Understandable	5 Very Understandable
5.	1 Very Dissatisfying	2 Somewhat Dissatisfying	3 Undecided	4 Somewhat Satisfying	5 Very Satisfying

APPENDIX E - MISCELLANEOUS ITEMS

1. The instructor was readily available and accessible when I needed help.

1	2	3	4	5
Disagree Strongly	Disagree	Undecided	Agree	Agree Strongly

2. The feedback to students' questions and concerns was very prompt.

1	2	3	4	5
Disagree Strongly	Disagree	Undecided	Agree	Agree Strongly

3. Overall, I am satisfied with the learning environment, and I would take another class utilizing such environments.

1	2	3	4	5
Disagree Strongly	Disagree	Undecided	Agree	Agree Strongly

4. In this class I was able to learn at my own pace.

1	2	3	4	5
Disagree Strongly	Disagree	Undecided	Agree	Agree Strongly

APPENDIX F - THE SWITCH TO THE CONSTRUCTIVIST MODEL

Comparing the second half to the first half to of the semester...

1. I felt that there was a difference in the teaching method in the second half of the semester.

1	2	3	4	5
Disagree Strongly	Disagree	Undecided	Agree	Agree Strongly

2. I felt that I had to be active and involved ...

1	2	3	4	5
Much more in the first half	Somewhat more in the first half	No difference Between the halves	Somewhat more in the second half	Much more in the second half

3. I was encouraged to think more and to use my imagination to understand the materials...

1	2	3	4	5
Much more in the first half	Somewhat more in the first half	No difference Between the halves	Somewhat more in the second half	Much more in the second half

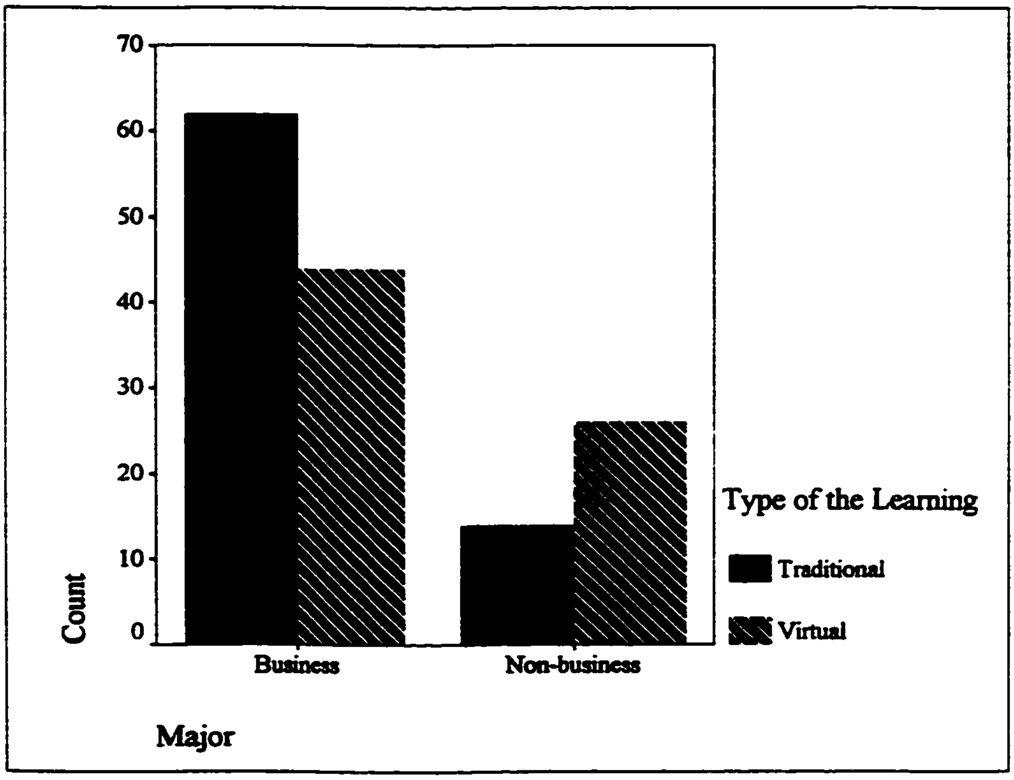
4. I felt that I had to think more about "why" things are done in a certain way...

1	2	3	4	5
Much more in the first half	Somewhat more in the first half	No difference Between the halves	Somewhat more in the second half	Much more in the second half

APPENDIX G - SPSS OUTPUT ON DEMOGRAPHIC INDICATORS

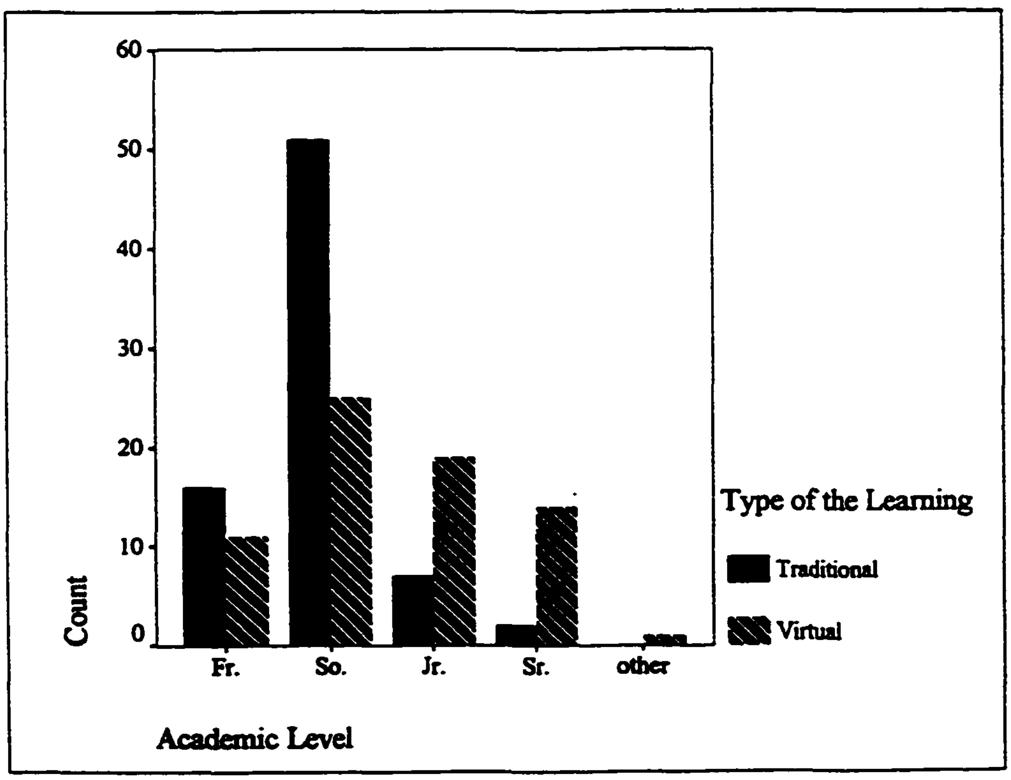
Major * Type of the Learning Environment

			Type of the Learning Environment		
			Traditional	Virtual	Total
Major	Business	Count	62	44	106
		% within Type of the Learning Environment	81.6%	62.9%	72.6%
	Non-business	Count	14	26	40
		% within Type of the Learning Environment	18.4%	37.1%	27.4%
Total		Count	76	70	146
		% within Type of the Learning Environment	100.0%	100.0%	100.0%



