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A TEACHER'S DUAL ROLES AS A CLIENT AND CHANGE AGENT: AN EXAMINATION OF THE ADOPTION OF AND TEACHING WITH HYPERMEDIA TECHNOLOGY presented by

MA. LETICIA C. ALTAMIRANO

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### A TEACHER'S DUAL ROLES AS A CLIENT AND CHANGE AGENT: AN EXAMINATION OF THE ADOPTION OF AND TEACHING WITH HYPERMEDIA TECHNOLOGY

By

Ma. Leticia C. Altamirano

## A DISSERTATION

Submitted to Michigan State University in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

**Educational Systems Development** 

1998

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### ABSTRACT

### A TEACHER'S DUAL ROLES AS A CLIENT AND CHANGE AGENT: AN EXAMINATION OF THE ADOPTION OF AND TEACHING WITH HYPERMEDIA TECHNOLOGY

By

Ma. Leticia C. Altamirano

Researchers have focused little attention on college teachers' experiences in using new computer technology. Instructional designers and educational technologists should know how college faculty make use of computers to be able to approach the instructional problems which college teachers might experience in adopting new technology.

This qualitative research study focused on a teacher educator, and the dynamics of her teaching when using a new hypermedia technology. In investigating the dynamics of her teaching, the study viewed how the teacher undertook the role of a *client* as she pursued her teaching tasks while incorporating the use of a technological innovation. Simultaneously, the study also investigated how the teacher portrayed the *change agent's* role, as she introduced the technological innovation to her students and helped them use it as a means to learn about the course's subject matter.

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portrayed dua diffusion of in the teacher rece aspects of tech client also sup Because of the better perspect learning from direct her atte teacher's port beyond the un autonomous, tools. The findings of this study revealed that the teacher experienced two simultaneous diffusion processes, which were influenced highly by what the teacher brought with her to technology use. In addition, the teacher's role as a client in innovation use is comprised of three subsequent phases, namely, the adoption of innovation use, the integration of inovation use into the lessons, and the learning of tools and equipment in relation to innovation use. Moreover, as a change agent, the teacher primarily focused her tasks on planning, implementing, and assessing student technology use.

Major conclusions include that, in teaching the course, the teacher portrayed dual roles as she experienced two simultaneously occurring diffusion of innovation processes. Throughout the two diffusion processes, the teacher received timely support to aid her with the software and hardware aspects of technology use. The help which the teacher received while being a client also supported her needs as she pursued her role as a change agent. Because of this, the teacher's instructional role primarily focused on gaining a better perspective of innovation use through interactions with colleagues and learning from their similar experiences. In addition, the teacher was able to direct her attention to innovation use while teaching her course. Finally, the teacher's portrayal of her role as a client in one diffusion process went well beyond the usual connotation of the term since she was an active, autonomous, and assertive user of innovation and learner of technological tools.

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### DEDICATION

I humbly dedicate my dissertation work to my God through our Lord Jesus Christ, Whom I declare to be my personal Friend and Savior.

1 Peter 1:8-9 (NIV)

"Though you have not seen Him, you love Him; and even though you do not see Him now, you believe in Him and are filled with an inexpressible and glorious joy, for you are receiving the goal of your faith, the salvation of your souls."

I am sincere with this wonderf d development! I Kr øspecially because extended.

My sincerest Committee and Di bine, and energy of years. Through you this program. Ma and guidance, esp to Dr. Patrick Dicc Patience, especial Very special Very special the valuable opp My exposure to a cap immensely. Kara Suzuka, for Virginia Keen, O Rosenberg, and

#### ACKNOWLEDGEMENTS

I am sincerely grateful to everyone who took part in providing me with this wonderful opportunity for personal and professional growth and development! I know that I enjoyed this intellectual pursuit and challenge, especially because of the various types of support which people shared and extended.

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My si much for you interviewed y course who p Special provided me v Dr. Castelle Ge Parkhurst, Dr. ) Kathleen Wight dissertation defe l wholehe for your loving brother, and thei <sup>and Brendan Car</sup> Reymund Bautis I am very g opened themselve <sup>and</sup> grandma: to <sup>encoura</sup>gement an <sup>nephews,</sup> and gra Nico; Debbie and <sup>Altamirano</sup> (Alan, <sup>Sarah,</sup> Sheila, She  $^{
m loy);\ Morie}$  and Sq <sup>and ]]</sup>; Marjory an <sup>Camille,</sup> Jericho); { <sup>and Mamerta</sup> Mar

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My sincerest gratitude goes to my study participant. Thank you so much for your extra time and patience, especially as I observed and interviewed you. Special thanks go to the co-instructor and students of the course who permitted me to collect data.

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I am very grateful to an especially wonderful family that warmly opened themselves to me, and treated me like a daughter, sister, cousin, aunt, and grandma: to my father-in-law, Domingo Altamirano, for your continued encouragement and support; to my "new" brothers and sisters, nieces and nephews, and grandchildren: Roger and Senen Altamirano (Ivan, Jovilyn, Nico; Debbie and Leo; Mariel; Aris and Karyl; Reimart); Amor and Aurora Altamirano (Alan, Mabel, Allyana); Divinia and Amando Dimayuga (Walter, Sarah, Sheila, Sheryl, Charmaine); Rolly and Minnie Altamirano (John and Joy); Morie and Sorcy Altamirano (Marge, Christian, Alex, Jonathan; Michelle and JJ; Marjory and James; MJ(†)); Elsie Aguila (Jerome, Christine, Claudette, Camille, Jericho); to my "new" cousins Josefa Fernandez, Virgilio Reodica, and Mamerta Manalo.

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My sinceres treating me like a d Ingram, for taking Occena, for believit to our Savior; Hyel Glenda Soriano, Jo Viray, Marita and Andry Kovich, and Dr. David Horner ludy Fogle, Mike Eiden, Dr. Josep} encouragement t Finally, I <sup>for</sup> giving me a daughter, Brigi everyday that ging Mama H on your own. loving husbar <sup>m</sup> my endeav <sup>go beyond</sup> m <sup>lourself</sup> to d over Brigitte My sincerest thanks go to wonderful friends: Agripina Padilla, for treating me like a daughter and taking very good care of Brigitte; Elizabeth Ingram, for taking good care of me when we had our newborn; Lillian Occena, for believing in my capabilities; Myong-ye Bang, for bringing me close to our Savior; Hye-sook Park, for a beautiful friendship; Sue Saguiguit, Glenda Soriano, JoAnne Palma, Cheribeth Tan, Lilian Ungson, Emmanuel Viray, Marita and Tito de Leon, Carmen Pavorada, Sonia Dietz, Charito Andrykovich, and Violeta Becker; my husband's supervisor and officemates: Dr. David Horner, Pamela Copeland, Mary Jane Cervantes, Peggy Arbanas, Judy Fogle, Mike Fisch, Olga Lami-Schimizzi, Nancy Rademacher, Vera Elden, Dr. Joseph Cousins, and Patricia Walters for your warm support and encouragement to my husband and his family.

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# CHAPTER ONE INTRODUCTION

This is a study about the dynamics of a teacher's use of hypermedia technology for teaching purposes. I described how a teacher first learned to use a cutting-edge computer program and then incorporated it into her teaching as she planned, implemented, and assessed student technology use. The instructor used the Student Learning Environment program (a hypermedia application) and the appropriate hardware to teach a portion of a course on teaching methods. I investigated how she assumed two roles in the adoption process. First, I investigated her role as a *client* as she adopted a new technology. Second, I studied her role as *change agent*.

#### The Context: Educational Computer Technology

Since the 1950s, when people began to use computers for instructional purposes, the features of programs have changed dramatically. As we all recognize, new technological hardware and software are being developed every day. It seems difficult to believe how the first computer programs for educational purposes functioned because of the dramatic evolution of these programs through the years.

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The first features of instructional computer programs were patterned after printed programmed instruction. The earliest instructional computer programs, which were developed in 1950s and 1960s, allowed users to move along the program if they obtained a correct answer. Each answer had corresponding comments. Moreover, every user had access to practically the same text and answers. The only feature which could change was the amount of time a user could spend on a material.

Now computer technology is relatively sophisticated in comparison to the early days. Presently, users are able to experience much more from instruction via computer. For instance, in some educational computer programs, users can branch from a page to any other page in the same group, or to a page in another set. Moreover, branching may not only take the user to another printed page but may show the user a picture or a video segment. In addition, the type of feedback may be *written*, *drawn* (with graphic tools), *heard* (for example, the instructor's voice which is live or was recorded), or *seen* (like a video segment from a videotape player/monitor or a laser disc player/monitor).

The first uses of computers for instructional purposes were as *tutors* (Lepper and Gurtner, 1989; Suppes, 1966). As a tutor, the teaching computer took an objective role. The tutor did not insult or embarrass the user. Students proceeded at their own pace, while the computer maintained its patience (Lepper & Gurtner, 1989). This idea of having a student

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interact with a computer on a one-to-one basis seemed to have been influenced by the vision of some people that

"... in a few more years millions of schoolchildren will have access to what Philip of Macedon's son Alexander enjoyed as a royal prerogative: the personal services of a tutor as well-informed and responsive as Aristotle." (Suppes, p. 207)

Through the years, teachers have involved their students in using computers in three ways: 1) as *tutorials*: to diagnose individual skills and to provide instruction on an individualized basis; 2) as *ancillary materials*: to provide supplementary information or activities to the lessons taught in class (Naron and Estes, 1986); and 3) as *teaching aids*: to assist teachers as they taught their lessons. In some classes, teachers combine these uses and have students use computers on an individual basis as part of the class time.

### The Educational Problem:

## Integrating Technology into Classrooms

According to Cuban (1986), educators have been accused of being slow to make use of innovative technologies like computers. He said that most often critics blame teachers for their slowness to respond. Moreover, he observed that even when studies documented the computer's effectiveness, teachers were reluctant to make use of the technology. Cuban mentioned that there seems to be a pattern of teacher complaints about the flaws in the technology and counter complaints by critics that the teachers are not using

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the tool enough. He stated that these arguments produced specific criticism of administrators and teachers:

"Such surveys would unleash mild to harsh criticism of administrators who left costly machines in closets to gather cobwebs, or stinging rebukes of narrow-minded, stubborn teachers reluctant to use learning tools that studies had shown to be academically effective. Once limited classroom use had been established, teacher-bashing (as the British label it) produced a series of sharp critiques blaming intransigent teachers for blocking improvements through modern technology." (p. 5)

But Cuban revealed that the surveyors asked administrators about the teacher's use of technology. They did not ask classroom teachers who might know what technology is needed based on their personal and practical experiences.

