1-1-2005

Educational technology : learning in a computer-mediated environment.

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EDUCATIONAL TECHNOLOGY: LEARNING IN A COMPUTER-MEDIATED ENVIRONMENT

A Dissertation Presented

by

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Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

DOCTOR OF EDUCATION

September 2005

Education

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ABSTRACT

EDUCATIONAL TECHNOLOGY: LEARNING IN A COMPUTER-MEDIATED ENVIRONMENT

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This study investigates the impact of online versus pen and paper homework on college students' learning and performance, and explores their experiences in each modality. After familiarizing students with two different homework modalities, students' decision to work in the online versus the traditional environment was utilized as the student preference indicator. Students' gender and computer comfort levels were also recorded. Although differences were found on the computer comfort levels of male and female students, there were no significant differences on learning outcomes. The findings suggest that students can learn equally well in either modality, regardless of their preference, gender or computer comfort

level. In the attempt to better understand their experiences, students were asked to describe and compare their learning in both modalities. According to the students, instant feedback was the most valuable feature. They enjoyed working with computers; it helped them stay interested and motivated. They mentioned, however, that they learn better writing down on paper rather than typing on a computer keyboard.

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OVERVIEW OF THE STUDY

1.1 Introduction: Educational Technology

For the last 25 years, the use of computers in education has increased dramatically. Today, at the beginning of a new millennium, technology is emerging as a defining educational resource. The average computer per student ratio continues to increase while the effectiveness of computers for learning still is questioned and uncertain (Tozoglu and Varank, 2001). "Without question, technology has become a pervasive part of the campus environment and college experience," observes Kenneth C. Green, director of the Campus Computing Project and a visiting scholar at the Center for Educational Studies at the Claremont Graduate University in California. Students of all ages and across all fields come to campus expecting to learn about and with technology (Green, 2000). This research study is an investigation of the way students learn with technology, paying particular attention not only to the learning outcomes achieved by students when learning with computers but also to the individual student's experience during the learning process.

During the 1990's, the debate surrounding the function of computers in education became more heated. Technology was being espoused as the new trend in education. In 1982, for example, "Time" magazine declared the personal computer its "man of the year", and included a special section entitled "Here Come the Microkids" on how children were learning with computers. As Besser, 1993, notes, "The primary argument given for instituting computer literacy requirements is the 'good citizen' one -- that in order to be a productive member of society, one must know about computers" (p. 63). This argument was largely accepted. During the 1990's, computers were introduced in astonishing numbers throughout universities, elementary schools, and in every academic institution. At that moment in time, little was said about the way computers would affect learning practices.

The consequences of this massive institutionalization of computers are multifaceted, complex and still under investigation. During recent years, students and instructors have started to explore and implement new computer applications; in a non-

systematic manner they discovered and applied computers for educational purposes. Reflecting the enormous amount of interest and concern, numerous research studies were conducted and Educational Technology materialized as a new field. While many different and contradictory opinions on the benefits of computers for learning were forthcoming, the presence of computers on campuses continues to increase and transform the educational setting. They have spread all over campus, from libraries to student dorms and college community cafés. An article published in the Chronicle of Higher Education Old Computers Never Die--They Just Cost Colleges Money in New Ways (Scott, 2003), shows how expensive it is not only to purchase, support and maintain computers but also to dispose of them.

Without a doubt, computers have affected the means and modes of communication. The new technologies have not only transformed the way students communicate with faculty -- e-mail is the most frequent means of communication between faculty and students (Green, 2000) -- but also the way in which information is created, reviewed, distributed and stored --as of today, the number of e-journals ranges from 3,000 to 4,000;

librarians are concerned with digital repositories and database access (Friedlander and Bessette, 2003).

During the last twenty years, although not without resistance and opposition, many educators have incorporated computers into their teaching practices and online institutions flourished. These "early adopters", who enthusiastically believed computers could enhance educational experiences, integrated technology and used them to adapt their teaching into a more student-centered teaching approach (Diem, 1996). They also opened the doors to higher education for non-traditional students who could now go to college online while keeping their family obligations. The growing acceptance received by students and faculty, prompted many research studies to examine the benefits of computers for learning. In his book, "No Significant Difference Phenomenon," Thomas Russell (2004) catalogs more than 300 studies, dissertations and technical reports that show no significant difference in student learning outcomes between face-to-face and technology-mediated instruction.

The largest part of these studies focused on the validation of computer-mediated learning for non-

traditional students. The purpose has been to demonstrate that online off-campus students could achieve the same outcomes achieved by on campus students. Once legitimatized, the investigation of learning technology has shifted from measuring learning outcomes, to the understanding of the cognition process and the emergence of new pedagogical models (Young, 2004). This study belongs to the second shift on the research. It explores the ways students learn with technology, paying special attention not only to outcomes but the learning process.

1.2 Scope and Rationale: Learning Styles

Repeatedly, it has been proclaimed that technology would revolutionize learning by its capacity to respond to the individual learner's style (Geisert, 1990). Learning style theory development has been delayed by the controversy over the benefits of matching instruction and style. The disagreement on the benefits of matching teaching style with learning style has generated thousands of articles on both sides of the argument (Robotham,1999); and even when some reach agreement, there is no consensus on the approaches and methods by which instruction should match style (Curry, 1990).

After decades of research and theories, there is today no clear understanding of the functions of learning style or the way instruction should respond to them.

The literature on the connections between learning styles and technology is fragile, ambiguous and confusing. The limited number of existing research focuses on the effects of matching and/or mismatching learning styles with technology (Cordell, 1991; Larsen, 1992; Ester, 1995) even though the learning style literature itself has not yet reached consensus on the benefits of matching instruction and style (Letteri 1980; Shapiro 1996; Ramirez 1982; Schmeck 1991; Lamarche-Bisson, 2002).

This study goes beyond this controversy and explores how learning occurs in the new technology-mediated environment. It investigates students' ability to learn with computers. The study takes advantage of the contributions made by learning style theorists during the last three decades with respect to the cognitive process, but it does not concentrate on the identification of and matching of styles.

While there are many factors that account for a successful learning experience with computers, such as access, computer competence, etc; little research explores and describes how students adapt, cope and learn utilizing the technology that has already infiltrated their college campus.

1.3 Purpose of the Study

In preparation for the research, a pilot project had been conducted. Last year different technologies were implemented in similar classes and students' responses toward each technology investigated. The main finding of the pilot project was students' capacity to adapt to the technologies proposed. Even when students reported themselves to be uncomfortable with a technology, they overcame that frustration and successfully completed tasks and assignments.

Differently from the pilot study that explores the benefits and drawbacks of different educational technologies, this research focuses on the use of one technology; online testing activities for homework. This technology, online homework, has been selected because

its focus is on the learning process. Homework seems to be the more personal learning activity, and the one less influenced by the instructor's teaching style. It is during homework when students internalize the material covered in lectures and assigned in readings, thus deepening learning.

This research investigates the impact and relationship of online homework versus traditional, pen and paper homework on students' learning the material as measure by performance. The subjects of this study are Springfield College undergraduate students enrolled in a required Spanish language course during the fall 2004 semester. The groups under study are two elementary Spanish classes, section 12 and 14.

The main research questions are:

- To what degree do the characteristics of the students who prefer online versus traditional homework affect learning? Are there differences based in gender, or computer comfort level?

- To what degree do learning modalities affect student learning outcomes?

1.4 Significance of the Study

Technology has become an essential building block in our society, therefore deeper analysis and understanding of how students learn and interact with computer technology is required. Today most banking activities can be conducted purely online; it is possible to schedule a flight, rent a car, buy a house, and to even elect a president online. Likewise, educational technology has become ubiquitous and relentless in higher education. Thus, it is essential that educators embark on the investigation of how learning occurs in this new computer-mediated environment. Carefully controlled experimental techniques and rigorous statistical analyses are necessary.

Our understanding of the learning process is limited although new research is constantly under development. Brain research, for example, provides a foundation for understanding how learning takes place in the brain, its physical nature and limitations. Neuroscientists have shown that the adult brain remains flexible and capable of a remarkable amount of change and development(Frith,

2000). They have demonstrated that its plasticity depends on how the brain is used, the more the brain is used, the better it works (Frith, 2000). This suggests that challenging learners to develop new learning styles and to adapt to new educational environments should benefit students' mental development. This research intends to verify that challenging students to interact, cope and learn with computers is positive and appropriate for students' development.

Technology mediated environments challenge many learners because they introduce new and unknown elements, therefore many educators are opposed its implementation. This study sheds light on how educational technology can enhance learning and better prepare students for a society where technology is a requirement for success. By providing a better understanding of how learning occurs in a computer-mediated environment, this research can benefit both students and educators.

This research is important for those educators who, aware of the challenges technology poses to many of their students, reject the use of computers as valid instructional tools. Today, small businesses to large

corporations rely heavily upon the use of instructional technology to train and advance their employees. Therefore the integration of technology becomes crucial for their success. E-learning is becoming a standard for career advancement at all levels of the work force. It is imperative for higher education institutions to prepare graduates to meet those rigorous corporate demands.

1.5 Overview of the Study

Chapter one has provided the overview of the study. The significance of the study is discussed along with the research questions and the hypotheses.

Chapter two describes the conceptual framework and literature appropriate to this study. The relationship between learning styles and educational technology is detailed. These concepts are described and discussed with respect to their linkage to the research.

Chapter three illustrates the research design and research methods employed in this research. Detail of the design is provided. An overview of the research

venue is detailed. This chapter also contains the limitations of the study, the ethical considerations, and the trustworthiness of the components.

Chapter four focuses on analysis. The data analysis methods are articulated. Student experiences are described. Quantitative and qualitative data is analyzed in the framework of the literature.

Chapter five summarizes the findings and describes insights into the problem. This chapter introduces the major conclusions and implications for practice. Possible future research studies are suggested.

CHAPTER 2

LITERATURE REVIEW

2.1 Educational Technology: a New Reality

Computer technologies have become an essential component of our society. College educators cannot overlook the importance of preparing students to interact, learn and work with computers in our highly technological world.

The problem: the average computer per student ratio continues to increase while the effectiveness of computers for learning is still questioned and uncertain (Tozoglu and Varank, 2001).