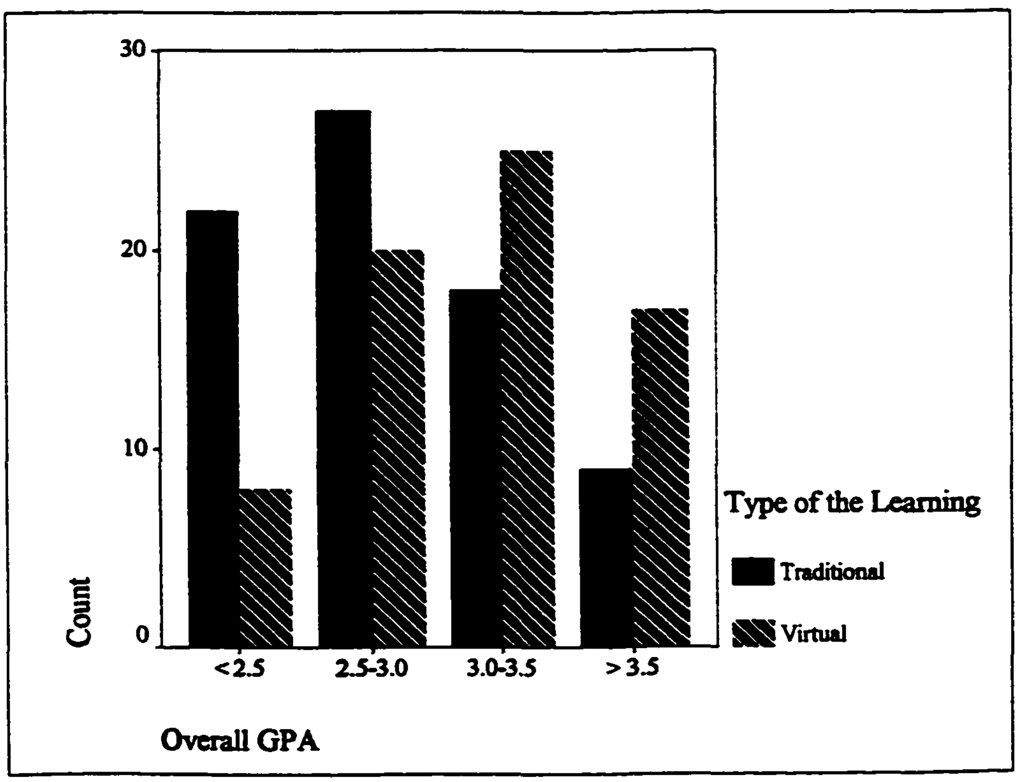
Academic Level * Type of the Learning Environment

			Type of the Learning Environment		
			Traditional	Virtual	Total
Academic Level	Fr.	Count	16	11	27
		% within Type of the Learning Environment	21.1%	15.7%	18.5%
	So.	Count	51	25	76
		% within Type of the Learning Environment	67.1%	35.7%	52.1%
	Jr.	Count	7	19	26
		% within Type of the Learning Environment	9.2%	27.1%	17.8%
	Sr.	Count	2	14	16
		% within Type of the Learning Environment	2.6%	20.0%	11.0%
	other	Count		1	1
		% within Type of the Learning Environment		1.4%	.7%
Total		Count	76	70	146
		% within Type of the Learning Environment	100.0%	100.0%	100.0%



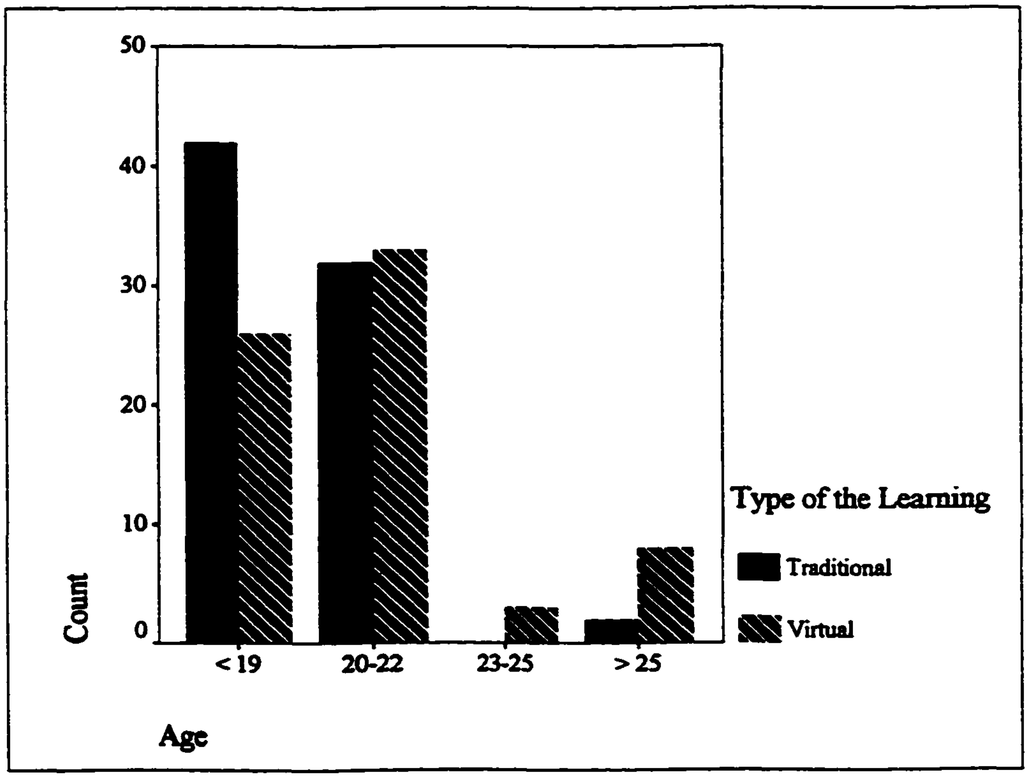
Overall GPA * Type of the Learning Environment

			Type of the Learning Environment		Total
			Traditional	Virtual	
Overall GPA	< 2.5	Count	22	8	30
		% within Type of the Learning Environment	28.9%	11.4%	20.5%
	2.5-3.0	Count	27	20	47
		% within Type of the Learning Environment	35.5%	28.6%	32.2%
	3.0-3.5	Count	18	25	43
		% within Type of the Learning Environment	23.7%	35.7%	29.5%
	> 3.5	Count	9	17	26
		% within Type of the Learning Environment	11.8%	24.3%	17.8%
Total		Count	76	70	146
		% within Type of the Learning Environment	100.0%	100.0%	100.0%