Should the teachers be blamed for the lack of use of technological innovations in schools? On the contrary, teachers have not been resistant to change. In fact, according to Cuban, teachers traditionally have not avoided change:

"Since the mid-nineteenth century the classroom has become home to a succession of technologies (e.g., textbook, chalkboard, radio, film, and television) that have been tailored to the dimensions of classroom practice. Yet the teacher has been singled out as inflexibly resistant to "modern" technology, stubbornly engaging in a closed-door policy toward using new mechanical and automated instructional aids." (p. 3)

The question becomes how to maintain the tradition of using new technologies in the schools in the age of computers. How can we foster the use of the latest computer technology in the schools?

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#### The General Research Problem:

#### Integrating Technology in College Classrooms

Computers and other related pieces of technological equipment are becoming more visible in classrooms. In addition, researchers are studying teachers and their use of computers in the classrooms. Some teachers on all grade levels have begun to use computer technology in their teaching. However, most researchers have reported on the use of computers in elementary (Dawson, 1998; Chernow, 1997; Edwards, 1997; Guha, 1997; Lecuyer, 1997; Stephen, 1997; Frase, 1996), middle (Cooperman, 1998; Duarte, 1997; Gullett, 1997; Houx, 1997; Owens, 1997), and high schools (Cato, 1997; Fuchs, 1997; McClure, 1996), and collectively on two or more levels (Durham, 1997; Gay, 1997; Thomas, 1996; Bitner, 1994; Hadley and Sheingold, 1993; Sheingold and Hadley, 1990; Olson and Eaton, 1986). Only Cooper Enyi (1997), Robertson (1997), Thorpe (1997), Dagostino, (1996), Heid (1995), and Aworuwa (1994) have looked at college instructor's use of computers.

Instructional designers and educational technologists should know how college faculty make use of computers to be able to approach the instructional problems which college teachers might experience in adopting new technology. This research study aims to address this problem by looking into various aspects of classroom teaching with the use of computer technology as a teaching aid. I hope that the findings from this study will help instructional designers in higher education to begin to create instructional theories, models, and representations of use of computer technology in college teaching.

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## The Specific Research Problem:

### The Dynamics of Integrating Cutting-edge Technology in College Classrooms

Researchers have focused little attention on teachers' experiences in using very new computer technology. This problem is continuous because new computers and new software applications appear daily. The focus of this study is how college teachers incorporate the use of cutting-edge technology into their teaching. Specifically, this research study focused on a teacher educator, and the dynamics of her teaching when using a new computer technology, that is, a hypermedia program. In investigating the dynamics of her teaching, the study viewed how the teacher undertook the role of a *client*, that is, how she pursued her teaching tasks while incorporating the use of a technological innovation. Simultaneously, the study also investigated how the teacher portrayed the *change agent's* role, as she introduced the technological innovation to her students and helped them use it as a means to learn about the course's subject matter.

The concept of 'hypermedia' was the result of combining aspects of multimedia environments for educational purposes and the hypertext-type software (Lampert and Ball, 1990). Thus, one can say that hypermedia was conceptualized in the 1940s (Chia-Shing and Moore, 1996) because the notion of hypertext was influenced by a system called "memex" which Vannevar Bush had conceptualized around that time (Lampert and Ball, 1990). According to Chia-Shing and Moore (1996), a hypermedia system is characterized by two qualities. First, a hypermedia system has the ability to provide information in a non-linear fashion. According to Chia-Shing and Moore, "The informational fragments in the hypermedia environment are linked based on users' real-time decisions, not on a predetermined sequence."

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Second, a hypermedia system provides information in a variety of formats, such as text, graphics, and video.

According to Chia-Shing and Moore, the computer industry developed hypermedia systems by integrating data bases with multimedia systems. Eventually, the industry built hypermedia systems which served as authoring tools such as 'Hypercard' or communication tools such as the various internet applications. In the area of commerce, establishments like museums and publishing companies use hypermedia systems as resource or presentation tools. Inspired by the various developments of the use of hypermedia systems in commerce and industry, more and more educators began to use these systems for instructional purposes (Chia-Shing and Moore, 1996). More recently, hypermedia systems have been hailed as "one of the most promising media for future educational reform" (Chia-Shing and Moore, 1996; Campoy, 1992; Dede; 1992).

If educational technologists are to help college teachers make use of brand new computer technology, they must know how professors will react when confronted with new systems such as hypermedia. Educational technologists must be aware of the factors that influence professors and the dynamics of the process of adoption to facilitate effective and efficient use of new systems. This investigation joins the few studies which have looked at the dynamics of the use of new technology and how the teacher's background, experiences, and intentions related to her implementation of computer use in the classroom.

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## An Overview of the Study

This is a case study of an experienced college instructor who for the first time used hypermedia, a state-of-the-art computer technology, as an aid to teach her students how to teach mathematics. The instructor used the Student Learning Environment (SLE) program (a hypermedia application) and the appropriate hardware to teach a portion of a course on teaching methods. The study intends to describe how the teacher first learned to use this cutting-edge computer program and incorporated its use into her teaching, planned to use it, and actually implemented parts of it to teach in several segments of the methods course. I was interested in finding out how the instructor would pursue her classroom teaching as a first-time user of this state-of-the-art computer technology. Initially, the primary question pursued in this study was: What are the dynamics involved in a teacher's use and integration of state-of-the-art computer technology into her classroom teaching? As the study developed, this question narrowed down to the following: What are the issues surrounding the dual role of the teacher as a change agent and a client? Thus, in this qualitative investigation, I focused on the instructor's perceptions of computer use in her course, observations of the class activities, and analyses of class materials and students' projects.

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### **Origin of the Study**

Why a study on a teacher's perceptions of computer use in her teaching, and the duality of her role in the use of the computer technology? Initially, I was very much intrigued and fascinated by the new technologies that people were developing. My initial encounters with computer technology were in college in the Philippines when I had my very first computer courses. The first course was an introduction to computers and the second was an application of computer use in business settings. I associated using computers with doing mathematics and I loved working with numbers. Then when I worked in a bank, I had the opportunity to use a computer spreadsheet. In both school and work experiences, my encounters with the computer was minimal because there were very few computers available. When I came to the United States to pursue my graduate education, I had the opportunity to use the computer again as a student and student employee. In all of these experiences, I used IBM-compatible computers.

After receiving a master's degree in Learning and Cognition, I had an opportunity to learn to use a Macintosh computer and specifically, the HyperCard program, which was just released at that time. I also enjoyed draw and paint programs. Since then, I was inclined to use Macintosh computers and was fascinated by the user-friendliness and compatibility of the programs. In my masters and doctoral programs I learned about Basic and Logo, and I became interested in wanting to understand the uses of technology, and meaningful ways that teachers have taught with them.

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My fascination with computer technology, which influenced me to do a research study on computer use, has now become a second reason to a much more important purpose. I have become interested in the users of the computers, specifically the teachers who use these machines for teaching purposes. This interest started when I worked as a graduate assistant for the Mathematics and Teaching through Hypermedia (or M.A.T.H.) project. As I worked on technical tasks for the M.A.T.H. project, I encountered videotapes of Drs. Lampert and Ball, who had taught mathematics to fifth-grade and third-grade children, respectively. Later on, given the opportunity to observe Dr. Ball actually teach a mathematics methods course to preservice teachers using the hypermedia, I noticed a purposeful instructor who encouraged her students to be the same with regard to their own learning. Through her use of the hypermedia in teaching prospective teachers how to learn about learning to teach, I observed how Dr. Ball intricately intertwined hypermedia use into the purposes of her lessons. Observing Dr. Ball's Teacher Education class was my first personal encounter with a teacher who actually integrated technology use to classroom instruction and learning. Her use of technology per se came second as it remained supportive of the purposes of the lessons. Thus, when I heard that other mathematics methods instructors were going to use the hypermedia in their classes, I jumped on the possible opportunity to observe one of the teachers. I was granted a wonderful and exciting opportunity which led me to do this research study.

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## CHAPTER TWO REVIEW OF THE LITERATURE

## A Teacher's Roles in a Diffusion of Technological Innovation in Education

This review is to achieve the following main objectives: 1) to explain the framework and the vocabulary used to understand the problem, and to clarify the method of analysis; and 2) to relate this study to similar empirical work and to distinguish it from other recent research since the study was done in 1994.

This study is concerned primarily with how college teachers incorporate the use of cutting-edge technology into their teaching. While focusing on the dynamics of a teacher educator's use of a hypermedia program in teaching a mathematics methods course, the study's main questions include: 'What is the teacher's role as a *client* as she pursued her teaching tasks while incorporating the use of a technological innovation?' and 'How did the teacher portray her role as a *change agent* as she introduced the technological innovation to her students and helped them use it as a means to learn about the course's subject matter?'

Thus, f overview: dit featuring the innovation?, (see Table 2.1 the education diffusion of 1 Who is the te research infe the final sect learning and THE ( Ques

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Thus, following are the parts of this literature review. First, a general overview: diffusion and diffusion of technological innovation are explained featuring the work of Rogers in the sections entitled 'What is diffusion of innovation?,' 'Who is a client?,' and 'Who is a change agent?,' respectively (see Table 2.1). Second, I summarize diffusion of technological innovation in the educational arena according to Havelock in the sections entitled 'What is diffusion of innovation in education?,' 'Who is the teacher as client?,' and 'Who is the teacher as change agent?,' respectively. Third, I provide recent research information related to learning and use of hypermedia technology in the final section entitled 'The current knowledge pertaining to teacher's learning and use of technology.'