In an article published in Educational Week, Larry Cuban (1999) says: "In other organizations (like hospitals, banks, supermarkets), computer use is ubiquitous. Not so in schools." Even though faculty use computers to conduct personal business, to communicate with friends, to search the internet, etc.; it is uncommon to find faculty drawing upon computers for teaching. Many researchers have looked at this phenomenon and attempted several possible explanations. The lack of faculty interest results from::

lack of training, incentive, leadership, time, technophobia, and so on; that, according to the literature, could be remediated with an increase in institutional support (Cuban, 1999; Sax, 2000; Spodark, 2003).

There are, however, some educators that encourage the integration of computers for student learning. These educators believe computers have the potential to increase students' learning by providing new ways of thinking and reasoning (Bolter, 1991; Landow, 1992). Contrarily, those who see computers as a negative influence, argue that students spend too much time working in isolation, mindlessly clicking and surfing, collecting bits of information, with minimal understanding of the relationship between the pieces (Armstrong & Casement, 2000; Healy, 1998; Stoll, 2000).

Despite the intensity and popularity of this debate, there are few data describing students' learning experiences in a computer-mediated environment and how learning takes place (Cuban, 2001). Very few studies demonstrate that students learn the concepts and skills that are presented in computer programs (Fletcher-Flinn & Gravatt, 1995; Forness, Kavale, Blum, & Lloyd, 1997;

Gillam, Crofford, Gale, & Hoffman, 2001). There is an urgent need to develop, diversify, and expand our understanding of how students learn from and with computers (Westby and Atencio, 2002).

Most of the literature has been focused on validating computer-mediated learning. "The No Significant Difference Phenomenon" website, is a compendium of more than 355 comparative research studies that show that students in technology-based (typically, distance learning) courses learn as well as their on-campus, face-to-face counterparts (Russell, 2004). These studies have typically been used by technology advocates to defend the quality and validity of their technological innovations against the predominant view that learning takes place only in a physical classroom (Twigg, 2001). The purpose of the research was to demonstrate that online students could achieve the same outcomes achieved by traditional students but it did not go beyond this controversy. There is a lack of research and understanding of how computers affect learning and how it differs, for example, from learning in a human-mediated class.

A deeper analysis of how students learn and interact with computer technologies is necessary and it is the main goal of this study. In 1996, 79% of 4th graders, 91% of 8th graders, and 96 % of 11th graders reported using a computer to write stories or papers (NCES, 1998). These 1990's computer users are today's college students. Today's educators must be able to use technology in their teaching if they want to help students develop the knowledge and skills they will need to become functioning members of their society (Westby, Stevens-Domingues, & Oetter, 1996).

2.2 Computers and Learning

Each person has a unique learning style, a unique way of approaching a learning situation, a particular rhythm for processing and organizing new information. The purpose of learning style (LS) research is to identify these different ways of perceiving and interpreting information, and to use this knowledge to adjust educational environments to make them more efficient and successful.

Learning styles theory could potentially help researchers and educators investigate the specific value of

technology for learning. Cognitive and learning styles could be used to study what kind of instructional strategies or methods would be most effective for a given individual and learning task in a particular environment. Technology offers a new set of visual, auditory, and interactive elements that can be used to adjust educational environments to the needs of each learning style.

Neuroscience research can also offer insights about the learning process. Unfortunately, despite the remarkable progress it made in the health sciences, neuroscience research, like learning style theory, has not yet formalized its application in educational practice (Frith, 2000). With the incorporation of technology, neuroscientists have achieved a better understanding of the brain functions. The integration of technology has enabled them to discover more about how the human brain works. Thanks to these new discoveries, and the dialogue that it opened between educators, psychologists and neurologists, the educational experiences of thousand of students has improved. It is worth mentioning, for example, the success achieved by students with attention-deficit/hyperactivity disorder, a long neglected group. Thanks to the advances in neuroscience, students are improving their focus to task,

self-control, and reaction time (The AD/HD Project, 2005). Financed mostly by the pharmaceutical companies; educators have been able to participate in the advances made by neuroscientists. Today educators have greater information about this disorder and its different possible interventions.

2.2.1 Possible Advantages

Computer technology makes it possible to match learning materials with the learning style of the learner. One of the advantages of using computer technology to adapt to different learning styles is that it is ready all the time; available whenever the student is active. It is versatile in that it perfectly responds to individual chrono-biological highs and lows (Geisert & Dunn, 1990). Learners can access learning materials, revise or modify information whenever they need. Classroom dialogue extends beyond the time and space constraints of class time in new "asynchronic" environment.

Computer technology can satisfy students who prefer learning more collaboratively by offering alternative ways of communication. It has the capacity to develop list-serves where students can safely ask questions to peers, or

experts, or to gather for cooperative learning activities. Electronic mail can extend discussions beyond the classroom; and bulletin boards, for instance, can be used to adjust the dialogue speed so students of different linguistic skills can follow and participate (O'Connor, 1997).

Computer technology can be designed to monitor performance, store responses, give feedback, and conduct assessments. It can be adapted for self-paced learning and tailor-made for individual instruction. If programmed appropriately, it can offer audio material to the auditory learner, images to the visual learner, and menus and interaction to the tactile learner (Geisert & Dunn, 1990). If programmed appropriately, information can be accessed globally by global learners, in steps by sequential learners, inductively, deductively, or intuitively. It can simultaneously offer "guided sequential learning for one set of students and discovery-based exploration and browsing for another" and a range of options for students who prefer a mix of styles (Jones et al. 1997, p. 10). Bates & Leary (2001) offer an example of how such systems can be developed by proposing a design taxonomy to build software to target multiple learning styles simultaneously.

In an interesting paper, Montgomery (1992) identifies the ways in which technology can be used to address the needs of different learning styles, especially those typically overlooked by traditional teaching methods. She notes, for example, that active processor learners, in opposition to reflective processors learners, often have a short attention span if they are not actively participating. For these learners the discovery of information is very important. They learn by experiencing situations more than by passively receiving information in lectures. "Sound, direct manipulation of interface objects (such as menus, tools, or instructional screens), visualisation of processes and dynamic video images" are some of the features that can be used to enhance the learning opportunities for today's students (Brickell, 1993, p. 103).

2.2.2 Possible Disadvantages

Research reports have shown that not every student can benefit from instructional technology. Friend and Cole (1990) postulated that sensing-thinking learners respond more favorably than intuitive-feeling learners because these learners require more human interaction. Enochs et

al. (1985) found that concrete learners achieved desired learning outcomes better than abstract learners. In his article on educational computing, Pritchard (1982) claims that instructional technology does not support all learning styles equally; further he explains, individuals with an affinity for accuracy and attending to detail, and who have a preference to work alone, learn from computers more easily than others.

Hoffman and Waters (1982) stated that instructional technology is suited best for learners who "… have the ability to quietly concentrate, are able to pay attention to details, have an affinity for memorizing facts, and can stay with a single track until completion" (p.48). Dun and Dun (1979) asserted that learners who are motivated, sequential, and enjoy feedback generally do well with technology but, kinesthetic, peer oriented learners may not adequately engage with the material.

Gregorc (1985) points out that the use of technology may systematically discriminate against certain learners, just as the lecture format, best suited for Abstract Sequential learners, discriminates against the other styles. According to Gregorc (1985), sequential learners

enjoy instructional technology because it is seen as an extension of the sequential mind. Random learners require environments that are flexible and provide opportunities for multidimensional thinking (Butler, 1984).

It has been argued that instructional technology can help instructors to meet the need of more styles (Schelechter, 1991). While there have been advances in intelligent tutoring and adaptive interfaces that adjust and respond to learners' input, highly interactive systems are very expensive thus limiting their production and development (Ellis, 2001). Regrettably, the majority of available educational software, developed by faculty with non-technological skills or by technologists with non-teaching experience, is weak and inadequate.

2.3 A New Educational Environment: Computer-Mediated Learning

The most original element introduced by technology is interactivity, the interaction between the learner and the information presented (Song, 2002). Dewey already recognized that "effective interaction" between the teaching environment and the learner would improve learning (Greeno, 1997). Despite many years of research, it still

is unknown what makes an interaction effective (Alexander, Kulikowich and Jetton, 1994; Lawless and Kulikovich, 1998).

The two problems identified by research on the effectiveness of technology are linked to interaction. First, students cannot develop complex learning skills in computer-mediated environments because they inadequately monitor the level of their own learning (Butler and Winner, 1995). Students tend to persist using rudimentary learning skills that are inadequate for more complex learning tasks (Jacobson and Shapiro, 1995). Second, the science of instructional technology design is just beginning to be developed; therefore there is a lack of empirical data guiding effective ways of presenting information, and ways of triggering and responding to students' input (Ayersman and von Minden, 1995).

2.3.1 Immediate Feedback

The capacity to provide immediate feedback is the most important contribution made by technology for student learning. Computer generated instant feedback has been incorporated into multiple choice tests with ease. Since World War I, the use of multiple choice tests significantly increased (Mislevy, 1991). Educators found that these

tests were easier to score, were reliable, minimized subjectivity, and could be returned at the next class meeting as opposed to essay examinations that require substantial amount of time, energy, and attention to score, including subjectivity in scoring and variation in the quality and quantity of feedback (Epstein et al., 2002).

With the advent of technology, multiple choice systems are widely used. Multiple choice tests, however, can not be thought of as an innovation brought by technology but the inclusion of instant feedback. Computerized test banks have made it easier to create and manage a bigger number of tests while providing immediate feedback. They have become an excellent support tool by enabling students to review particularly challenging areas. By providing students the amount of practice time they need, the valued class time can be dedicated for clarifying and discussing difficult topics (Woit and Mason, 2000; Tunc and Armstead, 2001; Kaczmarczyk, 2001: Thelwall, 1988; Sly, 1999; Roberts, 2000).

Multiple choice questioning has not been totally accepted as a valid assessment methodology, both for reasons of academic acceptance and also with respect to

their unfairness towards gender and certain sections of society (Childs, 1990). Differences have been consistently found in the performance of different groups in multiple choice tests (male- female, Latino-Asian-Black students, etc.). Due to a variety of factors, certain groups perform consistently lower; however, there is not adjustments made to most of the available multiple choice tests. Recent studies have demonstrated that multiple choice tests that do not provide corrective feedback do not facilitate learning nor retention (Epstein et al., 2002). Although, in many circumstances, essay examinations are more appropriate, due to the ease of creation and management, computerized multiple choice tests will continue to increase in higher education.

Much of the discussion around alternative testing turns around learning style theory. Currently, most of the assessment of learning is aimed toward the logical-mathematical intelligence as specified in "Multiple Intelligences" (Gardner, 1993). The question that begs to be answered is "why do we continue to assess students in long ago established forms when there is a greater understanding of learning styles and new possibilities enhanced by technology that extend our ability to

adequately assess students?" (Granger and McGarry, 2002, p 8).