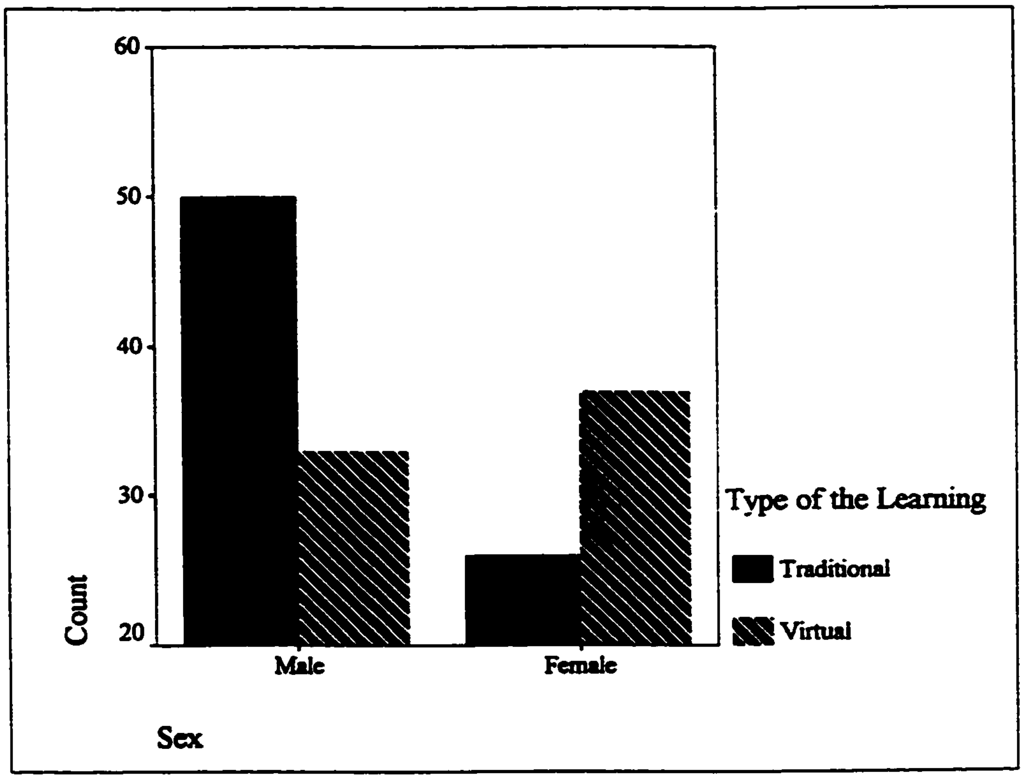
Age * Type of the Learning Environment

			Type of the Learning Environment		
			Traditional	Virtual	Total
Age	< 19	Count	42	26	68
		% within Type of the Learning Environment	55.3%	37.1%	46.6%
	20-22	Count	32	33	65
		% within Type of the Learning Environment	42.1%	47.1%	44.5%
	23-25	Count		3	3
		% within Type of the Learning Environment		4.3%	2.1%
	> 25	Count	2	8	10
		% within Type of the Learning Environment	2.6%	11.4%	6.8%
Total		Count	76	70	146
		% within Type of the Learning Environment	100.0%	100.0%	100.0%



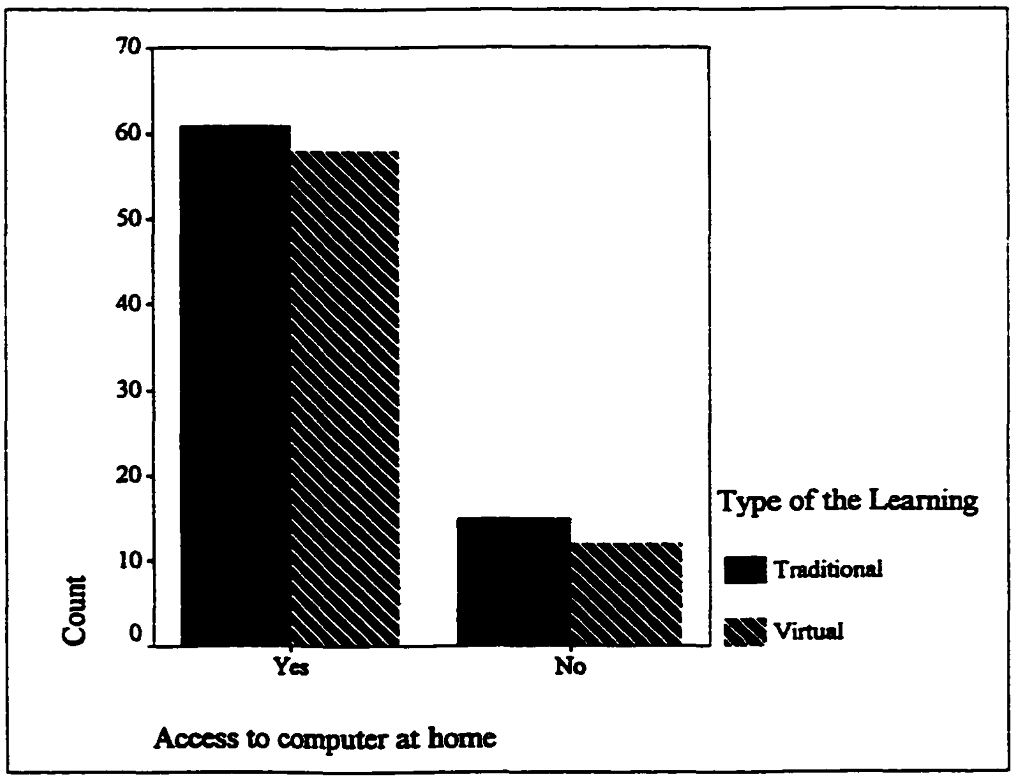
Sex * Type of the Learning Environment

			Type of the Learning Environment		Total
			Traditional	Virtual	
Sex	Male	Count	50	33	83
		% within Type of the Learning Environment	65.8%	47.1%	56.8%
	Female	Count	26	37	63
		% within Type of the Learning Environment	34.2%	52.9%	43.2%
Total		Count	76	70	146
		% within Type of the Learning Environment	100.0%	100.0%	100.0%



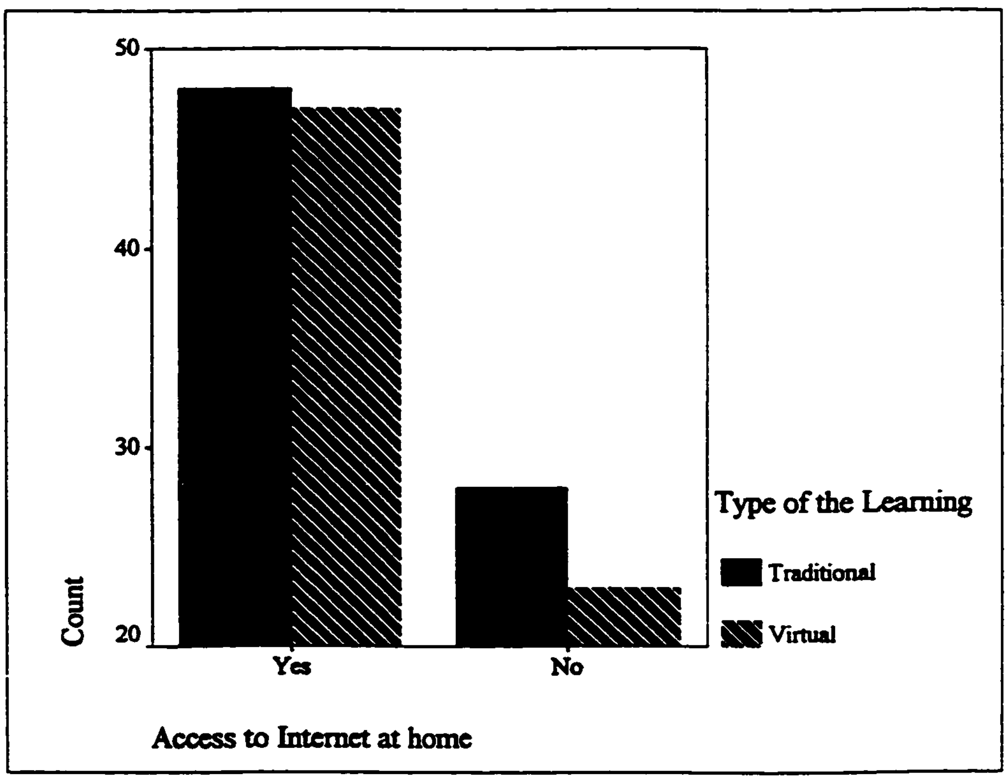
Access to Computer at Home * Learning Environment