## TABLE 2.1

The General Diffusion of Innovation Framework			
Questions	Aspects of Diffusion	Subcomponents	
What is diffusion of innovation?	A. Definitions of diffusion (Rogers, 1983, 1995)		
	B. Components of a diffusion process (Rogers, 1983, 1995)		
	C. Definition of technology (Rogers, 1983, 1995)		
	D. Characteristics of technological innovation (Rogers, 1983)		

#### THE GENERAL DIFFUSION OF INNOVATION FRAMEWORK

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Who is a client?	A. Potential adopter:	<ol> <li>Time-oriented innovator (Rogers, 1983, 1995)</li> <li>Decision-maker a. Stages of a decision- making process</li> <li>Types of decisions (Rogers, 1983, 1995)</li> <li>C. Consequences of decisions made about an innovation (Rogers, 1983, 1995)</li> </ol>
	B. Potential beneficiary (Kettner, Daley, and Nichols (1985)	
Who is a change agent?	A. Change agents as linkers (Rogers, 1983, 1995)	
	B. Change agents who bring about change for the clients' welfare (Rogers, 1983, 1995)	1. Factors which help a change agent achieve her goals in bringing about a client to adopt an innovation

## The General Diffusion of Innovation Framework

## What is diffusion of innovation?

This section presents the general topic of diffusion of innovation in order to give readers a broad perspective about the concept and to set the base for the more specific area of diffusion of innovation in *education*. The researcher chose to summarize Everett M. Rogers' ideas about the matter since he has examined it in an indepth fashion, based on a broad range of situations and experiences of people from different walks of life. To this date,

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the very first edition of Rogers book, *Diffusion of Innovations*, in 1962 has undergone three revisions. Rogers specified how the trend of his thoughts and writing changed and these shifts were based on approximately 4,000 publications published on the topic of diffusion. In his latest revision (1995), the author, while asserting a critical stance, examined the established diffusion concept for its flaws and inadequacies as a way to develop new ideas about diffusion.

This section on the general description of diffusion of innovation consists of four parts (see Table 2.2): The subsection on *Definitions of diffusion* describes a broad diffusion process. Components of a diffusion process defines elements of a program in which a diffusion of innovation process in involved. *Definition of technology* describes the hardware and software aspects of a technological innovation. Finally, *Characteristics of technological innovation* pertains to the attributes of an innovation which influence a client's rate of adoption.

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### TABLE 2.2

### WHAT IS DIFFUSION OF INNOVATION?

What is Diffusion of Innovation?		
Aspects of Diffusion	Basic Elements	
A. Definitions of diffusion (Rogers, 1983, 1995)	<ul> <li>process</li> <li>communication</li> <li>new ideas</li> <li>social change</li> </ul>	
B. Components of a diffusion process (Rogers, 1983, 1995)	<ul> <li>innovation</li> <li>communication channels</li> <li>time</li> <li>social system</li> </ul>	
C. Definition of technology (Rogers, 1983, 1995)	<ul><li>software</li><li>hardware</li></ul>	
D. Characteristics of technological innovation (Rogers, 1983)	<ul> <li>relative advantage</li> <li>compatibility</li> <li>complexity</li> <li>trialability</li> <li>observability</li> </ul>	

Definitions of diffusion. Rogers (1983, 1995) defined diffusion in three inclusive ways, namely, (1) it is a *process* which involves *communication* that occurs over time and among the constituents of a unit, and (2) includes *new ideas* involving some degree of uncertainty. (3) Diffusion brings about *social change* in the organization and purpose of the unit.

<u>Components of a diffusion process</u>. The diffusion process has four main components, namely, innovation, communication channels, time, and the social system. These components are elements of every study or program involving diffusion of an innovation. Taking each element at a time, an *innovation* is a concept, thing, or a way of life which a person or social system

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intending to adopt perceives as new. As he defined the concept of newness further, Rogers (1995) explained that

"Newness in an innovation need not just involve new knowledge. Someone may have known about an innovation for some time but not yet developed a favorable or unfavorable attitude toward it, nor have adopted or rejected it. "Newness" of an innovation may be expressed in terms of knowledge, persuasion, or a decision to adopt." (p. 11)

A communication channel is an approach or method used in an exchange of information from one person or unit to another individual or unit. Because diffusion is an activity focused on the interchange of new ideas from one person to another, the activity itself is comprised of four components, namely, the innovation, a person or social system knowledgeable about the innovation, a person or social unit unfamiliar with the innovation, and the communication channels bridging the gap between these two groups of people.

Then, the concept of *time*, which is essential, is present in three aspects of the diffusion process. First, the person who goes through an innovationdecision process spends time passing through the phases involved in finding out and learning about the innovation, weighing its aspects, and deciding on its use. More specifically, there are five stages involved and these are knowledge, persuasion, decision, implementation, and confirmation. Second, the classifications contained in the adopter categories are based on the time a person decides to accept or decline an innovation. These categories include innovators, early adopters, early majority, late majority, and laggards. Third, the concept of time is observed in the measure called rate of adoption. This determines the relative speed individuals of a unit adopt a new idea.

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pronounced <u>Chara</u> technologica rate of adop the follow in Finally, a *social system* is an assemblage or unit which is made up of interconnected constituents. The members of a social system who may be individuals or subsystems work collectively in pursuance of a common resolution.

Definition of technology. There are different kinds of innovations and technology is one. According to Rogers (1983, 1995), technology is "a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (p. 12). Moreover, he described a technological innovation as having two components, namely, hardware and software. The hardware portion is a device that serves as embodiment for the technology and the software aspect relates to the data supply for the device. To illustrate this, the author depicted the hardware as computer hardware which is comprised of electrical components and the metal case to protect them, and the software as computer software which is made up of codes and commands which people could use to help solve problems. Although in this illustration, the hardware aspect is very obvious, which is the case with equipment-type technological innovations, this is not true with some types of innovations, like a philosophical idea or religious notion. In addition, although at times the hardware aspect is more pronounced, at other times, it is the software component.

<u>Characteristics of technological innovation</u>. Based on research, technological innovations have five characteristics which help explain the rate of adoption more than any other qualities (Rogers, 1983), and these are the following: (1) As people rate an innovation and its alternatives, *relative* 

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advantage refers to the degree that they perceive an innovation as better when compared to the others. Prestige, convenience, and satisfaction are sample measures of this characteristic. (2) Compatibility describes how well a potential client sees an innovation as being congruent with her past, her present beliefs, and her needs. (3) Complexity relates to how an individual discerns an innovation to be simple or complicated to comprehend and adopt. (4) Trialability pertains to whether an innovation may be tested or not on a trial run, and (5) observability refers to how well the consequences of innovation use are evident and comprehensible.

Having provided a general foundation for the review of the literature, what follows are two important roles present in the diffusion process, namely, the client and the change agent. Immediately following this introduction, the topic, *Who is a client?*, deals with various aspects of the characteristics of a person or social system that has an intention to acquire an innovation. Although the portrayal of the client role continues to be broad in this section of the review, this serves as a stepping stone for comprehending the teacher's role as a client in the latter part of this chapter. Based on the literature, the client pursues two general kinds of roles, namely, as potential adopter and as potential beneficiary. These two roles are described in great detail in the following section:

#### Who is a client?

Based on numerous studies, researchers developed models of a client as potential adopter (Rogers, 1983, 1995; Zaltman and Duncan, 1977) and as potential beneficiary (Kettner, Daley, and Nichols, 1985). Taking the first one, the client as a potential adopter takes more or less time to adopt an

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Aspects Diffusi A. Potentia adopter innovation. The classifications involved may be described by the relation between promptness to adopt and the types of relationships the client has with other members within her social unit. A person having very good associations with people tend to adopt an innovation earlier than others. In this situation, the client is described as being *time oriented*. A potential adopter also may be described as a *decision maker*, who pursues several phases of learning about an innovation before making the final decision to adopt or reject it. The client's third role is as potential beneficiary, assessing the effect of technology use on her. Thus, following are descriptive elaborations of the client's three roles (see Table 2.3):

# TABLE 2.3

WHO	IS A	<b>CLIENT?</b>

Who is a Client?			
Aspects of Diffusion	Subcomponents	Basic Elements	
A. Potential adopter	1. Time-oriented innovator (Rogers, 1983, 1995)	<ul> <li>innovators</li> <li>early adopters</li> <li>early majority</li> <li>late majority</li> <li>laggards</li> </ul>	

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	making process	• attitude
		• legitimation
		• trial
		• evaluation
		• symbolic adoption
		• adoption or rejection
		(Zaltman and Duncan, 1977)
		• knowledge
		• persuasion
		• decision
		<ul> <li>implementation</li> </ul>
		• confirmation
		(Rogers, 1983)
	b. Types of	• optional innovation-decisions
	decisions	• collective innovation-decisions
	(Rogers 1983	• authority innovation-decisions
	1995)	• contingent innovation-decisions
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<u>The potential adopter: A time-oriented innovator</u>. According to Rogers (1983, 1995), individuals belonging to a social system differed in the promptness they adopted an innovation. Because logging the individual adoption time within a social system was a tedious task, Rogers decided to

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classify people based on adopter categories which delineated innovativeness according to the following five descriptions: innovators, early adopters, early majority, late majority, and laggards. Taking each description at a time, first, daring to take risks, an innovator's main role is as a gatekeeper, being responsible for bringing and launching in the social system innovative ideas from the outside boundaries. Innovators mingle with a cosmopolite group instead of the local network, and with a group of innovators even though they may be separated by considerable physical distance from one another. Second, taking leadership among local peers in adopting an innovative idea, an early adopter's main role is to add certainty to it and manifest its worth to peers within the local network. Compared to the innovators who belong to a cosmopolite group, early adopters are an integral part of the local network and the other members seek them for opinion and advice about an innovation. Third, the early majority deliberate longer than the innovator and early adopter before adopting an idea. The early majority have frequent interactions with the local peers but do not take lead roles within their circle. Within the social system, they serve as a linkage, being in between the very early adopters and the ones who lag behind. Fourth, the late majority are skeptical about the innovation and adopt only after the average number of people do. Waiting for favorable signs from others who have adopted ahead of them, the late majority are pressured to adopt due to financial reasons and by their peers within the local network. Fifth, laggards cling to the traditional. Segregated from others within the social system, laggards are usually the last to adopt an innovation; thus, they almost do not hold any opinion leadership. Being the last to adopt could be due to traditional values and limited financial resources.

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<u>The potential adopter: A decision maker</u>. The potential adopter's role as decision maker is described in two ways, namely, by the decision-making process a person goes through and by the kinds of decisions she acts on. Further details about both aspects of the decision-making process are as follows:

a. The stages of a decision-making process. According to Zaltman and Duncan (1977), before the decision to adopt or reject an innovation occurs, a person goes through several stages of the decision process, which include perception, motivation, attitude, legitimation, trial, evaluation, and symbolic adoption. Then, the adoption or rejection stage follows after which the final step, resolution, takes place. In a similar way, Rogers (1983) described a decision-making process which is comprised of five levels, namely, knowledge, persuasion, decision, implementation, and confirmation. Because these two types of processes seem to overlap, following is a description of the process flow, taking the similarities of both activities into consideration, where appropriate. Being comprised of more levels than Rogers', each of Zaltman and Duncan's decision phases is described first and interrelated with the corresponding Rogers' levels, when available.