Hamalainen, Whinston, and Vishik (1996) and Robin and McNeil (1997) warn that technology alone will not make learning more effective if developers continue to re-implement traditional classroom practices. This study does not defend nor condemn multiple choice tests. Rather it attempts to unveil an important contribution made by technology, one of which is the capacity to provide instant feedback.

2.3.2 Interactivity and Design

In a study conducted by Ricketts and Wilks (2002) the importance of instructional design is revealed. They reported that a change of the computer interface, the way information is presented to students, has significant influence on students' performance. In an effort to ensure that all learners can benefit from instructional technology, many researchers suggest that information on how learners adapt to the new technological environment must guide the design of instructional media (Chiann-Ru Song, 2002).

In educational technology the interaction between learner and content is addressed by design. In an interesting article, Weiss, et. Al. (2002) speak about principles for using design in computer-based instruction. They argue that beyond the physical production, the designer must consider other significant attributes. Pictures, text, and animation can have a cosmetic function when used to make instruction attractive to learners. They can provide a concrete reference and a visual context for ideas (Spivey-Knowlton and Bridgeman, 1993). It may not add new information, but it could clarify the accompanying text and help learners to better grasp the relationship between ideas. Design can also improve retention of information due to the link between static and dynamic visuals (Weiss et al., 2002).

Design can guide learning in different directions. It can improve instruction by providing step-by-step models as well as non-linear guidelines for students' potential learning styles (Knowlton and Morisson, 2002). It can organize instruction so that the learners can experience the various stages of learning at their own pace. When an activity requires problem-solving techniques, as many games do, the design can lead students through the process of

critical thinking and other different cognitive stages. The potential of computers to guide learning and to provide feedback according to the learner's input could enhance education by requiring the learner to improve and expand their learning styles (Tennyson and Breuer, 2002).

Despite advances in computer technology, the development of effective instructional technology prototypes did not produce many noteworthy theories and/or results (Chan et al., 2001). However, we can expect this to change. In the United States., every family, every classroom and almost anyone will soon be able to afford a computer in some form; and learning is one of its main applications. Businesses are also implementing technology for their training needs. The reduction in travel costs, saving in personnel time, the increased capacity of delivering the same consistent program, and the flexibility to meet specific needs (just-in-time training for specific needs) are some of the reasons for its rapid development (Janicki, 2003). Cummings (2001) projected that by the year 2004 corporations will have spent $14.5 billion on various forms of e-learning.

2.4 Summary

In summary, the literature on educational technology focused first on validating technology, comparing outcomes achieved by traditional and online students. Once legitimized as a valid educational modality, the interest shifted to the learning process. Researchers began to investigate how technology affects learning. The major theory used in their investigation has been the learning style theory. Unfortunately, they applied the learning style models developed from traditional settings without adjusting them to the new technology mediated environment and its new agents; interactivity, immediate feedback and design.

CHAPTER 3

RESEARCH DESIGN AND RESEARCH METHODS

3.1 Overall Approach and Rationale

This chapter provides detailed information on the implementation of the research. This study seeks to investigate the impact of educational technology for learning upon two classes taught to undergraduate students at a small private four-year college in Western Massachusetts during fall 2004. The model adopted for the research is the mixed methods design; quantitative and qualitative approaches will be implemented to collect and analyze data.

Historically, two main underlying epistemological assumptions about the nature of scientific knowledge have separated social researchers into quantitative and qualitative sides. Under the assumption that the social element is independent and "constant across time and settings", quantitative researchers develop knowledge by collecting and analyzing numerical data. Conversely, qualitative researchers believe that the social element is "transitory and situational". For qualitative researchers the social environment is "constructed" and interpreted by individuals. Therefore, they

develop knowledge by collecting verbal data from the participants (Gall et. al. 1996, p.28).

Both research methodologies have their specific strengths and applications. Used in conjunction they do not contradict but complement each other. While qualitative research is best used to discover themes and relations, quantitative research validates those themes and relations (Gall et. al., 1996). This research was designed not only to explore and describe the learning experiences of the students under study, it also sought to validate students' experiences by measuring the impact of technology upon learning. Therefore a mixed method approach is well suited for this particular study.

Qualitative data was collected through student interviews and surveys. Students were assigned different homework modalities, pen and paper and/or computer, alternatively throughout the semester. Homework modality, along with the corresponding test scores and modality preference were then analyzed based on a variety of factors. The convenient position of the instructor-researcher relative to the student-participants allowed for a non-obtrusive gathering of data. The goal then, was to identify and describe the learning process as

experienced by the students. Students were asked to describe and compare their experiences when using each modality.

3.2 Learning Styles as a Framework of Analysis

This study is designed to investigate how students learn with technology. Even when the researcher's assumption is that every student has a unique and particular learning style, the study did not implement a learning style instrument. The main reason for this decision being that no one instrument has been able to reliably and accurately measure learner's preferred or dominant style (DeBello, 1990). Peter Honey, a psychologist that co-authored with Alan Mumford "The Manual of Learning Styles" (Peter Honey Publications, 1992) and the "Learning Style Questionnaire" (LSQ), the most utilized instrument, states that the trouble in measuring style resides in the fact that style is a mixture of internal preferences and external behaviors, hard to identify and measure accurately (Delahoussaye, 2002). Another important reason for the exclusion of learning style instruments from this research is that all the available instruments measure learner's styles in the traditional classroom, without integrating the effects of the new computer-mediated environment this study attempts to explore.

Instead of implementing learning styles instruments to measure students' style, the study identified one major indicator of preference. Students' decision to work in the online versus the traditional environment was used as the student preference indicator. During the semester, students sequentially completed a series of online and traditional homework assignments. In the middle of the semester, when every student had already experienced both modalities, they were asked to complete homework in their preferred modality. Students' selection for online versus paper homework defined their preferred homework modality as the variable of interest for this study.

3.3 Research Participants

The participants were students enrolled in two particular Spanish classes: Elementary Spanish section 12 and section 14. Each class was divided into two groups, A and B. Students were randomly assigned to one of the groups. Data were collected on every student registered; however, students who chose not to participate in the study, older students, drop outs, etc. were identified and withheld from the analysis.

The two classes were taught at a small private college in New England. The age of the participants ranged from 18-21. The gender and diversity representation was based on enrollment. The students' academic majors differed in the groups; some students majored in business, exercise science, computer sciences; some students had not yet chosen a major. It is important to mention, however, that because the college does not offer it, none of the students majored in Spanish. For all of them Spanish was one of the academic requirement for graduation, not a career choice.

The participants were a reasonably homogeneous group. The college currently has an undergraduate and graduate student body of approximately 5,000 students. The undergraduate student population is mostly white; with few international or students of color. Because the college is the birthplace of basketball and has a strong commitment to sports, the students are often athletes and major in some sort of exercise science. The college attracts students mostly from New England. The majority of them live on campus but travel home for holidays and long weekends. Even though there is an intense campus life, students appear to keep their connections off-campus with family and friends.

The required book for the class, selected by the department chair, was Imágenes. It includes a paper workbook with homework activities and an access code[1] to the online homework website. The online homework activities were an exact match of the paper activities. Online multiple-choice, matching, fill in the blanks, and crossword puzzles were graded by the computer and only monitored by the instructor when requested by the student. It is important to mention that the computer interface allowed students to request instructor control if they believed the grade given by the computer was conflicting. Only in a few instances students made use of this feature. Usually, as a result of a technical problem, a computer crash, or a bad network connection, students were locked out of the system in the middle of an activity. They requested to the instructor to overwrite grades assigned by the computer and/or reset the activity for new submission. The instructor graded all other activities: open-ended questions, tests and exams. Tests were developed to be as similar as possible to homework activities and, in all cases, they were graded by the instructor.

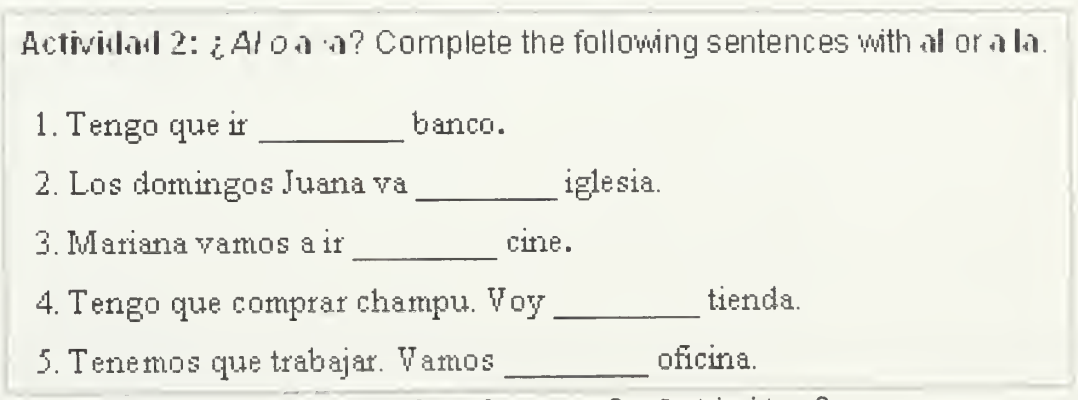
Each class met three times a week for fifty minutes during the fourteen week semester for a total of 42 contact hours. One

[1] The publisher, Houghton Mifflin, provided 50 access codes at no cost for this study.

of the weekly classes took place at the language lab. The language lab has an interconnected system of 16 computers. It provided an excellent environment where students and the instructor were able to become familiar with the technology and troubleshoot problems. At the end of each chapter students completed a test, similar in design to the homework activities.

3.4 Materials

The workbook activities are designed to help students learn the chapter material. The Listening section is keyed to the recordings on the Audio Program cassette. Activities are grouped by chapters; at the end of each chapter, students submit all the activities to the instructor for correction.


Actividad 2: ¿*Al o a la*? Complete the following sentences with **al** or **a la**.

1. Tengo que ir _____ banco.
2. Los domingos Juana va _____ iglesia.
3. Mariana vamos a ir _____ cine.
4. Tengo que comprar champu. Voy _____ tienda.
5. Tenemos que trabajar. Vamos _____ oficina.

Figure 3.1 Workbook: Chapter 3, Activity 2

The online workbook is the interactive version of the Activities Manual. Activities fundamentally similar in content are transformed through web technology to provide a better interface design and feedback.