			Type of the Learning Environment		
			Traditional	Virtual	Total
Access to computer at home	Yes	Count	61	58	119
		% within Type of the Learning Environment	80.3%	82.9%	81.5%
	No	Count	15	12	27
		% within Type of the Learning Environment	19.7%	17.1%	18.5%
Total		Count	76	70	146
		% within Type of the Learning Environment	100.0%	100.0%	100.0%



Access to the Internet at Home * Learning Environment

			Type of the Learning Environment		
			Traditional	Virtual	Total
Access to Internet at home	Yes	Count	48	47	95
		% within Type of the Learning Environment	63.2%	67.1%	65.1%
	No	Count	28	23	51
		% within Type of the Learning Environment	36.8%	32.9%	34.9%
Total		Count	76	70	146
		% within Type of the Learning Environment	100.0%	100.0%	100.0%



APPENDIX H - SPSS OUTPUT ON DEPENDENT VARIABLES

	Type of the Learning Environment	Mean	N	Std. Deviation
Perfomance-1st half (Objectivist)	Traditonal Environment	82.7105	76	10.8331
	Virtual Environment	84.3143	70	15.2387
	Total	83.4795	146	13.1092
Performance - 2nd half (Constructivist)	Traditonal Environment	76.0658	76	18.4039
	Virtual Environment	80.6857	70	16.2726
	Total	78.2808	146	17.5089
Self-efficacy 1st Half (Objectivist)	Traditonal Environment	6.5276	76	1.6599
	Virtual Environment	7.1529	70	1.7341
	Total	6.8274	146	1.7188
Self-efficacy 2nd Half (Constructivist)	Traditonal Environment	6.5461	76	1.7041
	Virtual Environment	7.1943	70	1.8798
	Total	6.8568	146	1.8136
Satisfaction - 1st Half (Objectivist)	Traditonal Environment	4.0605	76	.6921
	Virtual Environment	3.8696	69	.9987
	Total	3.9697	145	.8542
Satisfaction - 2nd Half (Constuctivist)	Traditonal Environment	3.9711	76	.6339
	Virtual Environment	3.5343	70	.9978
	Total	3.7616	146	.8541

APPENDIX I - SPSS OUTPUT ON BASELINE VARIABLES

ANOVA - on Base Line Items

		Sum of Squares	df	Mean Square	F	Sig.
Previous Experience	Between Groups	1.644	1	1.644	1.981	.161
	Within Groups	119.479	144	.830		
	Total	121.123	145			
Enjoys computers	Between Groups	1.842	1	1.842	1.899	.170
	Within Groups	139.617	144	.970		
	Total	141.459	145			
Threatened by computers	Between Groups	.384	1	.384	.275	.601
	Within Groups	201.239	144	1.397		
	Total	201.623	145			
Expected difficulty	Between Groups	1.954	1	1.954	3.331	.070
	Within Groups	84.484	144	.587		
	Total	86.438	145			
Learning Expectaitons	Between Groups	1.854E-02	1	1.85E-02	.029	.866
	Within Groups	93.523	144	.649		
	Total	93.541	145			
Word - knowledge	Between Groups	.671	1	.671	.506	.478
	Within Groups	190.836	144	1.325		
	Total	191.507	145			
Power Point - knowledge	Between Groups	1.006	1	1.006	1.127	.290
	Within Groups	128.501	144	.892		
	Total	129.507	145			
Excel - kowledge	Between Groups	11.883	1	11.883	9.973	.002
	Within Groups	171.576	144	1.192		
	Total	183.459	145			
Access - knowledge	Between Groups	6.119E-02	1	6.12E-02	.073	.787
	Within Groups	120.494	144	.837		
	Total	120.555	145			
Pre treatment quiz	Between Groups	.617	1	.617	.167	.683
	Within Groups	530.507	144	3.684		
	Total	531.123	145			

Descriptives on Base Line Items

		N	Mean	Std. Deviation	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Previous Experience	Virtual	70	3.36	.90	3.14	3.57
	Traditional	76	3.14	.92	2.93	3.35
	Total	146	3.25	.91	3.10	3.40
Enjoys computers	Virtual	70	4.01	.99	3.78	4.25
	Traditional	76	3.79	.98	3.56	4.01
	Total	146	3.90	.99	3.74	4.06
Threatened by computers	Virtual	70	2.20	1.20	1.91	2.49
	Traditional	76	2.30	1.17	2.04	2.57
	Total	146	2.25	1.18	2.06	2.45
Expected difficulty	Virtual	70	2.40	.86	2.20	2.60
	Traditional	76	2.63	.67	2.48	2.78
	Total	146	2.52	.77	2.39	2.65
Learning Expectaitons	Virtual	70	4.21	.83	4.02	4.41
	Traditional	76	4.24	.78	4.06	4.42
	Total	146	4.23	.80	4.09	4.36
Word - knowledge	Virtual	70	3.39	1.16	3.11	3.66
	Traditional	76	3.25	1.14	2.99	3.51
	Total	146	3.32	1.15	3.13	3.50
Power Point - knowledge	Virtual	70	1.77	.98	1.54	2.01
	Traditional	76	1.61	.91	1.40	1.81
	Total	146	1.68	.95	1.53	1.84
Excel - kowledge	Virtual	70	2.40	1.26	2.10	2.70
	Traditional	76	1.83	.91	1.62	2.04
	Total	146	2.10	1.12	1.92	2.29
Access - knowledge	Virtual	70	1.69	.91	1.47	1.90
	Traditional	76	1.64	.92	1.43	1.85
	Total	146	1.66	.91	1.52	1.81
Pre treatment quiz	Virtual	70	6.3143	2.0680	5.8212	6.8074
	Traditional	76	6.1842	1.7717	5.7794	6.5891
	Total	146	6.2466	1.9139	5.9335	6.5596