Taking each phase at a time, *perception* begins the decision process. For the actual adoption to occur at a later phase, the client needs to perceive both the need and innovation. A person realizes that an innovation is important for a specific need only after being thoroughly familiar with the innovation. The perception phase is characterized by several factors: (1) Although there are times when investigators impose their own perceptions in order to attain a fit when classifying them, it is important to insist on the

dient's perc individuals be taken in (3) It would has over th phase is Ro about an in In the barriers to c occurring an those which out a proble <sup>chan</sup>ge are of a need, t are the one <sup>their</sup> probie <sup>control</sup> ove ln th <sup>innovation</sup> <sup>beliefs,</sup> but <sup>com</sup>ponent: Zaltman an <sup>place</sup> when <sup>not to</sup> a pre

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client's perceptions. (2) Changes in perceptions are bound to happen as individuals proceed through the decision process and these changes need to be taken into account as their influence take place in individuals' behaviors. (3) It would be helpful to take note of the degree of control a client thinks she has over the change process. Related to Zaltman and Duncan's perception phase is Rogers' *knowledge* level. During this time, an individual learns about an innovation and how it operates.

In the *motivation* phase, a client may learn to overcome certain barriers to change. Two kinds of behaviors which could hinder change from occurring are: ones which people are comfortably and regularly doing, and those which people have attained successfully during their first try at working out a problem. Several factors which could influence the occurrence of change are the following: (1) The more individuals feel they were deprived of a need, the more they would pursue change; (2) people willing to change are the ones who discerned that an innovation is capable of straightening out their problem; and (3) some prefer change once they feel that they have control over things which affect them.

In the *attitude* phase, as people increase their knowledge about an innovation from inquiring and reading about it, they also begin to develop beliefs, but are marginal at this time. This stage is comprised of three components, namely, cognitive, affective, and behavioral. Corresponding to Zaltman and Duncan's attitude stage is Rogers' <u>persuasion</u> level which takes place when a potential adopter begins to discern an innovation as agreeable or not to a present problematic situation.

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The *legitimation* phase occurs when an individual looks for additional supporting evidence in order to be certain that a specific action is befitting the situation for which it was intended. This stage is characterized by social interaction as the individual resorts to other people either to follow how they perform an operation or to seek an approval. Related to Zaltman and Duncan's legitimation phase is Rogers' *confirmation* level which takes place when a person acquires more information about an innovation she decided to take. But this decision may change if she finds out any unfavorable information about the innovation.

In the *trial* phase, the client personally tests the innovation before adopting it completely. In cases where performing actual tests are not possible, people go through this stage through vicarious experience. Similar to Zaltman and Duncan's trial phase is Rogers' *implementation* level which occurs when a potential adopter tries an innovation and revises it where appropriate.

The *evaluation* phase is essential before adoption takes place. This stage involves an analysis of the advantages and disadvantages of using an innovation. Corresponding to Zaltman and Duncan's evaluation phase is Rogers' *decision* level which occurs when an individual discerns the benefits and drawbacks of using an innovation through communication with peers. The individual tries to prepare oneself for any adverse repercussions that may occur.

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In the symbolic adoption phase, a client experiences constraints in adopting an innovation either in actually using it or in her attitude toward it (which the authors termed as "symbolic adoption as a point of lag" and "behavioral adoption as a point of lag," respectively). If the case is a 'symbolic adoption as a point of lag,' an individual would not adopt an innovation either due to its unavailability or because it was unfit for the circumstance. If the case was a 'behavioral adoption as a point of lag,' the individual may be using the innovation but she may not be in total agreement with the idea of using it.

At the *adoption/rejection* stage, a client decides either to commit oneself to using an innovation or to forget about it. This phase includes three aspects, namely, cognitive, affective, and behavioral. Although these components are similar in type as those in the attitude phase, in the adoption stage the cognitive aspect is prime because it is based on personal experience and the affective state is stronger due to the commitment made. The commitment to change brings this phase to a value-state. The rejection stage occurs if a client feels an innovation to be unfit. This phase also includes the three aspects of the adoption stage and an individual feels similar intensity for each component. Zaltman and Duncan's adoption/rejection phase corresponds to Rogers' level with the same name. By adopting an innovation, an individual sees that utilizing it fully is peerless for one's purpose, and by rejecting, an individual does not adopt the innovation.

The final phase is *resolution*. In this stage, some individuals wholeheartedly adopt an innovation while others may hesitate if there are other options to choose from. Zaltman and Duncan's resolution phase is

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comparable to Rogers' *discontinuance* level which occurs when an individual decides to change a previously-made decision due to a dissatisfaction or satisfaction with an innovation, or to a discovery of a better idea or a conflicting one.

b. Types of decisions. According to Rogers (1983, 1995), there are four types of innovation decisions. The first three are based on the people who make them and the fourth is dependent upon a previously-made decision to adopt or reject an innovation. The first set of decisions comprised of three types include the following: (1) Optional innovation-decisions are choices which an individual acts on, although the social system she belongs to may have some influence on the decisions she makes. (2) Collective innovationdecisions are options which constituents of a social unit choose from in agreement and as a whole group; and (3) authority innovation-decisions are options which a small group of people with authority act on. Rogers (1995) described how these decisions have appeared in real-life experiences:

"Collective and authority decisions are much more common than optional decisions in formal organizations, such as factories, schools, or government organizations, in comparison with other fields like agriculture and consumer behavior, where most of the innovationdecisions by farmers and consumers are optional." (p. 29)

The fourth type of decisions, the *contingent* innovation-decisions, are choices made only after a previous decision on an innovation has been acted on.

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c. Consequences of decisions made about an innovation. According to Rogers (1983, 1995), deciding about an innovation results in modifications in an individual or unit, and there are at least three kinds of these consequences, namely, (1) desirable versus undesirable results which pertain to innovation use which were found to be either useful or not to a social entity; (2) direct versus indirect results depending on whether the consequences of innovation use was an immediate effect on the social entity or resulting from a direct consequence of innovation use; and (3) anticipated versus unanticipated results which refer to whether the effects of innovation use were the expected outcomes or not.

<u>The potential beneficiary</u>. In this section, the client as a potential beneficiary is described in two ways, namely, based on how participants of a change process would benefit from it and according to the consequences of decisions made about an innovation. Following are detailed descriptions about each aspect:

a. Participants of a change process. Kettner, Daley, and Nichols (1985) mentioned that a change process involves the participation of five types of individuals, groups, organizations, or communities which include the change agent, initiator, client, target, and action systems. In addition to describing the clients as participants of the client system, these authors also explain the possibilities of clients taking part in the initiator, target, and action systems. First, the participants of the *client system* are expected to be the main beneficiaries of the change process. There are two types of beneficiaries, namely, primary and secondary. Clearly being the ones affected by change, primary beneficiaries are people whose quality of life directly and tangibly

turned for beneficiari the change their needs system to t system cou beneficiari or groups target syst and its par the initiato coordinato who take p accomplish delineated are possibl <sup>to</sup> be accor objectives ; resources. To s <sup>namely</sup>, as two import <sup>chan</sup>ge age <sup>betwee</sup>n a ( <sup>describes</sup> t} <sup>namel</sup>y, as turned for the better due to the planned change. As compared to primary beneficiaries, secondary beneficiaries gained less directly and tangibly due to the change. Second, the people involved with the *initiator* system inform their needs, issues, or concerns to the change agent system, and request the system to take action. Aside from possibly having multiple initiators, the system could also include the client system, to which the expected beneficiaries of change belong. Third, the *target* system is composed of people or groups who require shifting in order to fulfill the purposes of change. The target system's components may be altered throughout the change process and its participants may include the change agent, the sanctioning institution, the initiator, or the client. Fourth, with the change agent system as the main coordinator, the participants of the *action* system include people and groups who take part in designing the objectives for change and pursue to accomplish the tasks involved. The activities of the action system could be delineated in two, namely, the *planning* and *implementing* systems. Clients are possible participants of the planning system which is responsible for tasks to be accomplished before the implementation phase and include setting objectives and exploring ways to achieve them through the available resources.

To sum up, the client system may be described in two general ways, namely, as potential adopter and as potential beneficiary. The client is one of two important roles present in a diffusion process. The other role is that of a change agent who possesses a very essential part, that of being a mediator between a change agency and a client. The following subsection further describes the change agent's role which could be manifested in two types, namely, as a linker and as someone concerned about a client's welfare.

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## Who is a change agent?

A change agent has an explicit task of influencing clients' decisionmaking processes which are related to and according to the change agency's policies. In their encounters, the change agent works to build an open communication with the clients so that both parties are able to share similar information and encourage a common understanding of matters. Following is a discussion and description of the various roles of a change agent (see Table 2.4).

### **TABLE 2.4**

### WHO IS A CHANGE AGENT?

Who is a Change Agent?					
Aspects of					
Diffusion	Subcomponents	Basic Elements			
A. Change agents as linkers (Rogers, 1983, 1995)		<ul> <li>to develop a need for change</li> <li>to establish an information- exchange relationship</li> <li>to diagnose problems</li> <li>to create an intent in the client to change</li> <li>to translate an intent to action</li> <li>to stabilize adoption and prevent</li> </ul>			
		discontinuance • to achieve a terminal relationship			
B. Change agents who bring about change for the clients' welfare (Rogers, 1983, 1995)	1. Factors which help a change agent achieve her goals in bringing about a client to adopt an innovation	<ul> <li>the extent of change agent effort in contacting clients</li> <li>how a change agent directs her activities toward a client orientation</li> <li>the degree to which a diffusion program is compatible with clients' needs</li> <li>empathizing with clients</li> <li>credibility in the clients' eyes</li> <li>increasing client ability to evaluate innovations</li> </ul>			

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a. To letting her in existence introduces informs the <u>Change agents as linkers</u>. The role of change agent comes about due to disparities in social and technical beliefs between a change agency and a specific client system. Thus, through the process of a diffusion of an innovation, the change agent serves as a link between these two systems. According to Rogers (1995),

"One of the main roles of a change agent is to facilitate the flow of innovations from a change agency to an audience of clients. For this type of communication to be effective, the innovations must be selected to match client's needs. For the linkage to be effective, feedback from the client system must flow through the change agent to the change agency so that it appropriately adjusts its programs to fit the changing needs to clients." (p. 336)

According to Rogers, the role of the change agent as a linker has three essential aspects, namely, to find out an innovation which is helpful to a specific client's needs, to communicate this information back to the change agency, and to deliver a program from the change agency which hopefully is appropriate for the need which the client initially expressed. Rogers outlined seven steps which change agents take to introduce an innovation to their clients. These are:

a. To develop a need for change. The change agent begins her task by letting her clients know of a specific problem which they noticed and has been in existence for some time or which the change agent helped create. She introduces alternative ways to treat the problem, explains its importance, and informs the clients that they are capable of overcoming it.