The first screen prepares students to start the activity. It reminds students that abandoning an activity without completion will result in an "incomplete." The intention is to focus student attention.

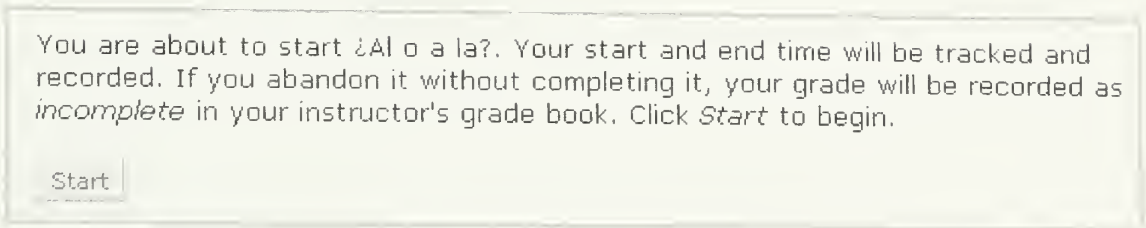


Figure 3.2 Online: Chapter 3, Activity 2, screen 1

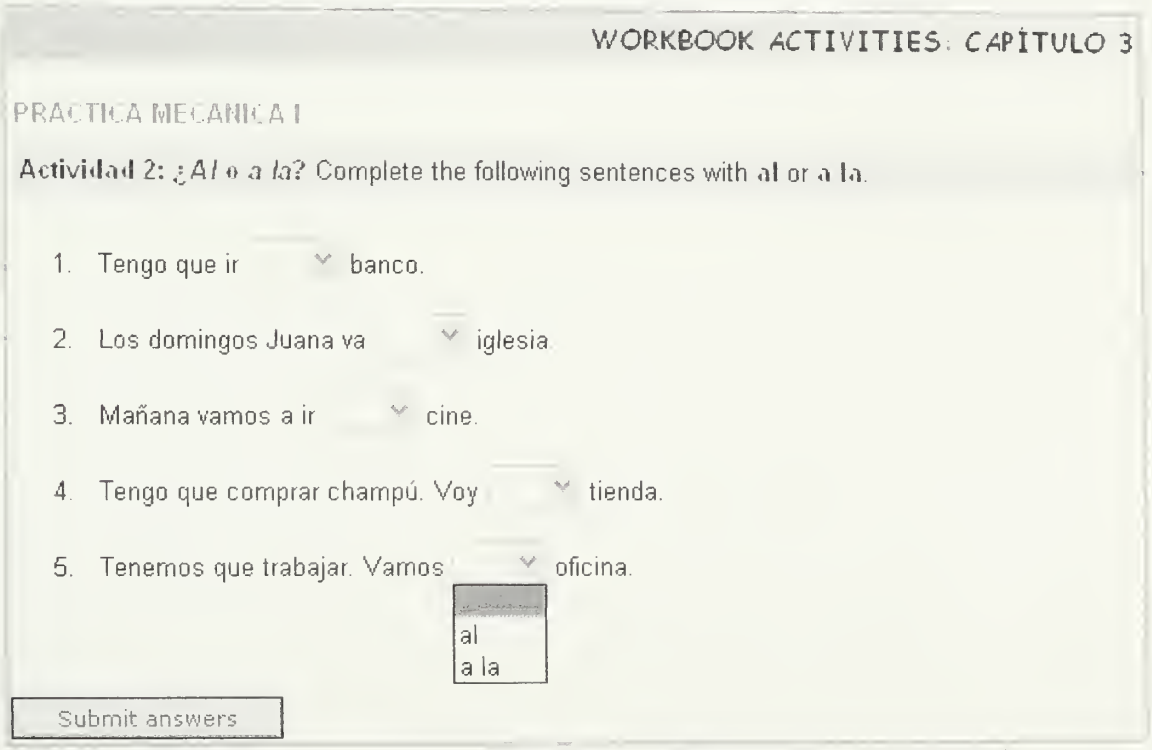


Figure 3.3 Online: Chapter 3, Activity 2, screen 2

The second screen presents the activity. In this particular case, the fill-in the blanks workbook activity has been enhanced with a pop-up menu that presents students with the only two possible answers: "al" or "a la."

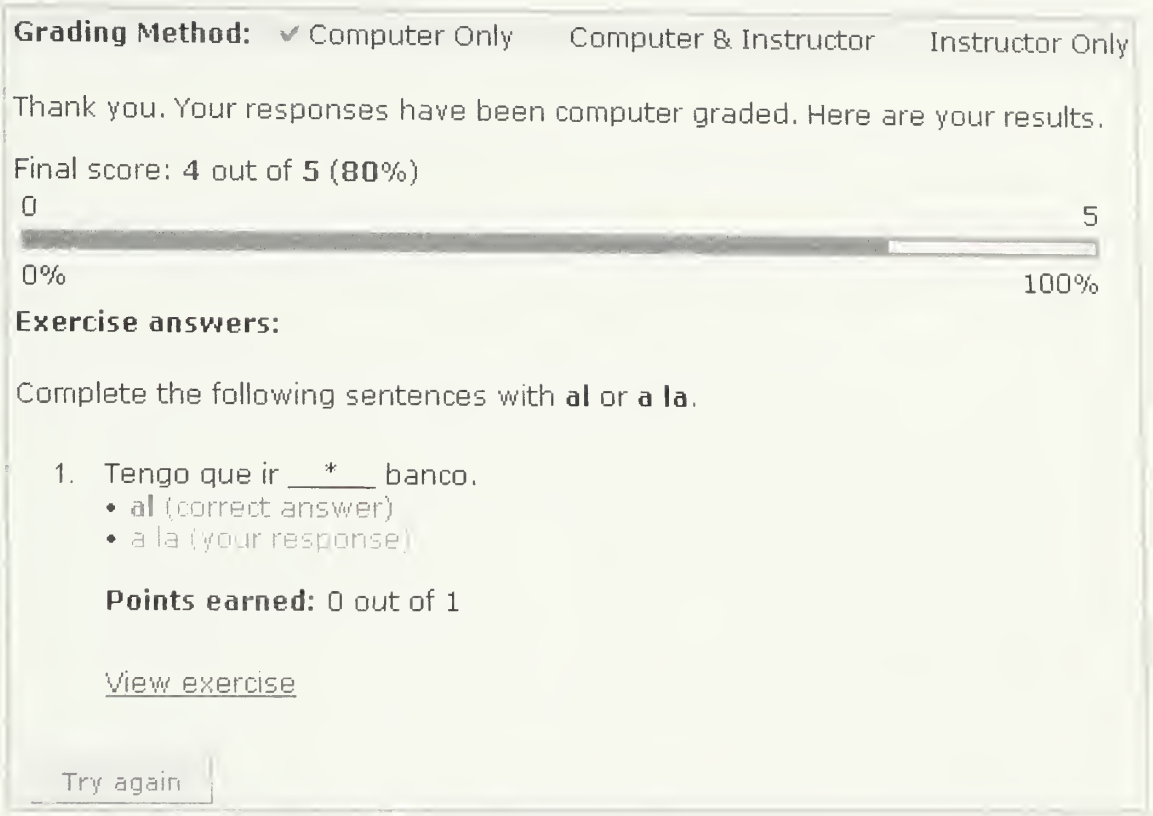


Figure 3.4 Online: Chapter 3, Activity 2, screen 3

The third screen provides the feedback. First, it presents information to students about the activity grading method (computer only - computer & instructor - instructor only). Then, it provides the overall score and detailed information on the correct or incorrect student response. It offers students to resubmit the activity "try again" up to three times.

3.5 Data Collection and Analysis

Standardized tests and questionnaires were used to collect quantifiable data. The first day of class, participants completed a background questionnaire that gathered bio-data and

information regarding their confidence with computer technology[2]. Gender and computer comfort level, as reported by students, were incorporated as factors for analysis. Section 12 had 15 students; section 14 had 26 students, each with roughly an even number of males and females. Each student had an email account and access to a computer and the Internet. Access was provided both through the library and/or campus housing. The participants were reasonably proficient in basic word processing and Internet-related skills, thus, caution must be utilized in generalizing the results.

Students were asked to describe and compare their experiences when using computers and traditional methods in an open-ended questionnaire through a discussion board. The college has a course management system that includes an anonymous discussion module. The discussion module was implemented instead of the post-office module to collect the data. Similar to email, it offers a simple and familiar way for students to post and read messages while preserving the author's anonymity. The data collected was analyzed qualitatively. The emergence of patterns or themes in their descriptions elucidated the analysis.

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[2] The questionnaire can be found in Appendix A.

During the semester, students sequentially completed a series of online and traditional homework assignments as described in the following homework modality chart.

Table 3.1: Homework Modality

Classes	Group	Chapter 1	Chapter 2	Chapter 3	Chapter 4	Chapter 5
Section 12	A	Online	Paper	Choice	Online	Paper
	B	Paper	Online		Paper	Online
Section 14	A	Online	Paper		Online	Paper
	B	Paper	Online		Paper	Online

The researcher compared mean test scores of the groups A and B to measure the effectiveness of each modality (online required, online preferred, traditional required, traditional preferred) for students (grouped by gender and comfort level). Multiple comparison procedures were conducted using independent-sample t-tests to determine which groups were significantly different. All the statistical tests utilized are in the classical statistical domain, and are broadly used across the social sciences including education. The Statistical Package for the Social Sciences (SPSS) version 13 program was used for the computational process.

3.6 Role of the Investigator

While the role of the instructor is of an educator whose first responsibility is to design and adjust instruction in

order to provide students with a successful educational experience, the role of the researcher is to deepen our understanding of the learning process. In this particular study, the investigator also happens to be the instructor. This dual role of instructor-researcher provides an exceptional advantage. The value of the available online activities could not be determined without an investigation of its impact on student learning. Therefore, as an instructor, taking the risk of experimenting with the new technology and challenging students to learn outside traditional methods, is in alignment with the researcher role. The instructor-researcher aimed to capture the impact of online homework for learning in order to make an informed decision about the best homework modality for the future. Can traditional homework be safely replaced by online activities?

3.7 Ethical Considerations

In this study where personal information was obtained from the subjects, the information is kept confidential and anonymous. An informed consent agreement[3] was signed by the participants. A brief synopsis of the research findings was reported and delivered to the subjects. No incentives were provided. The development and implementation of this research

[3] The informed consent agreement can be found in Appendix B.

project did not take prominence or affect the quality of instruction. As stated in the methodological section the data collected was used for the purposes specified which are within the ethical bounds.