APPENDIX J - TESTING THE UNDERLYING ASSUMPTIONS

Extremes

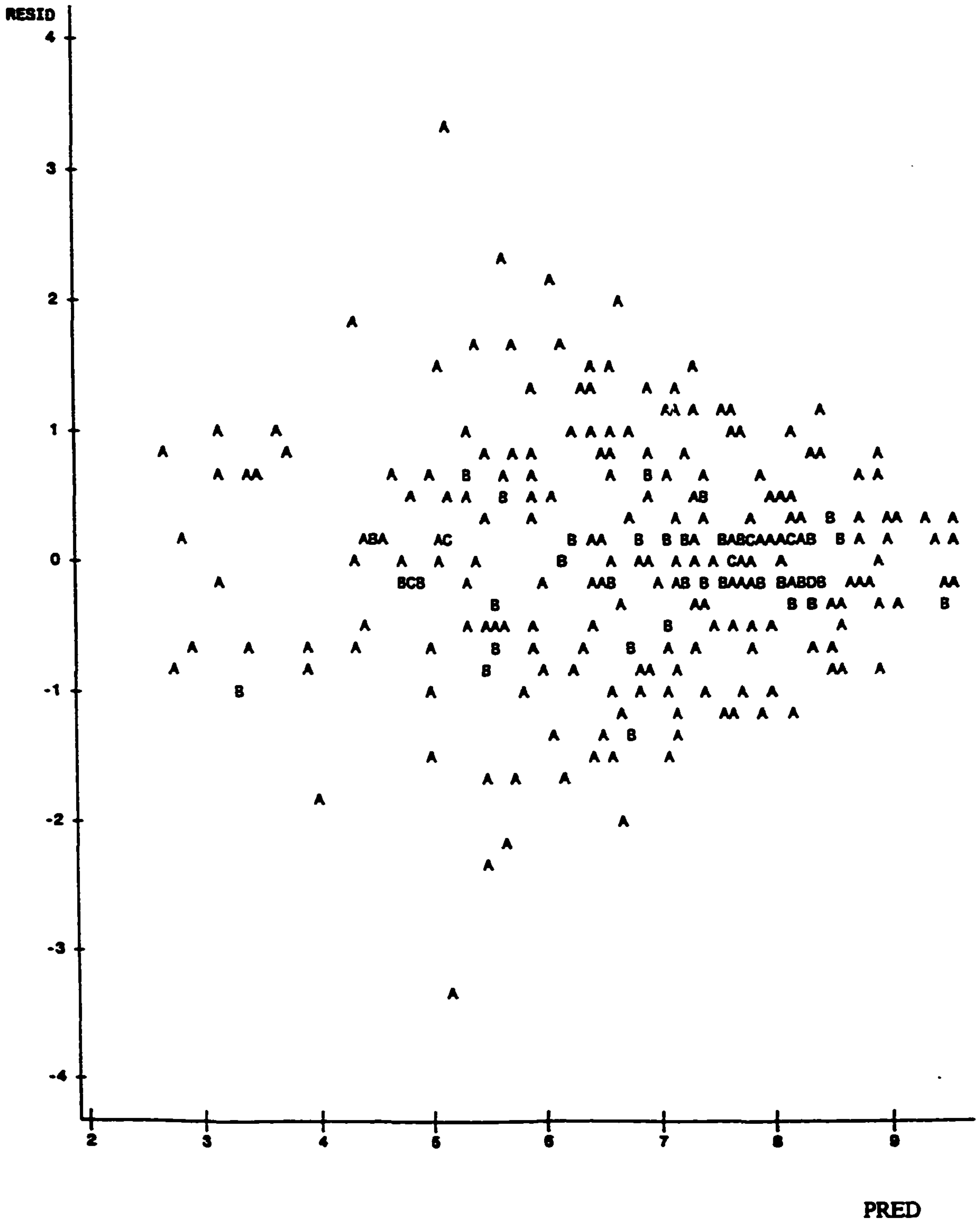
Lowest	Obs	Highest	Obs
-3.33889(	213)	1.808333(	84)
-2.33485(	19)	1.961111(	183)
-2.10441(	134)	2.104412(	280)
-1.96111(	37)	2.334848(	165)
-1.80833(	230)	3.338889(	67)

```
                         Histogram                          #              Boxplot
  3.25+*                                                    1                 *
      .
      .*                                                    2                 0
      .****                                                 7                 0
      .********                                            16                 |
      .**********************                              44                 |
      .***************************************             77              +--+--+
      .**************************************              76              +-----+
      .**********************                              43                 |
      .********                                            16                 |
      .****                                                 7                 0
      .*                                                    2                 0
      .
 -3.25+*                                                    1                 *
       ----+----+----+----+----+----+----+----
       * may represent up to 2 counts
```

Variable=RESID

```
                          Normal Probability Plot
  3.25+                                                       *
      |
      |                                                      **
      |                                                 *****++
      |                                            +*****
      |                                      *******
      |                               ********
      |                        ********
      |                  *******
      |            *****+
      |  ++*****
      |**
      |
 -3.25+*
       +----+----+----+----+----+----+----+----+----+----+
           -2        -1         0        +1        +2
```

Plot of RESID*PRED. Legend: A = 1 obs, B = 2 obs, etc.



APPENDIX K - SPSS OUTPUT ON REPEATED MEASURE MANOVA

Multivariate Tests[b]

Effect			Value	F	Error df	Sig.
Between Subjects	Intercept	Pillai's Trace	.982	2592.027[a]	139.000	.000
		Wilks' Lambda	.018	2592.027[a]	139.000	.000
		Hotelling's Trace	55.943	2592.027[a]	139.000	.000
		Roy's Largest Root	55.943	2592.027[a]	139.000	.000
	TYPE	Pillai's Trace	.152	8.281[a]	139.000	.000
		Wilks' Lambda	.848	8.281[a]	139.000	.000
		Hotelling's Trace	.179	8.281[a]	139.000	.000
		Roy's Largest Root	.179	8.281[a]	139.000	.000
	TEACHER	Pillai's Trace	.072	3.590[a]	139.000	.015
		Wilks' Lambda	.928	3.590[a]	139.000	.015
		Hotelling's Trace	.077	3.590[a]	139.000	.015
		Roy's Largest Root	.077	3.590[a]	139.000	.015
	TYPE * TEACHER	Pillai's Trace	.008	.397[a]	139.000	.755
		Wilks' Lambda	.992	.397[a]	139.000	.755
		Hotelling's Trace	.009	.397[a]	139.000	.755
		Roy's Largest Root	.009	.397[a]	139.000	.755
Within Subjects	LMODEL	Pillai's Trace	.183	10.372[a]	139.000	.000
		Wilks' Lambda	.817	10.372[a]	139.000	.000
		Hotelling's Trace	.224	10.372[a]	139.000	.000
		Roy's Largest Root	.224	10.372[a]	139.000	.000
	LMODEL * TYPE	Pillai's Trace	.028	1.326[a]	139.000	.269
		Wilks' Lambda	.972	1.326[a]	139.000	.269
		Hotelling's Trace	.029	1.326[a]	139.000	.269
		Roy's Largest Root	.029	1.326[a]	139.000	.269
	LMODEL * TEACHER	Pillai's Trace	.013	.603[a]	139.000	.614
		Wilks' Lambda	.987	.603[a]	139.000	.614
		Hotelling's Trace	.013	.603[a]	139.000	.614
		Roy's Largest Root	.013	.603[a]	139.000	.614
	LMODEL * TYPE * TEACHER	Pillai's Trace	.046	2.254[a]	139.000	.085
		Wilks' Lambda	.954	2.254[a]	139.000	.085
		Hotelling's Trace	.049	2.254[a]	139.000	.085
		Roy's Largest Root	.049	2.254[a]	139.000	.085

a. Exact statistic

b.