**b**. To agent tries to because clier innovation. competent, **c**. To client's orie approaches **d**. To alternative toward a sp e. To clients chie the change the client t f. To <sup>the</sup> change <sup>innov</sup>atio; **g**. To <sup>works</sup> to e

<sup>innovation</sup>

b. To establish an information-exchange relationship. Then the change agent tries to build a good relationship with clients. This phase is important because clients would accept a change agent first before they would the innovation. For this reason, the change agent tries to show her best in being competent, trustworthy, and sensitive to the clients' situation.

c. To diagnose problems. While focusing on and being sensitive to the client's orientation, the change agent examines the previously-taken approaches which were unsuccessful in solving the problem at hand.

d. To create an intent in the client to change. After looking through alternative pursuits to solving the problem, the change agent tries to lean toward a specific innovation.

e. To translate an intent to action. The change agent is aware that clients chiefly are influenced by the interpersonal network they belong. Thus, the change agent gathers suggestions from peers in order to try to influence the client to check out the innovation.

f. To stabilize adoption and prevent discontinuance. During this time, the change agent encourages that clients maintain their decision to accept an innovation.

g. To achieve a terminal relationship. By this time, the change agent works to exit from the scene by helping clients become confident in using an innovation to the point of self-reliance.

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<u>Change agents who bring about change for the clients' welfare</u>. There are factors which would help a change agent achieve her goals in bringing a client to adopt an innovation. Rogers (1995) provided some of these tips which focus on dealing with specific aspects of one's relationship with the client:

a. The first factor deals with the extent of change agent effort in contacting clients. It is important for a change agent to give her best as she deals with the clients. This factor includes elements like, how much time she spent with clients and when during the diffusion process she came in contact with them, among other components.

b. The second factor which could bring about a change in the clients' lives is if the change agent directed her activities according to *a client orientation, rather than to a change agency orientation*. Every change agent's role has potential for tug-of-war as she is pulled from opposite directions by the change agency and the clients. As the change agent deals with clients, she performs according to the change agency's expectations of her as a professional. However, these ways usually are incongruent to how clients would like to be approached and treated. In order to be successful, a change agent needs to work based on her client's expectations. What would help is if she were open to her clients' input and suggestions, if she builds good relations with them, and if she acts according to their needs.

c. A third factor that could contribute to change is the degree to which a diffusion program is compatible with clients' needs. Although it is important for a change agent to consider her clients' needs, she ought not to

allow them not related 1 into account would supp d. A helpful in fi difficulty of do and plac would see 1 e. Th ensue in a c up to the cl credibility, know ledge: trustworthy of both type f. Fir her role is t For some cl <sup>proposed</sup> c <sup>goal.</sup> In the <sup>learn</sup> a chai <sup>assess</sup> inno<sup>,</sup> <sup>agent</sup> role. allow them to take over the situation which could result in decisions that are not related to the initial purposes for change. The change agent should take into account the clients' needs in order to come up with a program which would support them beneficially in the long run.

d. A change agent would find that having *empathy* with clients is helpful in fulfilling her role. Some change agents are challenged by the difficulty of understanding their clients' situations. However, the more they do and place themselves in their clients' shoes, probably the better clients would see the importance of an innovation for their purposes.

e. The fifth factor is *credibility in the clients' eyes*. For good relations to ensue in a change agent-client relationship, it is essential for clients to look up to the change agent and find them credible. There are two kinds of credibility, namely, *confidence credibility* which pertains to being seen as knowledgeable, and *safety credibility* which refers to being observed as trustworthy. The ideal situation is when the change agent possesses a balance of both types.

f. Finally, the sixth factor which aids a change agent in the pursuance of her role is to promote an *increasing client ability to evaluate innovations*. For some change agents, their end goal is for their clients to adopt the proposed change. However, in most cases, this should remain a short-term goal. In the long run, what really would be important is when clients get to learn a change agent's technical skills, as well as those that would help them assess innovations by themselves. Then clients, in turn, assume the change agent role. Up to this point, what has been discussed was the general topic of diffusion of innovation which included specific areas within the main headings of What is diffusion of innovation?, Who is a client?, and Who is a change agent? Within the first heading about diffusion of innovation, the following subtopics were dealt with: the definition of diffusion, the components of a diffusion process, the definition of technology, and characteristics of technological innovation. The second heading which talked about the client described her as a potential adopter who is time-oriented and a decision maker, and as a potential beneficiary. Finally, the third heading presented the nature of a change agent who is a linker between a change agency and a client system, and who helps bring about change for the client's welfare.

The next section of the literature review is focused on the educational arena mainly because the present study is about a teacher who went through the process of diffusion while she taught a course. The topics that follow fall under three main headings, namely, What is diffusion of innovation in education?, Who is the teacher as client? and Who is the teacher as change agent? Just as in the earlier section, I provide broad descriptions of each topic in this section in order to describe and understand them fully. In addition, these general descriptions could help readers gain some perspective as to where we are at or how much has been done with regard to the topics at hand. These topics are dealt with respectively.

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### The Specific Framework for Diffusion of Innovation in Education

#### What is diffusion of innovation in education?

This section discusses the work of Havelock (1973) who defines the diffusion process as it is applicable to the educational arena. According to him,

"This is a guide to the process of innovation. It is written for the many educators who are working for reform at all levels, helping school systems, schools, and individual teachers learn about new developments in administration, classroom management, curriculum, and teaching methods." (p. 3)

The author created a guide in which he outlined the diffusion process through definitive stages. He based the procedures on the perspective of the change agent who could be any one of the numerous educators involved with change processes in the lines of administration and teaching.

Havelock described the diffusion process foremost as a *planned* set of procedures. Between the present situation and the kind of future we hope the situation could turn into are six delineated stages which comprise the diffusion process. These six phases include the following: Stage I, *relationship*, occurs as the change agent works to establish good relations with the client system. Proceeding to Stage II, *diagnosis*, the change agent sets to examine and define the problem and to find out how well the client has been aware of it. The diffusion process at Stage III, *acquiring relevant resources*, occurs as the change agent seeks possibly useful resources for solving the problem at hand. Being equipped with pertinent knowledge, the change agent choice

ľ C ŀ cl ir m 0 c'n st ra ch ex **a** 5 for a solution and adjusts it as is necessary in order to conform it according to the client's needs. By this time, the change agent's objective is Stage V, gaining acceptance, with the hope that the majority of the client system would agree to the choice of innovation and adopt it. Finally, in Stage VI, stabilizing the innovation and generating self-renewal, the change agent's goal is for the client to become self-reliant with regard to maintenance and appropriate use of the innovation.

After describing the aspects of a diffusion process, it seems appropriate to inform the readers about the lead roles in this type of performance in education. Because the present study is focused on the teacher, portrayals of roles are defined from a teacher's perspective. Thus, the teacher roles as client and change agent are discussed respectively.

### Who is the teacher as client?

Based on Havelock's description of the diffusion process above, the client system is the one whom the change agent helps to adopt an innovation. In addition, the author described three possible ways that a client may proceed through an adoption phase and these are: First, the client may opt not to do anything about a situation where a problem exists. Second, in *change by simple reflex*, the client behaves in reaction or resistance to a stimulus and through the process of trial-and-error. Third, in *change by rational problem-solving*, the client goes through four steps, namely, (1) choosing to take action based on a need; (2) being involved actively in examining the need; (3) discerning possible relevant solutions; and (4) putting a solution to use in order to check its practical utility for a specific purpose.

Ab view. Th role furth summary teache**r** a and/or v **tea**ching B broadly some wi help to decision experie willing the lear experie their si them d want to descrip work Althou them ( met (S Above is a general description of a client from an educational point of view. The following subsection of this review intends to define the client's role further based on a teacher's perspective. In view of this, the following summary includes findings from research studies which examined the teacher as someone who learned about computer technology and its uses and/or were at a position to adopt or reject the technology for classroom teaching.

Based on the review of literature, studies described teachers as clients broadly: First, teachers saw computer use as an additional workload. While some were willing to adopt technology use, others preferred to hire outside help to teach students about computer-related topics. Second, teachers' decisions not to use technology were largely influenced by past negative experiences using educational technologies. However, other teachers were willing to try and integrate technology use into the curricula if it supported the learning theories. Third, as teachers adopted technology use, they experienced how it was both beneficial and, at the same time, not as helpful to their situations. Fourth, while teachers worked on technology use, some of them did not have the initiative to learn on their own, while others did not want to use a technology to its full capacity. Following are more specific descriptions about the teacher as a client.

Computer use was in one way or another associated with additional work load and this notion brought about varied reactions from the teachers. Although some teachers felt that technology use was an additional load for them to handle, they were willing to adopt technology use if some terms were met (Strudler and Gall, 1988). According to Strudler and Gall, these teachers

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felt burdened due to the additional work of incorporating technology use to their present planning and teaching loads. Other teachers preferred to integrate computer use to the curriculum if they would be able to focus on instructing students rather than preparing additional class materials (Strudler and Gall, 1988; Alifrangis, 1990). Part of some teachers' hesitancy or excitement to use computer technology could be influenced by their past. According to Strudler and Gall, teachers who had very negative past experiences in using educational technologies found it very difficult to adopt new technologies. However, viewing things from a different perspective, teachers felt that they could attain successful integration if computer programs were comparable to the present curricula and supportive of the learning theories (Alifrangis, 1990).

It seems that some teachers made up their minds not to use computer technology for their purposes. Many of them did not see how computer use could help improve their teaching tasks (Strudler and Gall, 1988). Strudler and Gall reported that while some were not convinced with the idea that all classroom teachers ought to integrate computer use to the curriculum, others felt that it was better to hire a computer personnel to teach students about the computer-related aspects of the curriculum.