3.8 Summary

This study investigated the impact of educational technology on learning. After familiarizing students with two different homework modalities -traditional and online-, students' preferences, learning outcomes and experiences in each modality were recorded and analyzed.

CHAPTER 4

ANALYSIS AND FINDINGS

This chapter presents the research findings and analysis. First, descriptive statistics are used to illustrate students' preferences for each modality as well as their different comfort level with computers. Second, inferential statistics are implemented to investigate the impact of each modality on learning. Third, qualitative data on the students' experience are presented and analyzed.

4.1 Student Characteristics

From 26 registered students in Section 12 at the beginning of the semester, only 15 satisfied the requirements and were included in the study. Six students dropped out during the first weeks of classes, 2 students were older students (graduate), and 3 students did not complete the required homework and quizzes at the time assigned (illness, family, or personal problems). From 25 students registered in Section 14, only one student was excluded from the study, an older student (graduate).

4.1.1 Preference: What are the characteristics of the students who prefer online versus traditional homework?

It is interesting to notice the similar proportion of students in each section that chose to complete online versus traditional homework when for chapter three they were given the option of choosing their preferred modality.

Table 4.1: Students' Preference

Section 12	online	Workbook
N=15	8	7
	53%	46%

Section 14	online	Workbook
N=24	10	14
	42%	58%

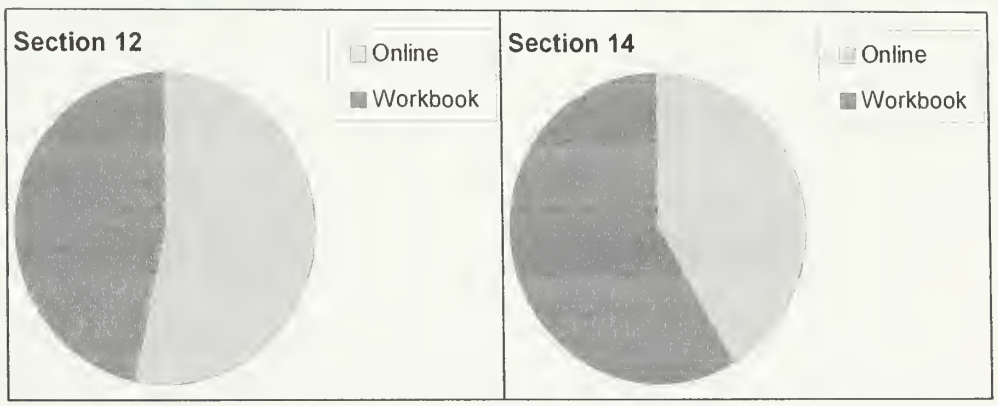

Figure 4.1: Students' Preference

4.1.2 Preference by Gender: Are students who prefer online versus traditional homework different in gender?

More male than female students preferred online homework in section 12. In section 14 there is no difference on students' preference based on gender, however, most of the men and women preferred traditional homework.

Table 4.2: Students' Preference by Gender

Section 12	online	workbook
Males = 8	5	3
Females = 7	3	4

Section 14	online	workbook
Males = 12	5	7
Females = 12	5	7

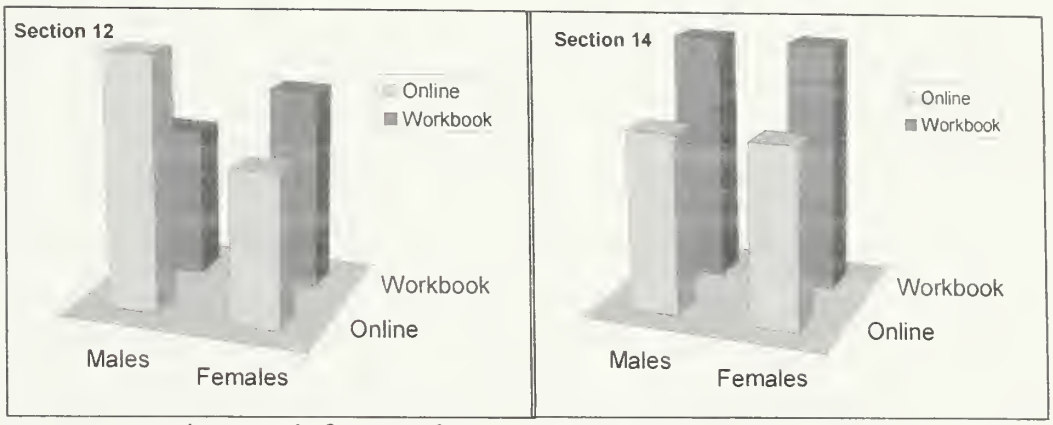

Figure 4.2: Students' Preference by Gender

4.1.3 Computer Comfort Level by Gender: Are male students better with computers?

According to their responses, male students are more comfortable with computers than their female counterparts.

In section 12, 75% (6 out of 8) of the male students reported having a high level of comfort with computers, the remaining 25% (2 out of 8) reported a medium level. Contrarily only 15% (1 out of 7) of the female students reported having a high comfort level and most of them, the 85% (6 out of 7) reported a medium level.

In section 14, 66% (8 out of 12) of the male students reported being highly comfortable with computers, the

remaining 25% (3 out of 12) having a medium level and only 9% (1 out of 12) having a low level of comfort with computers. Contrarily only 25% (3 out of 12) of the female students is highly comfortable with computers; again, most of them, 42% (5 out of 12) reported having a medium level of comfort, and the remaining 33% (4 out of 12) a low comfort level.

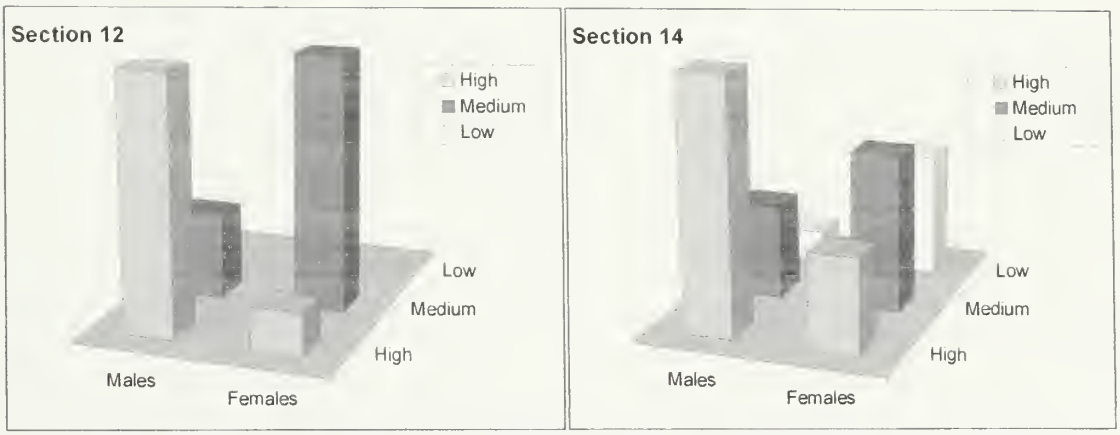

Figure 4.3: Computer Comfort Level and Students' Gender

4.1.4 Preference by Computer Comfort Level: Are students who prefer online versus traditional homework different in computer comfort level?

Approximately the same number of students with high and medium computer comfort level chose online or traditional homework. Low computer comfort level students, however, preferred the workbook in bigger numbers.

In section 12, male students with high levels of computer comfort preferred online (4) instead or traditional (2) homework, however, in section 14 they equally chose each homework modality (4 online; 4 traditional). The only female student in section 12 with high levels of computer comfort preferred online homework; and only one out of the three preferred the online modality in section 14.

There was no difference in the modality chosen by male students with medium levels of computer in section 12; in section 14 only one out of three male students chose to complete the homework online. Most (4 out of 6) of the female students with medium levels of computer comfort in section 12 preferred traditional homework; contrarily, in section 14, most (3 out of 5) of them chose to complete the online modality.

The only male student with low level of computer comfort in section 14 preferred traditional homework, as well as the majority of the female students (3 out of 4). There were no students with low computer comfort level in section 12.

Table 4.3: Preference by Computer Level

Section 12		online	workbook
Males	High	4	2
	Medium	1	1
	Low	-	-
Females	High	1	
	Medium	2	4
	Low	-	-

Section 14		online	workbook
Males	High	4	4
	Medium	1	2
	Low	-	1
Females	High	1	2
	Medium	3	2
	Low	1	3

4.2 Learning Outcomes

4.2.1 Difference according to student preferred modality: Were learning outcomes different for students who preferred different homework modalities?

An independent-samples t-test was conducted to evaluate whether there was a significant difference on the performance of students who preferred different modalities. Both sections were combined for this analysis to increase the number of respondents.

4.2.1.1 Comparison of test scores achieved when students were engaged in their preferred modality

In completing homework for chapter three of the book, students were given the option of choosing their preferred modality of homework. The test scores of the students who chose online were compared with the scores achieved by the students who chose to complete the workbook. On average,

students who preferred online homework scored 1.56 points higher.

The group who preferred online scored higher (M1 = 89.28, SD = 12.155) than the group who preferred to complete homework in the traditional pen and paper workbook when given the option (M0 = 87.71, SD = 8.951), however, this difference was not significant (as shown in table 4.2.1.1.1, $t(37) = 0.462$, $p=.647$).

Table 4.4: Preferred Modality Scores

Test	Preference	N	Mean	Std. Deviation	Std. Error Mean
workbook	workbook	21	87.71	8.951	1.953
online	online	18	89.28	12.155	2.865

Table 4.5: Independent Samples Test

		Levene's Test		t-test for Equality of Means					95%	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Chapter Three Test Scores	Equal variances assumed	1.949	.171	.462	37	.647	1.563	3.387	-5.299	8.426

4.2.1.2 Comparison of test scores achieved when students were engaged in a mandated homework modality

Correspondingly, in an attempt to better understand the impact of preference on learning outcomes, a second independent-samples t-test was conducted. The test scores achieved by students when engaged in the mandated modality (their less preferred modality) were averaged and compared.

On average, when mandated to complete homework on their less preferred modality, students who preferred online homework scored 2.51 points higher than the group who preferred the pen and paper workbook. The difference on performance, however, was not significant (as shown in table 4.2.1.2.1, $t(65.8) = -.780$, $p=.438$). According to these data, it can be concluded that homework modality preference did not have an impact on the learning outcomes of these students.