Design: Intercept+TYPE+TEACHER+TYPE * TEACHER
Within Subjects Design: LMODEL

Multivariate Test of Within-Subjects Effects[b,c]

Within Subjects Effect		Value	F	Hypothesis df	Error df	Sig.
LMODEL	Pillai's Trace	.183	10.372[a]	3.000	139.0	.000
	Wilks' Lambda	.817	10.372[a]	3.000	139.0	.000
	Hotelling's Trace	.224	10.372[a]	3.000	139.0	.000
	Roy's Largest Root	.224	10.372[a]	3.000	139.0	.000
LMODEL * TYPE	Pillai's Trace	.028	1.326[a]	3.000	139.0	.269
	Wilks' Lambda	.972	1.326[a]	3.000	139.0	.269
	Hotelling's Trace	.029	1.326[a]	3.000	139.0	.269
	Roy's Largest Root	.029	1.326[a]	3.000	139.0	.269
LMODEL * TEACHER	Pillai's Trace	.013	.603[a]	3.000	139.0	.614
	Wilks' Lambda	.987	.603[a]	3.000	139.0	.614
	Hotelling's Trace	.013	.603[a]	3.000	139.0	.614
	Roy's Largest Root	.013	.603[a]	3.000	139.0	.614
LMODEL * TYPE * TEACHER	Pillai's Trace	.046	2.254[a]	3.000	139.0	.085
	Wilks' Lambda	.954	2.254[a]	3.000	139.0	.085
	Hotelling's Trace	.049	2.254[a]	3.000	139.0	.085
	Roy's Largest Root	.049	2.254[a]	3.000	139.0	.085

a. Exact statistic

b.
Design: Intercept+TYPE+TEACHER+TYPE * TEACHER
Within Subjects Design: LMODEL

c. *Tests are based on averaged variables.*

Univariate Tests of Within-Subjects Contrasts

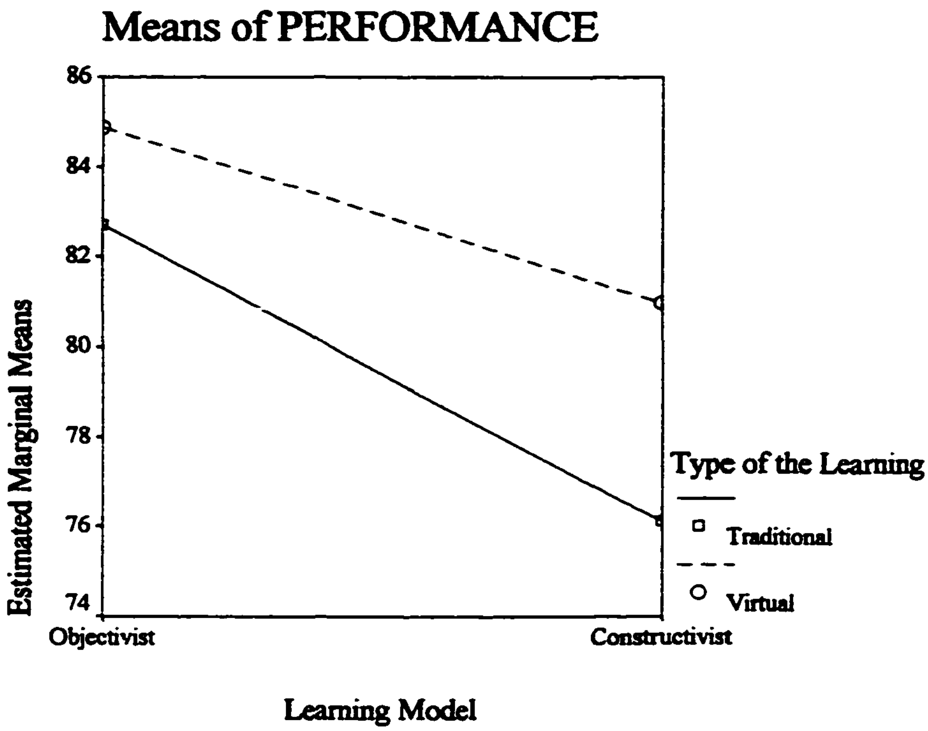
Source	Measure	LMODEL	Type III Sum of Squares	df	Mean Square	F	Sig.
LMODEL	PERFORM	Linear	1981.095	1	1981.09	17.69	.000
	SELF	Linear	.209	1	.209	.157	.692
	SATISFAC	Linear	2.807	1	2.807	7.693	.006
LMODEL * TYPE	PERFORM	Linear	127.780	1	127.780	1.141	.287
	SELF	Linear	2.538E-07	1	2.5E-07	.000	1.000
	SATISFAC	Linear	1.084	1	1.084	2.972	.087
LMODEL * TEACHER	PERFORM	Linear	49.914	1	49.914	.446	.506
	SELF	Linear	1.224	1	1.224	.920	.339
	SATISFAC	Linear	9.825E-03	1	9.8E-03	.027	.870
LMODEL * TYPE * TEACHER	PERFORM	Linear	144.252	1	144.252	1.288	.258
	SELF	Linear	3.073	1	3.073	2.310	.131
	SATISFAC	Linear	1.643	1	1.643	4.502	.036
Error(LMODEL)	PERFORM	Linear	15794.083	141	112.015		
	SELF	Linear	187.519	141	1.330		
	SATISFAC	Linear	51.450	141	.365		

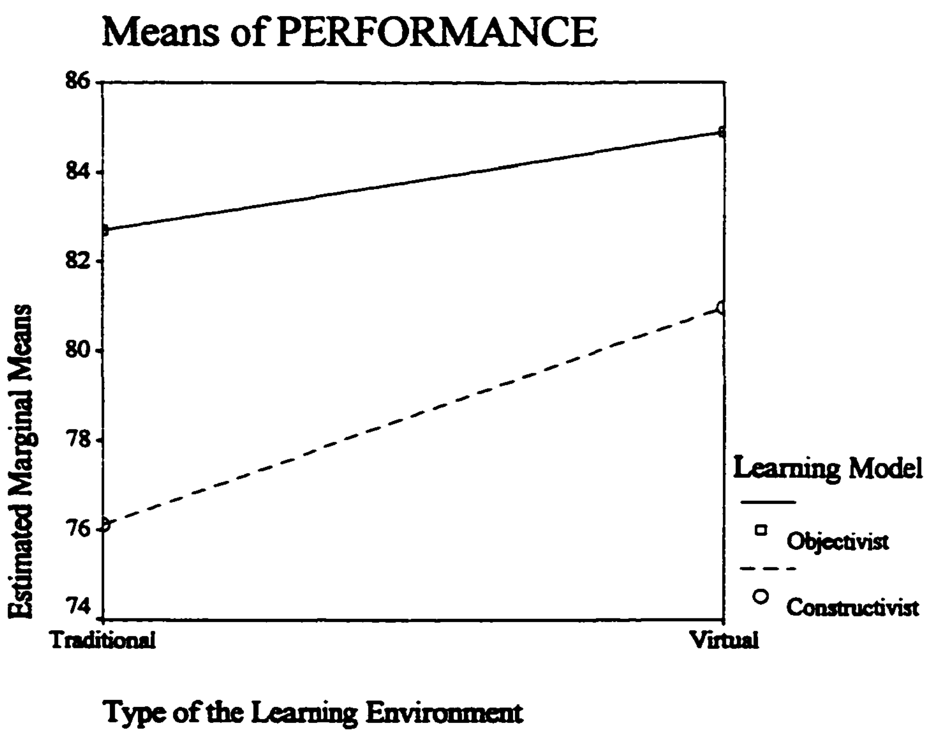
Univariate Tests of Between-Subjects Effects