Teachers who adopt computer technology gain a better perspective of its use. For some teachers, they realized that technology use could not be the ultimate answer to their problems. According to Strudler and Gall, as teachers discovered the usefulness of an innovation, at the same time, they discerned how the same innovation could not provide help in other situations. Based on these teachers' specific experiences, in trying to supplant

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necessarily co ways to apply and/or busyr innovation. seemed reluc (Keefe, 1986). initiative to ]. students with <sup>time</sup> on com<sub>i</sub>  $\mathsf{Teach}_{\varepsilon}$ <sup>classroo</sup>m tea <sup>teachers</sup> reali <sup>com</sup>Puter tect <sup>learn</sup> to perfq <sup>comp</sup>uter use <sup>encountered.</sup> <sup>took</sup> one teac

the existing curriculum with computer-based curriculum, teachers had to work around the realities of current technology applications, including how the software fit into the curriculum, what resources were available, and what possibly could have helped teachers to use computers with ease. The same teachers realized that only part of the computer-based curriculum could replace the existing one, while the rest could provide additional related information (Strudler and Gall, 1988).

Adopting technology use for one's teaching purposes does not necessarily come easily. Aside from untoward experiences due to complicated ways to apply technology use, teachers might also feel bouts of disinterest and/or busyness which could affect their learning and/or use of the innovation. In one instance, a teacher trainer noticed that some teachers seemed reluctant to use an innovation to its full capacity or learn about it (Keefe, 1986). Keefe reported that, at times, the teachers did not have the initiative to learn. The teacher trainer observed that teachers did not provide students with follow-through guidance, nor were they willing to spend much time on computers, including trying things on their own (Keefe, 1986).

Teachers also experienced the fact that learning to use computers for classroom teaching was similar to other types of learning. In one instance, teachers realized how much they learned from their experiences in using computer technology (Gay, 1997). Gay reported that teachers did not only learn to perform teaching-related tasks but also acquired knowledge about computer use through working on the computer-related problems they encountered. Morever, learning about computer use took a lot of time. It took one teacher several years to learn the skill (McClure, 1996).
The ab client, which diffusion of it learn about to students about willing to use integrated tec innovation w while some t teaching took technology to change agent it is portrayed

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Strud) <sup>res</sup>ponsibiliti Process. In s <sup>disse</sup>minator The above information described teachers who portrayed the role of client, which is one of two important roles present in the process of a diffusion of innovation. As clients, some teachers were not at all willing to learn about technology use and opted for an outsider change agent to teach students about the technology-related aspect. In addition, other teachers were willing to use computer technology but on a limited basis. Teachers who integrated technology use into the curriculum experienced that the innovation was far from being the answer to all related problems. Moreover, while some teachers learned that adopting computer use to classroom teaching took time, others did not take full advantage to learn and use technology to its full capacity. Immediately following is a description of the change agent, which is the other major role present in a diffusion process, as it is portrayed in the education field.

#### Who is the teacher as change agent?

Two authors examined the role of the change agent as it is portrayed in school settings. First, Strudler and Gall (1988) discussed the change agent as a non-school personnel hired specifically to attend to the needs of school personnel as they undergo change processes. Second, Havelock (1982) described four types of change agent roles. These two portrayals of the change agent role are described as follows:

Strudler and Gall defined a change agent as an aide whose responsibilities include introducing and guiding people through the change process. In schools, the duties of a change agent shifted from being a disseminator of pre-produced programs to attending to the needs of school

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personnel as they undergo the change process. The authors described four strategies which change agents utilized when they performed their tasks and these strategies are (1) resource-adding, (2) organizing and preparing, (3) training, and (4) collaborative problem solving. Taking each strategy at a time, a change agent pursued resource-adding by soliciting funds from the school and applying for external grants in order to be able to purchase necessary additional equipment. Because a change agent was aware of a teacher's general concern about having an overload of responsibilities, she would try to help the teacher with technologically-related tasks, like organizing things related to having a computer laboratory open for use and preparing the needed software and hardware equipment for ease of access. Then *training* involved helping teachers learn about the technology with confidence so as to ease and help facilitate its integration to the curriculum. Included in this main strategy were several supporting ones, like providing follow-up support, technical assistance, and emotional support; being nonjudgmental and non-evaluative; and encouraging teachers through supportive gestures of approval and demonstrating to them how to be effective with technology use. Fourth, the change agent worked collaboratively with individuals and groups of teachers. In addition, she met with the school's committee that was in charge of policies on computer technology use. According to Strudler and Gall, a change agent's attainment of goals would only be as far as the credibility she has established with her clients.

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After Strudler and Gall's discussion, another description of the change agent role was dealt with from a different angle. According to Havelock, change agents who go through a diffusion process manifest their roles in four different ways, and these are the following: First, the change agent as *catalyst* is one who helps instigate change in a system. People, like the student body, parents, or school board members, usually assume the change agent role in times when they feel that changes need to take place in certain aspects of an educational system and no one has acted upon the situation. Through voicing their opinions, they inform others about their dissatisfaction and pressure some to begin to make the necessary action to deal with these concerns. Second, the change agent as a *solution* giver provides useful ideas to help deal with a specific problem. A change agent who assumes this role would discern the best times and ways to offer her innovative ideas. In addition, she should have a good understanding of these ideas and their means to solve the problem at hand in order to be of help to a client. Third, the change agent as a process helper assumes a very important task of helping a client go through problem solving and decision making processes. Included in these procedures are the following stages, namely, (1) identifying the problem, (2) examining it and defining necessary objectives, (3) procuring important resources, (4) searching for solutions, (5) accommodating them to conform to the needs of the situation, and (6) determining the usefulness of the solutions to the present problem. Fourth, the change agent as a resource *linker* provides a client with help in looking for relevant resources which may range from financial to human resources. In a substantial way, the change agent aids the client in looking for these resources and applying them through optimal means.

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Because the first description of a change agent clearly is about a nonschool personnel who was hired to fulfill the task of helping other school personnel, the present study is not interested in this at the moment. Currently and on a broad perspective, the change agent role which the study is interested in should include regular school personnel. Although Havelock does not discount the fact that his discussion of the change agent role may include the hiring of non-school personnel to fulfill the task, his role description also includes the possibility of regular school personnel as possible change agents.

Havelock's description of a change agent is a role that may be assumed by various personnel involved in educational administration and teaching. In the following section, the study focuses specifically on defining the *teacher* as a change agent. According to Cantor (1992),

"All instructors share a unique opportunity to act as "change agents"... As an instructor of adults, your major responsibility is to instill a desired set of behaviors in your learners by providing guidance, support, direction, and suggestions. In your classes, you will discuss, demonstrate, critique, and sometimes lecture. Your learners will learn new information and skills, new ways of behaving and acting: in other words, you will function as a change agent for your learners." (p. 2)

In other words, by the nature of their work, teachers always assume the change agent role as they impart new knowledge to their students. Students may learn from the teacher directly through the new information that is being taught and indirectly through the teacher's ways of thinking, speaking, and acting as she implements instruction. So far, the teacher's role as change agent has been described as helping *students* learn. That is consistent with my study which is not interested in how a teacher influences other possible

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clientele including peer teachers. Finally, considering the role of change agent, my study is to examine a teacher who wanted to integrate computer technology use into the curriculum.

According to Aworuwa (1994), a teacher's integration of computer use in curriculum necessitates shifts in her previous teaching roles. One type of shift which computer use requires teachers to make is that from being an information provider to being a facilitator and "a learning partner" (p. 18). In describing the learner's role, a teacher would acquire knowledge, experience, and expertise. Teachers are uncomfortable with this kind of change because of several reasons, namely, (1) they do not have any idea about how to proceed with the change process; (2) as the shift takes place, they encounter numerous computer-related problems; (3) computer usage takes time, which includes the learning, planning, and implementation phases. Another shift that could take place in a teacher's role is that instead of working individually, she might see herself as a *team member* who may be a learning partner or peer teacher with regard to computer use. This idea came about because teachers are always involved as teams when working with curriculum innovations, either to learn or teach about an innovation. There also could be a shift in a teacher's roles as classroom manager as the teacher adjusts her management styles in accommodating students to learn with computers in groups.

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The teacher's tasks related to the integration of computer use in the curriculum is not simple, but requires creativity, especially in dealing with the necessary changes that would occur. According to Aworuwa (1994),

"Educators must begin to realize that the introduction of computers in education is a complex innovation which encompasses more than just bringing the hardware, the software packages, and some trained teachers together into schools. The process may require new teaching strategies, other types of classroom and school organization, other roles and tasks of the teachers, new relationships between teachers and students, and even new courses or new emphases in the content of existing courses" (p. 19).

According to Thomas (1996), having technology in the classroom redefined the teacher's role as *change agent*. Keeping in mind that this study is focused on examining a teacher who instructs students with technology use, following is the literature review focused on teachers as change agents:

Teachers integrated technology use to the curriculum in the elementary (Lecuyer, 1997; Stephen, 1997), high school (McClure, 1996) levels. The methods which teachers used were the following: Two elementary school teachers integrated the use of four computers (in each of the teacher's classroom) to the curriculum (Lecuyer, 1997). Other teachers attended inservice sessions and kept journals on technology use in the classroom (Thomas, 1996). One high school instructor integrated technology use to a physics curriculum and found out that this setup provided students with invaluable learning experiences (McClure, 1996). McClure reported that, at the same time that the physics instructor taught, he progressively learned new ways to integrate technological innovations to the curriculum and worked to understand their implications to student learning. Findings about

corr use one com proc teach comp teachi (Step† proces (Lecuy more s time to (Lecuye train, ar (Cherno with tec first and fostered computer integration include the fact that learning to integrate technology use to the curriculum takes a long time to do and it simply cannot happen on one occasion (McClure, 1996; Lecuyer, 1997). In addition, aside from gaining a command in computer knowledge, teachers learned about the integration process of computer use to classroom instruction (Lecuyer, 1997). Moreover, a teacher's manner of designing classroom activities which are related to computer usage are influenced by how she makes use of technology as a teaching tool and how she views it as being beneficial for student learning (Stephen, 1997). Factors which helped teachers go through the integration process included having a computer at home and attending training sessions (Lecuyer, 1997). Hindrances which otherwise could have contributed to a more successful curriculum-computer use implementation included lack of time to learn about technology use, access to on-site technical assistance (Lecuyer, 1997), apprehensions with technology use, inadequate chances to train, and lack of support from the school district and other teachers (Chernow, 1997). Finally, positive results came out from teachers' teaching with technology use. Edwards (1997), as a teacher, integrated computer use in first and second grade writing classes. She found out that computer use fostered student learning.

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<u>A summary</u>

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## The Current Knowledge Pertaining to Teacher's Learning and Use of Technology

The final segment of the literature review focuses on the knowledge pool about the broad topic of teacher's learning and use of technology from the time of the study's conception in 1994 until the present. The subparts in this section include (1) a summary of earlier ideas which influenced the study's conception in the first place, (2) an overview of the issue at hand in the kindergarten through twelve grade, and higher education levels, and (3) comparisons between the present study and more recent works. I would like to note that a lot of information in this section, as well as in the previous ones, were based on Aworuwa's study. In 1994, I perceived that Aworuwa's study was the most recent work which preceded my study along closely similar lines of inquiry.