Table 4.6: Mandated Modality Scores

Test	Preference	N	Mean	Std. Deviation	Std. Error Mean
online	workbook	42	84.90	12.233	1.888
workbook	online	36	87.42	15.665	2.611

Table 4.7: Independent Samples Test

		Levene's Test		t-test for Equality of Means					95%	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mandated Modality Test Scores Avrg.	Equal variances not assumed	3.857	.053	-.780	65.8	.438	-2.512	3.222	-8.945	3.921

Learning style theorists indicate that each person has a unique way to approach learning situations, a particular rhythm for processing and organizing new information. Instructional technology supporters argue that computers have the potential to adjust and respond to the needs of different learners. These research results, however, show no significant difference on the test scores achieved by

students when engaged in their preferred modality or when mandated to complete homework in their less preferred one.

According to this data, homework preference did not have an effect on student performance. They were able to learn equally well from both modalities, regardless of their preferences.

The online version presented the same information as the workbook but in a computer screen. Hamalainen et al. (1996) and Robin and McNeil (1997) have already warned us that technology alone will not make learning more effective if developers continue to re-implement traditional practices. The design of every activity was identical in both modalities. Therefore finding no significant difference on student performance shows students' capacity to adjust to the new media. It shows that challenging students to expand their learning styles to learn and cope with the new media is appropriate and positive.

4.2.2 Difference according to modality and gender: Were learning outcomes different for male and female students who preferred different homework modalities?

Independent-samples t-tests were conducted to evaluate whether there were significant differences in the

performance of male and female students when working in different modalities.

Table 4.8: Difference by Gender and Modality

Test Score when using		N	Mean	Std. Deviation	Std. Error Mean
online	Male	50	85.96	13.895	1.965
	Female	46	88.63	11.381	1.678
workbook	Male	50	84.90	14.118	1.997
	Female	49	88.39	10.793	1.542

Online homework modality by gender:

When engaged in online homework, female students scored higher (M_1 = 88.63, SD = 11.381) than male students (M_0 = 85.96, SD = 13.895). The scores achieved by male and female students however, are not significantly different ($t(94) = -1.025$, $p=.308$).

Table 4.9: Independent Samples Test

Test Score		Levene's Test		t-test for Equality of Means					95%	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
online	Equal variances assumed	1.320	.254	-1.025	94	.308	-2.670	2.606	-7.844	2.503

Workbook homework modality by gender:

When using the workbook, female students also scored higher (M_1 = 88.39, SD = 10.793) than male students (M_0 = 84.90, SD = 14.118), however, this difference was not significant ($t(91) = -1.383$, $p=.170$).

Table 4.10: Independent Samples Test

Test Score		Levene's Test		t-test for Equality of Means					95%	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
	Equal variances not assumed			-1.383	91.611	.170	-3.488	2.523	-8.498	1.523

In average female students scored higher in both modalities, however, because the difference on performance was not significant, it can be concluded that there is no significant difference on performance according to gender.

There is mounting evidence documenting the existence of a technological gender gap. The term "technological gender gap" has been used to refer to the idea that males and females have different technology related attitudes, behaviors, and skills. Research also shows that the existence of this gender gap is the reflection of inherent bias in women's perceptions. Women tend to see themselves as less technological apt than males, but that this gender bias disappears when comparing male and female performances (Mayer-Smith et al, 2000; Venkatesh, and Morris, 2000; Canada and Frank 1992).

In line with the findings, it is interesting to note that in this study even though most of the women students reported having a medium-low comfort level with computers,

they outperformed their male counterparts who reported a medium-high comfort level.

4.2.3 Difference according to computer comfort level: Were learning outcomes different for students with different computer comfort levels?

ANOVA was used to discover if students of different computer comfort level scored differently when engaged in online homework. The test scores of the chapters for which students were engaged in online homework were averaged and compared.

The significance value of the F test in the ANOVA table is .246, thus it can be concluded that the scores achieved by students with high, medium, and low computer comfort levels are not significantly different (as shown in table 4.2.3.2).

Table 4.11: Online Performance by Computer Comfort Level

Computer Comfort Level	N	Mean	Std. Deviation	Std. Error	95% Confidence		Min	Max
					Lower	Upper		
High	18	87.04	11.977	2.823	81.08	92.99	58	99
Medium	16	88.96	11.022	2.755	83.09	94.83	62	100
Low	5	79.20	7.662	3.426	69.69	88.71	73	92
Total	39	86.82	11.309	1.811	83.15	90.49	58	100

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	364.329	2	182.165	1.459	.246
Within Groups	4495.581	36	124.877		
Total	4859.910	38			

4.2.4 Difference according to computer comfort level, gender and preference:

Were there significant differences on the performance of students with different computer comfort levels, gender and preference when working in different modalities?

A multivariate test (General Linear Model -Repeated Measures) was implemented to test if there were significant differences in the scores achieved by students of different gender, preference and computer comfort level when engaged in each modality. The test scores of the chapters for which students were engaged in each modality were averaged and compared.

Table 4.12: Tests of Within-Subjects Contrasts

Source	modality	Type III Sum of Squares	df	Mean Square	F	Sig.
modality	Linear	4.539	1	4.539	.108	.745
modality * GENDER	Linear	20.707	1	20.707	.493	.488
modality * COMPUTER	Linear	69.244	2	34.622	.825	.449
modality * PREFERENCE	Linear	117.608	1	117.608	2.802	.105
modality * GENDER * COMPUTER	Linear	37.622	2	18.811	.448	.643
modality * GENDER * PREFERENCE	Linear	6.488	1	6.488	.155	.697
modality * COMPUTER * PREFERENCE	Linear	110.651	2	55.325	1.318	.284
modality * GENDER * COMPUTER * PREFERENCE	Linear	13.778	1	13.778	.328	.571
Error(modality)	Linear	1175.078	28	41.967		

As shown in table 4.2.4.1 there are no significant differences on the scores achieved between modalities. No main effect in modality (F=.108, p=.745), no interaction between modality and gender (F=493, p=.488), modality and computer comfort level (F=.825, p=.449), or modality and

preference (F=2.802, p=.105). There was no interaction when all variables were included in the model (F=.328, p=.571). Therefore, it can be concluded that there were no significant differences on the learning outcomes achieved by the students in both modalities regardless of their gender, computer comfort level, or homework modality preference.

4.3 Online Homework Qualities According to Students

At the end of the semester, students were asked to describe and compare their learning experiences when using computers and traditional methods for homework. Their responses were anonymously collected through the Discussion Board module[1]. Their comments broke down into the following four themes: instant feedback, learning, handwriting versus typing, design.

4.3.1 Instant Feedback

4.3.1.1 Positive comments

According to 33 students (85%), the main enhancement offered by the online homework was instant feedback and the option of redoing activities. The system allows the

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[1] More information on Manhattan Courseware System can be found in Apendix C.

instructor to determine how many times a student can re-submit each activity. There was a limit of three tries and only the highest score was recorded. Most of the students took full advantage of this possibility and achieved a 100% average for all their homework. Other students, however, were satisfied with 90, 80 and even 60%.

> I preferred working on Quia b/c it definitely helps to see that you are doing something wrong as you are doing it. it definitely helped me learn the 'correct' way, much quicker than doing the workbook all wrong and never seeing it right away.

> I prefer working on Quia more than the workbook because you can double check your answers to see if you are understanding the information. Quia also helped me to prepare for exams.

4.3.1.2 Negative comments

Nine students however (23%), the computer instant feedback was meaningless and useless. They expressed frustration about the computer inability to differentiate between a bad answer and a simple punctuation error.

> At times Quia was a pain because it did not accept what you had written as a correct answer when it was.

Some times on the grammar you would not really know your mistakes because we would just save our answers and they would not get checked.

The capacity to provide immediate feedback is usually described as the most important contribution made by technology for student learning. It provides an excellent support tool that could possibly replace the need for tutorial help and empower students pursuing new knowledge Students however, get easily frustrated because despite the advances made in the computer world, the development of intelligent systems able to provide feedback according to the learner input are weak and full of glitches (Chan et al., 2001; Woit & Mason, 2000; Tunc & Armstead, 2001, Kaczmarczyk, 2001).

Students are used to a more refined technology. Fully integrated into the everyday lives of millions of young people throughout the world, video games are a vital part of contemporary culture and society. These games are extremely intelligent systems that apply the most rigorous learning principles such as information on demand and just in time in their design. If a game cannot be learned and even mastered at a certain level, it frustrates users and does not get played. It is common therefore to find games

that adjust to different levels of difficulty. In fact, the initial levels of a game are hidden tutorials. (Gee, 2003; Aguilera & Mendiz, 2003)

4.3.2 Learning

4.3.2.1 Positive comments

One of the advantages of using computer generated homework is that students are given as much practice and feedback as necessary. They can drill on basic concepts until mastery. According to 25 students(65%), it allowed them to become more responsible and aware of their own learning.

> I feel that it was useful because get to see the feedback and the right answers right away. The computer was good because we could listen to the audio and that was good awareness, i liked how i could play it over and over again until i understood what it was saying. when a professor asks a question in Spanish in class i may feel like i have to answer right then even when i didnt really know what he/she was saying(hearing it only once).

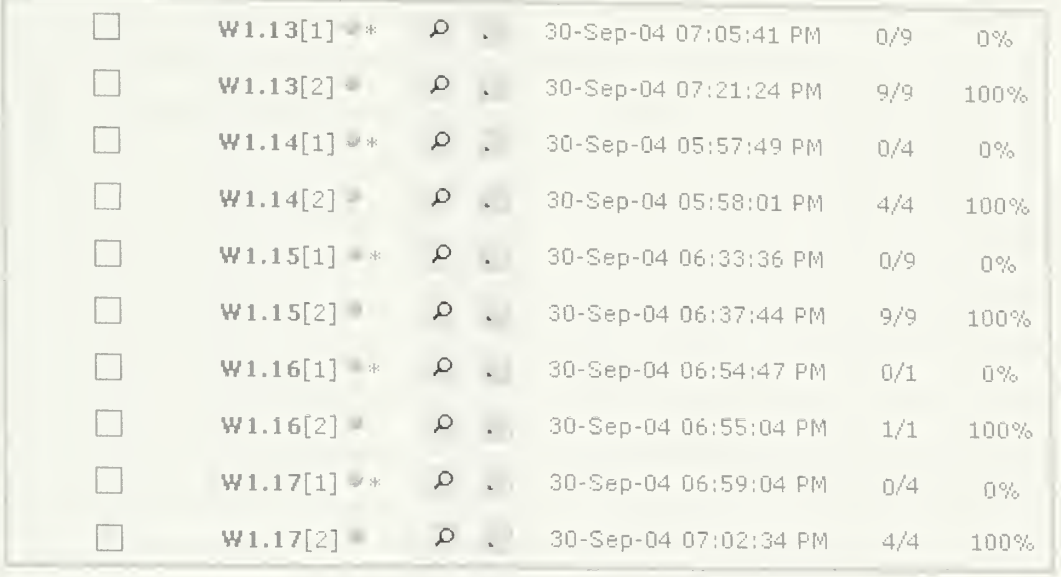
> It helped to learn the materail because it wasn't jsut talking through things, it was seeing it, thinking it, and doing it.