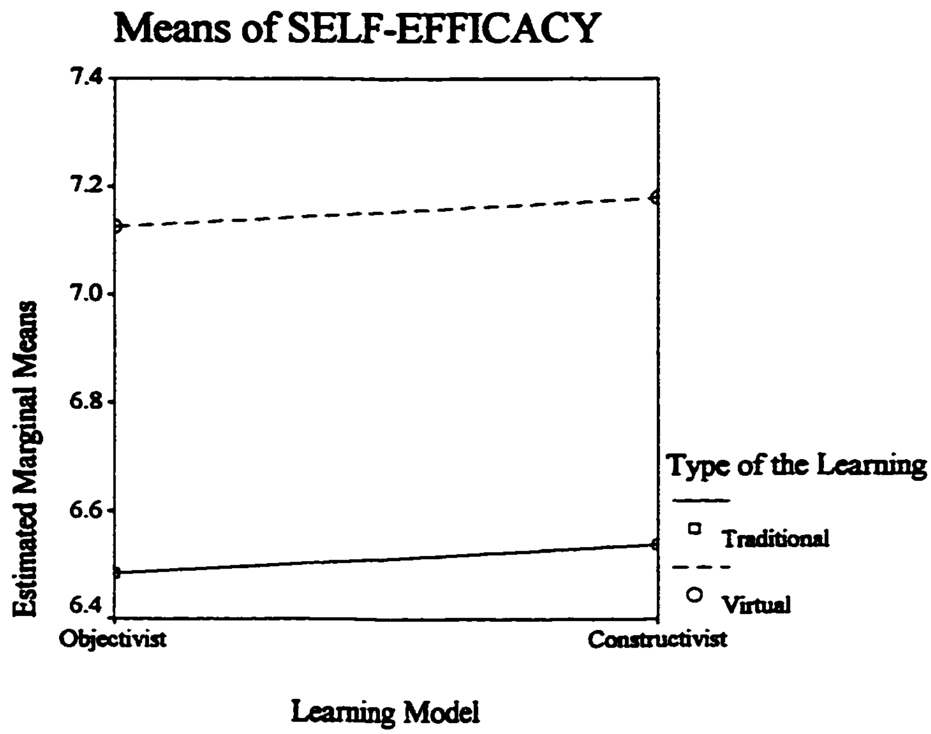
Transformed Variable: Average

Source	Measure	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	PERFORM	1894667.55	1	1894667.55	5309.24	.000
	SELF	13420.779	1	13420.779	2860.31	.000
	SATISFAC	4281.187	1	4281.187	4347.19	.000
TYPE	PERFORM	891.072	1	891.072	2.497	.116
	SELF	29.509	1	29.509	6.289	.013
	SATISFAC	5.865	1	5.865	5.955	.016
TEACHER	PERFORM	2.365	1	2.365	.007	.935
	SELF	13.366	1	13.366	2.849	.094
	SATISFAC	9.814	1	9.814	9.965	.002
TYPE * TEACHER	PERFORM	11.131	1	11.131	.031	.860
	SELF	.130	1	.130	.028	.868
	SATISFAC	.740	1	.740	.751	.388
Error	PERFORM	50317.541	141	356.862		
	SELF	661.582	141	4.692		
	SATISFAC	138.859	141	.985		