### A summary: Earlier ideas which influenced the study's conception

Earlier ideas which influenced the present study. The present study was conceived about midyear of 1994 and data collection went full speed through the rest of the year and the beginning of 1995. Related topics which were predominant around that time were concerned with computer anxiety among teachers (Gordon (1993) and computer anxiety among teacher education students (Overbaugh, 1993). Factors which influenced the present study in one way or another included the observation that there existed only a few qualitative studies about human-computer interactions (Howard (1994), and few studies examined how teachers use computers to attain specific

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student outcomes or "why" teachers use technologies rather than "how" they operate them (Agnew, Kellerman, & Meyer, 1992).

At that time, there existed only a few studies in higher education which investigated the teacher's use of computer technology in the classroom (Aworuwa, 1994). Scholarly discussions at the higher education level arrived at several propositions, namely, (1) that technology would have a supporting yet important role in relation to the educational aims of students, faculty and staff (Wilson, 1995); (2) that faculty ought to investigate novel instructional processes in view of the benefits which technology offered (Kaha, 1995); and (3) that faculty preparing to incorporate technology use in classroom instruction should work as a team (Wetzel, 1993). Some colleges/universities in fact attempted to integrate computer use to the curriculum. One of them was in a teacher education course (Roberts and Ferris, 1994). Findings included the observation that college educators needed to know more about the computer in terms of software programs and the hardware aspect (Roberts and Ferris, 1994). Methods used to describe the use of technology in the classroom include the survey method (Wetzel, 1993; Greene, 1991).

# A brief review of teachers' use of technology: Kindergarten through twelfth grade, and higher education levels

<u>Teachers' use of technology at the elementary, middle school, and high</u> <u>school levels</u>. At the elementary level, some teachers viewed computer use as an isolated activity similar to planning for class or assessing students' class projects, and did not view the computer as a potentially beneficial learning tool (Aworuwa, 1994). In addition, computers were used for the following

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purposes: playing games, computer-assisted instruction (CAI), demonstrating in front of class, holding classes with subject matter areas, such as computers as tools, remedial and enrichment CAI (Aworuwa, 1994); first and second grade composition writing (Edwards, 1997). Among all subject matter elementary teachers, mathematics instructors utilized computers the most (Aworuwa, 1994). Moreover, some of the schools' objectives for computer use included preparing students for the future, revising curriculum to meet present standards, and making schools more attractive (Aworuwa, 1994).

At the middle school, teachers ventured internet use in their elementary classrooms (Cooperman, 1998). In addition, some mathematics teachers who manifested interest in using the Mathematics standards for teaching also integrated computer use in the curriculum of grade levels five through eight (Duarte, 1997).

Aworuwa observed several factors which affected teachers' classroom performance in relation to computer technology use and these were the following: Factors which motivated teachers from elementary through high school levels to learn about computers and teach with them included general concern for student learning, more specific student concerns for computer literacy and awareness of keyboard functions, and personal satisfaction to learn to do a new skill. The primary factors which brought about success to teacher use of computers included teacher motivation and commitment, support for technology use both from administration and colleagues, availability of computer equipment, extensive technical support, and the time to learn about and be comfortable with computer usage. On the contrary, the chief elements which could hinder a teacher from successful computer

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implementation included teachers' negative views about computers, restricted access to technology and its use, inadequate time to learn, lack of support for teachers to use computers in the administration and school levels. Teachers used the computer for several purposes, which included drill and practice, problem solving, word processing, and data base applications. Several shifts occurred in the ways they taught with computer technology, and these were the following: (1) they expected more from their students, (2) they prepared more complicated demonstration materials, and (3) they sought to individualize instruction. Some of the technology-related concerns raised were lack of computer equipment and inadequate time to prepare computer-based lessons. Teachers saw the computer as a teaching aid or supplement.

Teachers' use of technology at the higher education level. According to Aworuwa, faculty implemented computer-related classroom tasks in five forms, which are described as follows: First, *computer as a tool* is descriptive of students' technology-related tasks of programming involved in analyzing a problem, statistical analysis, word processing, and electronic communication. Second, *computer as a tutor* occurred in situations when students learned mathematics concepts and writing skills through computer-assisted instruction. Third, *computer as a tutee* pertains to the task of programming for its own sake and is a common activity in the mathematics, engineering, business, and science departments. Fourth, *computer as a simulation* occurred when some students learned through computer-assisted instruction, while others programmed for specific purposes. Finally, *computer literacy* relates to the tasks of learning about various computer functions and tools.

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Moreover, Aworuwa noted more practical observations about teachers' use of computer technology at the higher education level. She explained that faculty in several universities, including Oakland Community College and University of Washington faculty, used computers for instructional purposes. Some of the educational aims focused on student learning, motivation and achievement, job readiness, and computer literacy. Several of these institutions provided financial, management and instructional types of support for computer-related courses, while others did not. Furthermore, additional financial and resource types of support came from private and government sources. According to the college faculty, some of the barriers to teach with computers included lack of hardware and restricted access to computer use. However, it also was observed that there had been a lack of initiative on a teacher's part to try various equipment in a technology-rich setting (Heid, 1995). In several universities, departments such as mathematics, education, business, and computer science, offered computer courses to their students. Examples of courses where instructors tried to incorporate computer use to classroom instruction included first year Algebra (Heid, 1995) and Instructional Technology, a required course for preservice teachers (Digh, 1997).

#### <u>Comparisons between the present study and more recent works</u>

Compared to the time when the study was conceived, currently there are more research studies about the topic in higher education. Based on this specific pool of literature, this subsection describes the present study's direction in two ways, namely, by showing the study's unique features, and by stating how a recent study relates to and supports the need for more research studies similar in purpose and methodology to this present one.

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Unique features of this study. Based on the literature search, although some studies looked at teacher's use of computers in higher education classrooms, their features were not descriptive of what the present study is about. Examples of such studies and the characteristics which were different are the following: First, from a methodological standpoint, a couple of research studies utilized the survey method to gather data. Cooper Envi (1997) surveyed college instructors by inquiring about the ways they used computers and had their students use them, and about their perceptions on technology use for classroom instruction. Questionnaires were sent to seventy-four colleges of education in twenty-three states. Then Robertson (1997) sent survey questionnaires to college instructors in order to find out the resources they used to teach prospective teachers about classroom use of technology. Moreover, Lu (1995) surveyed NABTE business teacher educators in order to obtain information about their use of technology for classroom instruction. Unlike the methodologies used in these three studies, the present study primarily was involved with qualitative observations of one college instructor and her use of the computer throughout one whole semester. The data collection procedures included analyzing class notes, audio and video recordings, and documents, in the form of class handouts and teacher's class notes, among others.

Second, one study intended to find out about teachers' attitudes regarding computer use. Heflich (1997) compared the attitudes and behavior of teachers belonging to two groups, namely, those who teach in classrooms where the utilization of on-line technology is wholly integrated to the curriculum and those who are in environments with less support for

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technology use in the classroom. Incongruent to this study's purpose, the present study aimed to understand the teacher's technology use per se according to the various instructional processes she pursued, such as, planning, lesson implementation, and assessment of student learning.

Third, another research work aimed at finding out the specific types of technology-related equipment teachers used and their purposes for classroom instruction. Specific findings include data about the types of computer equipment and software teacher used, the reasons for their usage, the perceptions teachers had on computer use in the classroom, among others (Lu, 1995). Different from the nature of this study's findings, the present study's findings focus on the various ways the teacher pursued to adopt technology use and encourage her own students to go through a similar adoption process.

Fourth, the present study is not about comparing classroom instructions. Digh (1997) examined and compared the attributes of five college teachers and found out that the better the quality of an instruction, the more positive students' attitudes were towards computers. Contrary to the purpose of this research work, the present study intended to study one instructor, while focusing on her own unique instructional qualities.

A study which relates to and supports the present study. One recent research work relates very well to the present study in purpose and methodology. Just as the present study, this research work investigated one college faculty's incorporation of technology use in her English composition class. Data collection procedures were quite similar as both qualitative studies

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included classroom observations, audio recordings of teacher-student interactions, note-taking of the faculty's behavior where computers were involved, and interviews with the instructor. Following is a summary of the recent study:

Dagostino (1996) studied an English composition college instructor's use and incorporation of technology to the curriculum. For seven class hours, the researcher observed as the teacher taught, and students learned about, drafted and later on revised their narrative essays. All of the student writing took place on individual computers which utilized an uncomplicated word processing software. Using the qualitative research approach, the researcher collected data by observing classroom instruction, audio taping teacher-student conversations, taking notes of the instructor's actions in the computer classroom, and interviewing the instructor and her pupils. Findings of the study include the following: (1) the teacher appropriated most of the class time for individual composition writing and a few times for group work. (2) The teacher taught a large part of composition instruction to students individually while they wrote in front of the computer. This instruction included providing instantaneous feedback and reading loudly what a student had written. (3) The teacher and individual student worked collaboratively to determine areas for improvement and possible ways to mend them. (4) The teacher possessed three essential ingredients which helped in integrating computer use in a composition course and these factors include good communication skills, knowledge of the subject matter, and technical skills. (5) The computer's screen, which permitted the teacher to view what a student was writing, was the aspect of computer use which the

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teacher found very useful for composition instruction and student interaction.

## Summary: How the Diffusion of Technological Innovation Frameworks . Guided the Methodology and Implications Chapters

The review of literature contains considerable information about the broad topic of diffusion of innovation and deals with a more specific focus of diffusion of innovation in education. I decided to provide an abundance of information about the two main topics in order to provide a clear foundation perspective of the framework that would be used to analyze the data gathered in the study. The diffusion of technological innovation frameworks, featuring the works of Rogers and Havelock, guided the study in several ways, specifically, in the analyses of the data and in coming up with the study's implications at the practical and policy levels.