Although it took longer to complete the homework, I thought it was effective because you had a chance to correct mistakes and learn them.

I do think it helps a bit, b/c it gives you situations and forces you to figure it out which definately is a benefit for me.

4.3.2 2 Researcher's Comments

Cheating remains an issue whether or not online activities are implemented in a classroom; it is important for educators to monitor and encourage responsibility in students. An important issue encountered at the beginning of the semester was cheating. Students rapidly learned that the instant feedback feature could be used to acquire all the answers. Fortunately, the system allows the instructor to easily monitor student submissions. As displayed in figure 4.3.2.2, a student, for example, submitted activity 13[1] at 7:05 pm and received 0% because none of the nine questions were answered correctly. Magically, at 7:21 pm, the student resubmitted the activity with all correct answers.



☐	W1.13[1]		30-Sep-04 07:05:41 PM	0/9	0%
☐	W1.13[2]		30-Sep-04 07:21:24 PM	9/9	100%
☐	W1.14[1]		30-Sep-04 05:57:49 PM	0/4	0%
☐	W1.14[2]		30-Sep-04 05:58:01 PM	4/4	100%
☐	W1.15[1]		30-Sep-04 06:33:36 PM	0/9	0%
☐	W1.15[2]		30-Sep-04 06:37:44 PM	9/9	100%
☐	W1.16[1]		30-Sep-04 06:54:47 PM	0/1	0%
☐	W1.16[2]		30-Sep-04 06:55:04 PM	1/1	100%
☐	W1.17[1]		30-Sep-04 06:59:04 PM	0/4	0%
☐	W1.17[2]		30-Sep-04 07:02:34 PM	4/4	100%

Figure 4.4: Student Submissions

This information was shared with students. They were reminded that homework is their learning tool and advised to make the best use of it. Some of the students argued that sometimes they looked at the answers and learned from them. They insisted that it was not a meaningless copying and pasting of information but a learning experience. After this discussion, homework going from a score of 0% to 100% in a matter of seconds progressively vanished. It is unknown to the researcher if they changed strategies or stopped cheating.

4.3.3 Handwriting versus Typing

12 students (30%) expressed that they missed doing pen and paper homework.

I did not like it, because I learn better by writing not typing. Also, the accents were annoying to have to add in. Whenever I had to hand in the workbook on Quia, I had to do the exercises in the workbook also, so I would remember better.

I personally liked working in the workbook because it was easier than fooling with the internet, and also sometimes I like writing more than typing.

I think the workbook helps me practice better because I am writing it out.

Even though some students argued that they learn better when writing down on paper, there is no theory corroborating their experience. Learning style theorists noted that students whose preferred learning style is not auditory often take notes during lectures to aid their retention. They had never made a distinction however, between writing down in paper and typing in a computer.

Furthermore, the same psychomotor theory of handwriting has been applied to typing. It assumes that first, a complete phonological code is specified in the brain and then it is translated into a graphemic code during the writing process. The motor behavior is viewed as the execution of the ordered sequences. No distinction is

made between the drawing of letters on paper and the punching keys on the keyboard (Will et al. 2003). It is clear, according to this data, that students are more comfortable learning from drawing letters on paper, a skill in which they were trained in their earlier schooling years.

The subsequent argument on this matter focused on the disadvantages experienced by computer user students who are forbidden to use them during examinations and cannot take advantage of the features offered by Word processors (Dalton and Hannafin, 1987; Russell and Plati, 2001; MacCann et al 2002).

4.3.4 Design

11 students (29%) mentioned that they enjoy working with computers

> Quia is a change of setting from the everyday homework. It gives us a chance to actually see and do what we are learning rather than reading and writing the entire time.

> The program was fun and kept me interested in the subject matter. It kept every student, not just myself, interested in learning the chapters.

The information was presented in a different way that the textbook presents it. Its not only fun, but provides a different way for some people to learn. A hands on way to learn Spanish.

It was good to be able to hear the different vocab when you put your mouse on it. You were able to repeat the voices all the time so if you did not get it the first time you could hear it over and over again.

It was a fun learning tool and it was a nice break from traditional learning.

Motivation is an important element that influences how and why people learn as well as their performances (Curry, 1990). Sound, images, video are some of the features that make computers an interesting educational environment that motivates student engagement (Brickell, 1993).

Students seem to enjoy working in the digital technology environment. Many philosophers, who deal with implications of the new media, agree that computers offer better representations of the mind such as hyperlinked words, images, etc. than the black-and-white linear rules of print. It is also important to mention that even though students were satisfied with the advantages offered by technology such as instant feedback, the quality of the

technology was mediocre and did not satisfy their expectations.

> I would rather do all the assignemnts in the workbook rather than Online. It was a pain because it did not accept what you had written as a correct answer when it was.

> It was tedious and sometimes very repeatative. The activities were not very helpful and sometimes confused me.

> I think the vocab activities were more useful than the grammer ones, b/c the grammer you had to be so specific that it sometimes caused a distraction from the main 'point'.

7 students (18%) expressed disappointment and frustration by the lack of sophistication of the system.

4.4 Summary

According to these findings, and in agreement with the existent literature, when given the option, not every student prefers the online modality. Nevertheless, when mandated to work in the online environment, there are no significant differences in students' learning outcomes. When comparing and describing their experiences, four

themes emerge: instant feedback, learning, handwriting versus typing, and design.

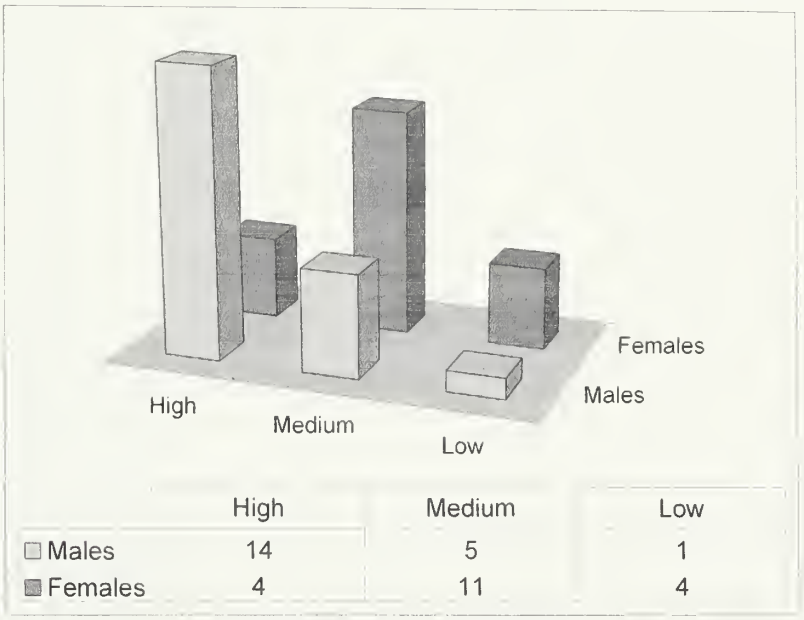
CHAPTER 5

DISCUSSION AND IMPLICATIONS

5.1 Summary of Findings

5.1.1 Preference, Gender, and Computer Comfort Level.

Female students reported having a lower comfort level with computers.



	High	Medium	Low
Males	14	5	1
Females	4	11	4

Figure 5.1: Computer Comfort Level by Gender

The same number of male and female students, however, chose to complete online homework when given the option; suggesting that students' preference for online versus traditional homework modality was not affected by gender or computer comfort level.

Male students with a high level of computer comfort chose the online modality in higher proportion than their female counterparts. Surprisingly, one of the female students who reported having a low computer comfort level chose the online version, while none of their low level male students selected this option.