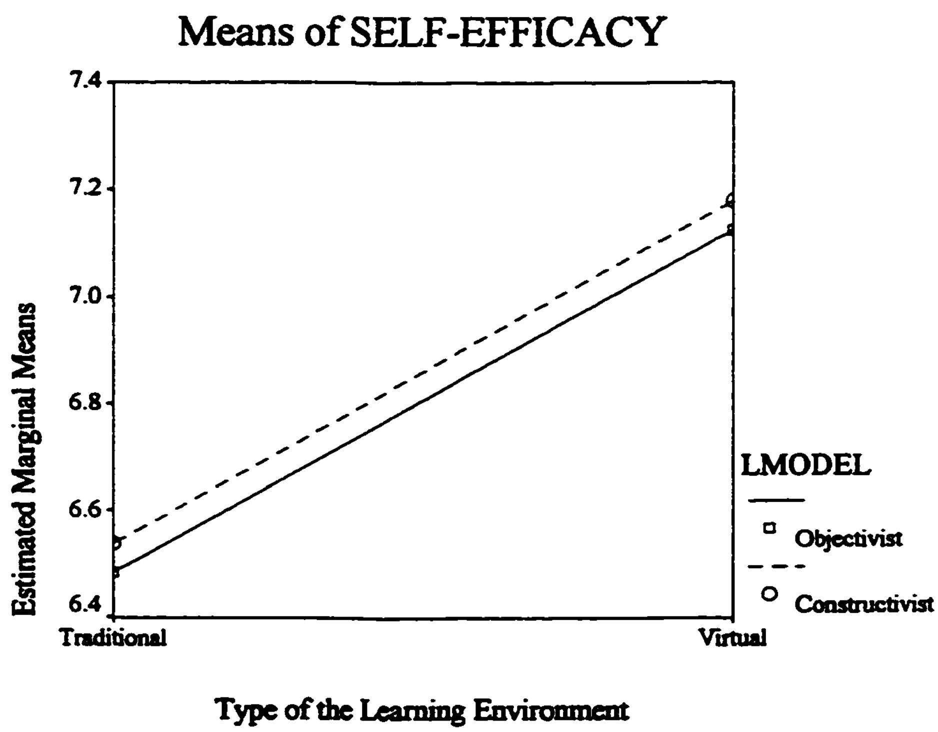
APPENDIX L - PROFILE PLOTS



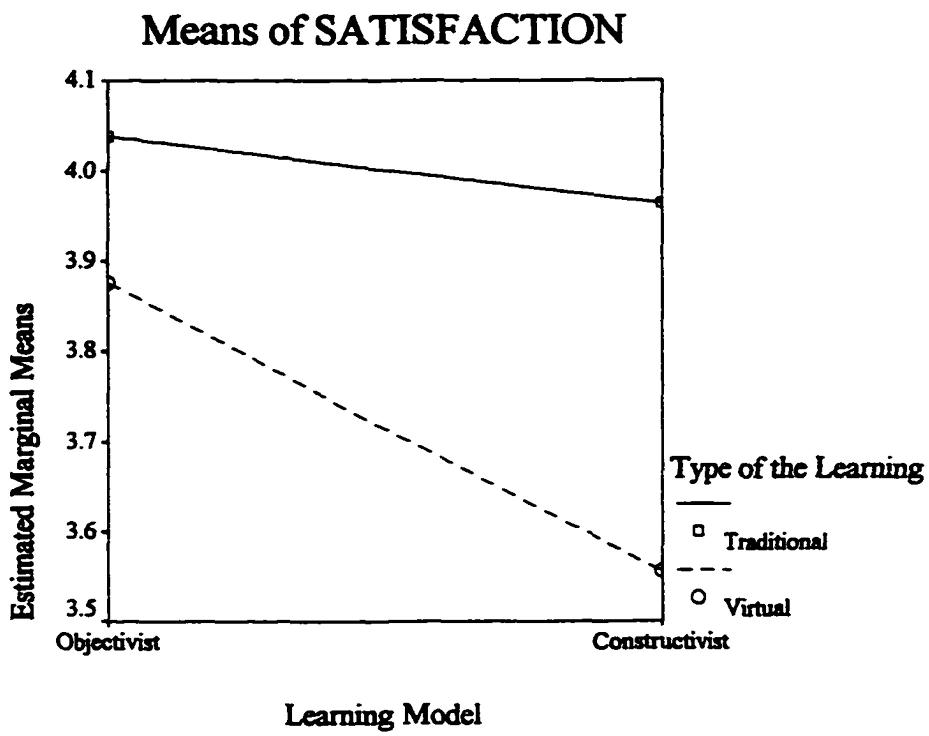


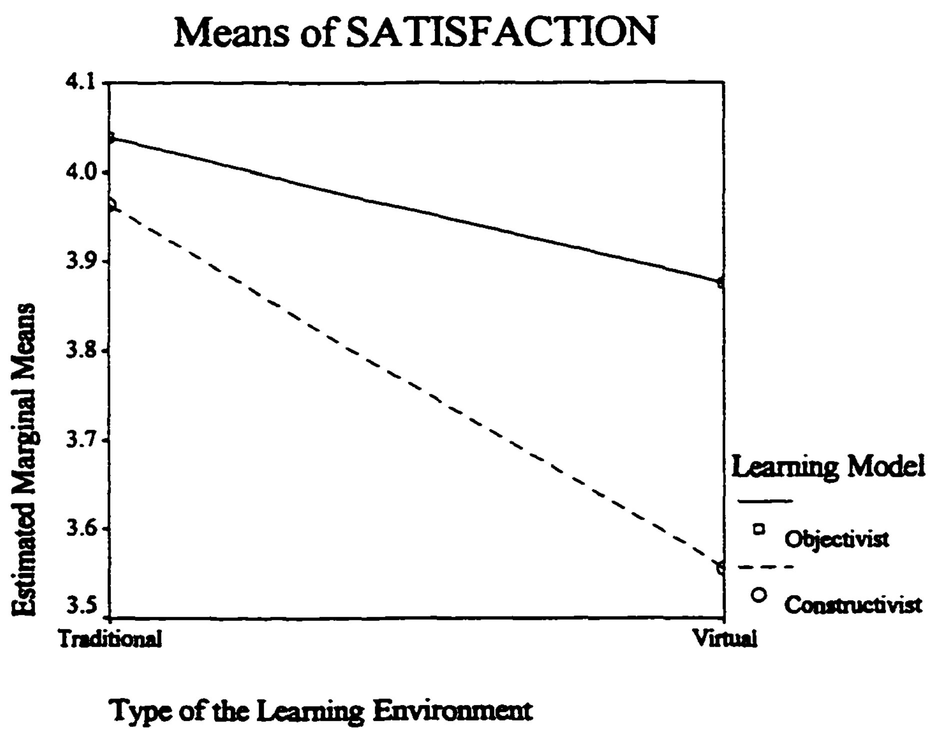


Means of SELF-EFFICACY
7.4
7.2
7.0
6.8
6.6
6.4
Estimated Marginal Means
Objectivist
Constructivist
Learning Model
Type of the Learning
Traditional
Virtual



Means of SELF-EFFICACY
7.4
7.2
7.0
6.8
6.6
6.4
Estimated Marginal Means
Traditional
Virtual
Type of the Learning Environment
LMODEL
Objectivist
Constructivist


Means of SATISFACTION
4.1
4.0
3.9
3.8
3.7
3.6
3.5
Estimated Marginal Means
Objectivist
Constructivist
Learning Model
Type of the Learning
Traditional
Virtual


Means of SATISFACTION
4.1
4.0
3.9
3.8
3.7
3.6
3.5
Estimated Marginal Means
Traditional
Virtual
Type of the Learning Environment
Learning Model
Objectivist
Constructivist

APPENDIX M - SURVEY ON REASONS FOR DROPPING THE CLASS

Appendix- Why Dropped?

To help us improve the quality of this class, we would appreciate your help by answering the following questions. It will only take a minute. Be assured that the information you provide will remain strictly confidential and will not affect you in any way.

I dropped ISDS 1100 because of the following:
(You can check one or more)

___ The virtual learning environment is inconvenient.
___ I can't learn without meeting the instructor face to face.
___ The class is very time consuming.
___ The class requires a lot of computer skills
___ The material is difficult.
___ The class did not have clear procedures.
___ I simply hate computers.
___ I did not like the instructor.
___ Personal Reasons.

Comments:

____
____
____
____
____
____

APPENDIX N - SELECTION OF STUDENTS COMMENTS

Section-V1- Virtual

#45 I was extremely happy with this of class. My job really cuts into the amount of time I can spend with schoolwork. This class allowed me t do my work on and Sundays nights for example. I feel like I learned more in this class than in any other this semester.

#49 It was a great environment to learn in when the internet systems were working properly. It became very frustrating when it was moving slow.

#50 This class was surprisingly difficult for me. I have no computer at home and it was very limiting in the amount of time I was able to spend in the lab. I had to commute to get to school anyway.

Section-V2- Virtual

#3 : If you don't have your own computer at home with the right software, don't take this class.

#4: I really liked the structure of this class because it was at your own pace. So you could projects that needed to be done. Everyone was really great in the discussion area.

#5: Very pleased with this environment and I would take a class similar to this if given the opportunity.

#6: I feel that I would learn the material better if it was "forced" on me by having actual class. I think you ought to have one class per week and use the Internet for the rest of the week.

#8: I think the class isn't a good idea. The tutorials do not show hands-on stuff like a class does. I hated it basically: servers would go down, and I never felt it was convenient to have to wait for a reply on the internet while trying to do a project. I'd rather go to class than struggle like I did.

Section-T1-Traditioanl

#3 sometimes it was hard to learn things sitting in the classroom without hand on the computer (not enough lab time)

#5 I was aggravated when I sometimes didn't know how to do something and he said "just play around with it and figure it out on your own"

#19 Hard to catch on when just when just watching the instructor in the classroom - better when it was in the lab.

Section-T2-Traditional

#16 I feel that I probably could have done this class over the net with a book. Towards the end of the semester I stopped coming to class because it was easier for me to teach myself. However, I did learn a lot from this class!

#27 Need more computers. The lab helpers were clueless when it comes to helping

#41 The instructor was a good teacher, but he went very fast.

VITA

Rami Ahmad has a diversified background in education, work experience and research interests. Before working towards his doctoral degree in Business Administration (Information Systems), he earned a master's degree (1991) in Systems Sciences and a bachelor's degree (1987) in Electrical Engineering, with a major in Computer Engineering and a minor in Computer Science.

Rami worked as a systems analyst for the Louisiana Department of Transportation, and as a sales representative for a software development and marketing company. He also managed his own business as a franchise Chevron dealer. In 1993, he joined a multinational development bank in Saudi Arabia as an information systems officer, and later as a project officer in the Operations and Projects Department in the same organization. He participated in the appraisal and follow-up of many projects in several developing countries until 1997.

Currently, he is conducting research in the area of virtual environments, as a research associate affiliated with the Center for Virtual Organization and Commerce, and serving as an instructor in the Information Systems Department at Louisiana State University. He is generally interested in studying the impact of Information Technology on people's lives on the individual, organizational and societal level. Furthermore, he is interested in investigating the potential benefits of Information Technology in building human resources and improving the quality of life in developing countries. He will receive the degree of Doctor of Philosophy in May 1999.

DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Rami Ahmad

Major Field: Business Administration
(Information Systems and Decision Sciences)

Title of Dissertation: Effectiveness Of Web-Based Virtual Learning Environments In Business Education: Focusing On Basic Skills Training For Information Technology

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

Dec 18, 1998

IMAGE EVALUATION TEST TARGET (QA-3)

150mm

6"

APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989