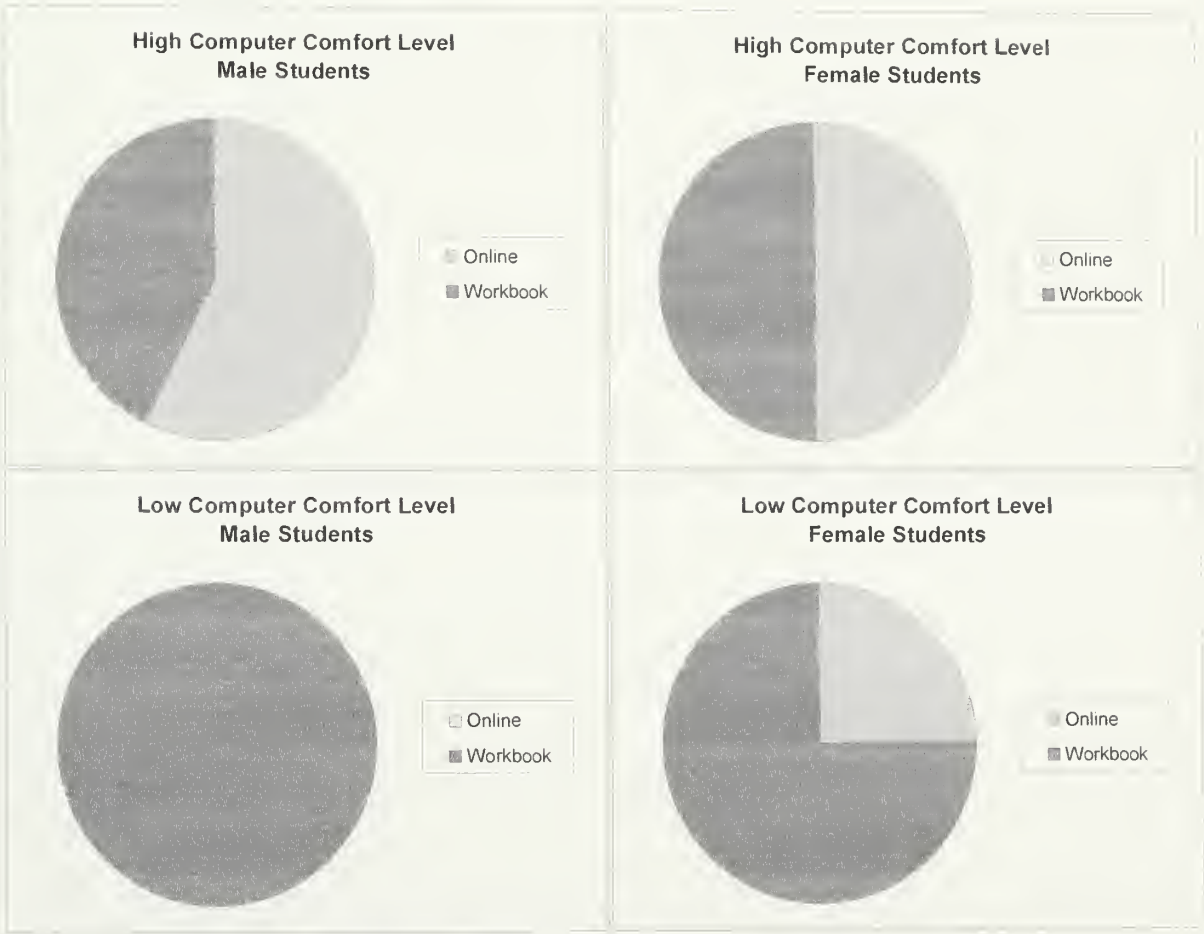


Figure 5.2: Computer Comfort Level by Preference

5.1.2 Learning Outcomes: Preference, Gender, and Computer Comfort Level.

The data shows no significant difference on learning outcomes. The findings suggest that students can learn equally well in either modality, regardless of their preference, gender or computer comfort level. Students who preferred online homework achieved the same scores when engaged in traditional or online homework. Vice versa, students who preferred traditional homework achieved the same scores in either modality. There was no significant difference either when students were grouped according to gender. Interestingly, female students scored higher in both modalities. Due to the same sample of the study, caution should be exercised on the implications of these results for other populations.

5.1.3 Online Homework Qualities: instant feedback, learning, typing, and design.

According to the students, the most valuable feature of the online modality was instant feedback. They enjoyed the opportunity to receive feedback and to monitor their own progress and responses. They felt empowered by it. On the other hand they were frustrated by the lack of meaningful feedback and the inability of the software to

differentiate between errors and simple punctuation mistakes.

According to some students, the online version allowed them to become more responsible and aware of their own learning. They also indicated that they enjoyed working with computers and that it helped them stay interested and motivated in the activity. Not all students can be included in this response; early in the semester, a group of students found a way to cheat when using the system.

The most interesting finding was some students' perception that they learn better writing down on paper than typing on the keyboard. They mentioned that when mandated to complete homework online, they felt the need to complete the pen and paper workbook to better learn the material.

5.2 Discussion and Implications

What is the role of higher education in preparing students for a society where computer literacy has become an essential requirement for participation?

Numerous studies have focused on educational technology. With the objective of validating computer-mediated learning, the main purpose of these studies has been to demonstrate that online students could achieve the same outcomes achieved by traditional students (Russell, 2004). In response to the increasing role instructional technology plays in higher education, researchers are interested not only in online long-distance students but in how it influences learning for traditional campus students. By comparing and analyzing the learning outcomes and experiences of the same students under both modalities, online and traditional pen & paper, this research provides some insights of the challenges faced by today students and faculty.

While many researchers have advocated that the value of technology resides in its capacity to respond to the needs of different learning styles, especially those learning styles typically overlooked by traditional teaching methods (Bates, 2001; Ross, 1999); other researchers have pointed out that the systematic introduction of technology discriminates against certain learning styles (Gregorc, 1985; Pritchard, 1982). The research on how each learning style adapts to the new

technological environment is not robust and the literature on e-learner typology is very limited (Ayersman and von Minden, 1995; Egan, 1988). This study goes beyond this controversy. While accounting for student differences, it explored how learning occurs in the new technology-mediated environment.

This study showed that even though not every student preferred working online, all of them were able to adapt and learn with technology. Limited by sample size and representation, this study showed that students, whose styles of learning were not in total alignment with the online modality, were able to interact, cope and learn with it. According to the data collected, students who preferred the traditional homework modality as well as those less comfortable with computers were able to achieve the same learning outcomes in both modalities. The utilization of technology has become an essential element in higher education and in our society in general. This study verified that challenging students to interact, cope and learn with computers is positive and appropriate for students' development.

Some students argued that they learn better when writing down on paper. Even though there is no theory corroborating their experiences (Will et al. 2003), their perceptions need to be acknowledged. From their first schooling years, calligraphic writing is the most common ingredient of student education. It is not surprising then, to find that many of them are more comfortable with pen and paper than with a keyboard. Today a common ingredient of culture, in the past writing was a specialized skill, practiced by professional scribes in the service of the State (Dalton and Hannafin, 1987). Now there are new literacy requirements; writing papers, sending emails to a professor, giving a presentation with audiovisual aids, and representing achievements via a web page are examples of the skills they need to acquire (Chen, 2003). Students are expected to move easily between oral, written and visual communication elements. For this study, all the testing was conducted in pen and paper. In order to reduce a possible bias in favor of traditional methods, it would be interesting to incorporate computer testing in future studies.

In the instructional technology literature there is evidence documenting the existence of a gender gap (Canada

and Brusca, 1992; Venkatesh and Morris, 2000). Also revealed in this study, this problem could render large numbers of female students unprepared to meet the technological challenges of the future. Understanding the causes of this gap and providing equitable educational opportunities for male and female students should focus the attention of all educators. As shown in other studies, there is a social bias that privileges men over women in technological fields. Most of the women in this study expressed having a medium-low computer comfort level. There is a lack of self-confidence that does not respond to women's intellectual disabilities but to a stereotyping of socialization (Tobias, 1990). There were no significant differences on the learning outcomes achieved by male and female students.

5.3 Limitations of the study

This study is not a follow-up or a continuation of any known (to this researcher) previously documented research. It is based on earlier teaching experiences and a similarly designed pilot study conducted during 2002-3 academic year in the same research venue.

There is always a possibility that any study can be conducted by other methods however, this research design was selected based on its appropriateness and feasibility for the study. For example, a bigger sample could be implemented to strengthen the design. The small sample size of the study limits the conclusions that can be drawn from the findings.

Learning outcomes, for example, were measured through written tests. Unfortunately, other possible indicators of learning outcomes were not included in the design, such as online testing, oral communication, etc, or other testing alternatives that go beyond the "logical-mathematical intelligence" (Gardner,1993). Measuring learning outcomes in such a limiting way also restricts our ability to adequately assess student learning and the new possibilities enhanced by technology.

5.4 Possible Future Research

The impact of technology for learning needs further investigation, both for students and instructors. As the incorporation of technology in higher education continues to increase, it is critical to identify how it affects student learning. The research field of instructional

technology needs independent, critical, longitudinal and large-scale studies with experimental and control groups.

New computer designs and interfaces influence the presentation of information and the way learners interact with it. Until now the research has focused on the validation of instructional technology by comparing it with traditional methods. Limiting the potential of technology to replicate the traditional methods of teaching and learning is a waste of time. New research needs to focus on the development of new pedagogical principles and models. A better understanding of the brain and the learning process should bring the development of instructional technology to a new level of complexity where it could be redefined and used to its full potential.

APPENDIX A

STUDENT SURVEY

Elementary Spanish I

Name _____

Email _____

Grade Level

Select one

- ○ First Year
- ○ Sophomore
- ○ Junior
- ○ Senior
- ○ Other

Gender

Male  Female 

Computer Comfort Level

Select one

○ High

○ Medium

○ Low

Access Code (for later use) _____

APPENDIX B

INFORMED CONSENT LETTER

EDUCATIONAL TECHNOLOGY: STUDENT COGNITION IN A COMPUTER-MEDIATED ENVIRONMENT

CONSENT FOR VOLUNTARY PARTICIPATION

I volunteer to participate in this research study and understand that:

1. In this study my gender, grade level and computer comfort level will be requested in a survey form the first day of class.

2. Throughout the semester, my homework and test scores will be recorded and analyzed by Karin M. Camihort as well as my preference for online versus paper homework modality

3. I understand that the primary purpose of this research is to examine the relationship between homework modality (online versus paper) and learning gains. Data collected on my performance will be used to investigate the impact of educational technology for learning.

4. My name will not be used, nor will I be identified personally in any way or at any time. I understand it will be necessary to identify participants in the dissertation by position and college affiliation (e.g., a Spanish class at Springfield College ...).

5. I may withdraw from part or all of this study at any time.

6. I have the right to review material prior to the final oral exam or other publication.

7. I understand that results from this study will be included in Karin M. Camihort doctoral dissertation and may also be included in manuscripts submitted to professional journals for publication.

8. I am free to participate or not to participate without prejudice.

9. Because of the small number of participants, approximately fifty, I understand that there is some risk that I may be identified as a participant of this study.

Researcher's Signature	Participant's Signature
Date	Date

APPENDIX C

MANHATTAN COURSE MANAGEMENT SYSTEM

The Manhattan Virtual Classroom (or simply "Manhattan") is a web based course management system. Manhattan can be used to add an online component to a traditional face-to-face course, or it can be used to support distance learning courses that only meet online.

The Manhattan software itself runs on a Linux (or possibly other Unix-based) server. Since it is a web based application, all of Manhattan gets installed on the server and no special software needs to be installed on the computers of teachers and students using the system. From their point of view, Manhattan is a web site.

- Provide their students with handouts, notices, lecture materials, interactive self-tests, and web sites to visit.
- Assign homework for students to complete, receive the work they do in response to those assignments, and provide feedback.
- Issue multiple-choice and short answer exams.
- Exchange private messages with their students.
- Host discussions with the entire class, or with teams of students.
- Keep students apprised of their grades.
- Engage in live online "chats" with their students.
- Track which students are using the system and when.

Manhattan was developed by Steven Narmontas and was first used at Western New England College in Springfield, Massachusetts in 1997. In October of 2000, the software was released in its entirety on the Internet for free under an unusual software license called the GNU General Public License. Today, Manhattan is in use around the world, and continues to be actively developed.

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