One of the main questions is 'how did the diffusion of technological innovation frameworks guide this research study?' As an educational researcher, viewing the teacher as a client and a change agent was a new experience for me. This novel perspective helped me understand the teacher's situation better, that is, be able to see where she was coming from. To start with, I perceived the teacher's dual situations through Rogers' definition of diffusion, his components of a diffusion process, and his definition of a technological innovation. With this frame of mind, I analyzed the teacher's roles as a client and a change agent. I noticed that several of the charact realizat deeply: informa better. research from reportray a underto though this chap occur as is more f characteristics described about the client did not apply to the teacher. This realization encouraged and pushed me to perceive the client's role more deeply. Then, although the teacher was an insider change agent, I included information about an outsider change agent in order to describe the role better. I used the descriptions which Rogers, Havelock, and the other researchers developed about the client and change agent, as well as findings from recent research studies as means to analyze and compare the teacher's portrayal of roles in the specific situation she was in to other teachers as they undertook the client's and/or change agents' roles. It is important to note though that Rogers', Havelock's, and the others' frameworks mentioned in this chapter represent very categorical approaches. However, reality does not occur as discretely as these categories present themselves to be since the world is more fluid and dynamic.

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## CHAPTER THREE DESIGN OF THE STUDY

#### The Qualitative Research Approach

This study is focused on examining the dual roles of a teacher as a change agent and a client in her use of computer technology for classroom teaching. As mentioned in the previous chapters, the primary questions pursued in this study were: 'What is the teacher's role as a *client* as she pursued her teaching tasks while incorporating the use of a technological innovation?' and 'How did the teacher portray her role as a *change agent* as she introduced the technological innovation to her students and helped them use it as a means to learn about the course's subject matter?' Specifically, I investigated how one college teacher used the most recent computer software and hardware for instructing about mathematics teaching methods in her course for preservice teachers. The investigation is two-fold: looking at how the teacher adopted the technology as a client and how she had her students use the innovation as a change agent. The research was designed to unearth the individual's perspectives and experiences as a teacher educator, her knowledge of the use of computer technology, and her plans and use of computer technology to teach her class, including her plans and use for technology, her students' use of the technology, and plans to use the computer laboratory as a "social" space. I also investigated how the teacher
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educator assessed all these experiences. Because these research questions called for details of the process of a teacher's application of a new technology, this study was an in-depth qualitative exploration, more specifically, influenced by two qualitative approaches, namely, a *phenomenological inquiry* and an *ethnographic inquiry*. Each qualitative approach is described, as follows:

#### Phenomenological inquiry

In a phenomenological inquiry, researchers try to understand circumstances and the communications and other forms of interactions among people that ensue (Bogdan and Biklen, 1992). Bogdan and Biklen explained that, as phenomenologists, researchers begin their studies without any assumptions about how the participants of their studies are thinking about or interpreting situations and events. The authors further noted that these researchers strive to learn about the subjective perspectives of their participants in order to gain entry into their conceptual worlds and eventually understand the meanings they form in their daily lives.

I tried to pursue this research study along this aspect of phenomenological inquiry. I did come to the study prepared with a set of research questions based on a general background knowledge pertaining to the type of research study I intended to pursue. However, to the best of my capabilities, I tried to set aside any leanings and biased interpretations that I might have had about the participant and her classroom. My main purpose was to gain a holistic perspective of the participant based on the things she brought with her to the course, and the things she said and did in the course.

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Ethnographic inquiry

Ethnography refers to the study of culture (Bogdan and Biklen, 1992). Bogdan and Biklen noted that people differed in their definitions of culture: For one, culture refers to people's understandings of things, the relationships of their perceptions to events they encounter and to the ways they decide to act upon these experiences. For another, culture deals with semiotics, which focuses on the signs and symbols in language. In this case, researchers contend that differences exist between perceiving a people's behavior and being able to act accordingly. A third cultural idea indicates that people belonging to a particular circle or group have similar perceptions of things which are unfamiliar to others who are not part of the group. In light of this situation, the so-called outsiders view the group's behavior and interactions differently from the insiders. Finally, a fourth definition of culture deals with the notion about shared meanings and defines culture by the factors which bring people to do things together.

In my research work, I wanted to find out the classroom culture which the teacher desired to impart to her students. Along this line of ethnographic inquiry, I studied a classroom culture which seemed similar to Bogdan and Biklen's first interpretation of the meaning of culture. I investigated the teacher's perceptions of technology and computer; her various experiences with technology and computer, based on her definitions of these terms; and her behavior, actions, and reactions in relation to her perceptions of technology and computer. I studied how the teacher used the hypermedia environment and, at the same time, tried to teach her students to discern this novel way of learning. In addition, I also analyzed how the teacher had her students use the hypermedia environment themselves and how she felt that

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#### The study's other factors related to the qualitative research approach

In addition to the above characteristic descriptions of how this study relates to a qualitative research approach, following are additional factors which further describe this work as a qualitative type of research. First, the findings of this study primarily is based on claims or assertions which were supported by information coming from different sources. This is an imperative quality by which this kind of research is known. Based on one definition of an example of a qualitative approach, it is said that "... ethnography ... is simply one social research method, albeit a somewhat unusual one, drawing as it does on a wide range of sources of information." (Hammersley and Atkinson, 1992, p. 2).

Second, supportive pieces of data or evidence really would not mean much unless these are explained in narratives called commentaries. Commentaries are made up of one or more sentences which clarify and situate data based on their contextual meanings. According to Erickson (1986), writing numerous descriptions of one's observations by itself does not characterize a study as ethnographic. According to the author, the key ingredient to one's narratives ought to be the clear intent to give primary importance to the "immediate (often intuitive) meanings of actions to the actors involved" (p. 120).

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<u>Pre-data</u> In (M.A.T.) <sup>my</sup> part <sup>to</sup> do m Third, I fulfilled my role in the field as both an observer and a participant. In defining these roles, Hammersley and Atkinson (1992) wrote:

"The ethnographer participates, overtly or covertly, in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions; in fact collecting whatever data are available to throw light on the issues with which he or she is concerned." (p. 2)

In my case, my intended and primary role was to be an observer. However, I eventually took a minor role as participant when I helped the participant with the technical aspect of the hypermedia.

The above information situated the research study based on the perspective of a qualitative research approach. This research study is a combination of phenomenological inquiry, ethnographic inquiry, and symbolic interaction. In addition, the study is characterized by additional factors which further indicate how this study is qualitative in nature. In view of this contextual approach, following are the sections, *The Research Strategies* and *Data Analysis*.

# The Research Strategies

# Pre-data gathering stage

In 1991, I joined the Mathematics And Teaching through Hypermedia (M.A.T.H.) project. At that time, I did not have any inkling whatsoever that my participating in the project eventually would lead me to the opportunity to do my own dissertation work. Having been a part of the project helped me gain a novel perspective of viewing mathematics education and the general teaching profession. Having been exposed to this novel type of thinking greatly prepared me to obtain some background knowledge on the research study which I intended to pursue.

# The History on the Hypermedia Technology in Teacher Education.

The inception of the M.A.T.H. project and the primary investigators. The idea of using hypermedia technology in teacher education was conceptualized by key figures, namely, Magdalene Lampert and Deborah Loewenberg Ball. Both of them were professors in the Department of Teacher Education (TE) and senior researchers with the National Center for Research on Teacher Education (NCRTE). Their professional interests were mathematics teaching and learning, and learning to teach mathematics.

To begin with, Dr. Lampert was an associate professor when the M.A.T.H. project started. (Later on, she moved to another university.) Between 1985 to 1990, Lampert wrote several publications in which she described and analyzed her own elementary classroom teaching. Several researchers and reformers thought that Lampert's teaching manifested examples of exemplary teaching (Lampert and Ball, 1990). According to Lampert and Ball,

"An analysis of the teaching described in Lampert's publications reveals that her lessons include instances of the sorts of mathematical activities that are considered desirable in the reform documents, e.g., the National Council of Teachers of Mathematics *Curriculum and Evaluation Standards* (1989a) and the National Research Council's *Everybody Counts* (1989)--indeed, the latter document refers directly to her work." (p. 1).

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Dr. Ball began as an assistant professor and became an associate professor during the duration of the M.A.T.H. project. Between 1988 and 1990, Ball's specific research interests concentrated on the role subject matter knowledge has on mathematics teaching, on future teachers' perspectives of mathematics, and on the ways students learn to teach mathematics. Ball took the primary responsibility in writing the teaching section of the National Council of Teachers of Mathematics Draft Professional Standards for the Teaching of Mathematics.

The initiation of the M.A.T.H. project. In its very early stage, the hypermedia environment used in this study was conceptualized as the relationship between new technologies and the investigation of teaching and learning." (Lampert and Ball, 1990, p. 1). This initial thought led Lampert and Ball to apply for a grant from the National Science Foundation (NSF) in order to form the M.A.T.H. project. Thus, when the project materialized in 1991, the primary investigators were Ball and Lampert. When Lampert moved to another university, Ball became the sole principal investigator until the project's culmination in 1994.

The M.A.T.H. project began to audio tape, videotape, and observe elementary school mathematics lessons when Ball and Lampert separately taught mathematics in elementary classrooms in the school year of 1989 to 1990. At that time, both teachers already had "strong backgrounds and interest in the discipline of mathematics and its relationship to the teaching of mathematics." (Lampert and Ball, 1990, p. 1). Lampert led a fifth grade class in a public school, while Ball taught a third grade class.

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The envisioned roles of hypermedia in teacher education. Lampert and Ball (1990) saw the complexities involved in instruction about the teaching and learning of mathematics. Because their view breaks away from the traditional method of teaching mathematics, their search for appropriate novel teaching procedures led them to the investigation of hypermedia environments as possible instructional aids. According the them,

"By using a hypermedia system to link multiple kinds of information about teaching and learning mathematics in a third grade and a fifth grade classroom across an entire year, we hope to learn about the potentials of new technologies to support novices' construction of an image of teachers' work that adequately reflects the messiness of practice in the classroom." (Ball, Lampert, and Rosenberg, 1991, p. 2).

Because the main focus of these professors was teacher education, the substantial focus of their ideas invariably were on the benefits of hypermedia technology to those students learning to teach.

A whole new world of possibilities for the students. Lampert and Ball (1990) saw the possibilities which hypermedia technology could make available for prospective teachers. First, the goal for having prospective teachers use the hypermedia environment was to provide them with the experience that would be closely similar to observing good mathematics classes. That was why the hypermedia environment would be solidly founded on theory and examples of good practice. Through the use of the technology, prospective teachers would be able to explore the sites of two classrooms which took place during an entire school year. According to Lampert and Ball, "The approach we are developing begins with the examination of mathematical ideas and teaching strategies set in the messy context of real classrooms" (Lampert and Ball, 1990, p. 3).

Second, the developers intended to include commentaries from teachers and scholars who would provide their views on teaching and learning based on their observations of the two classrooms. Lampert and Ball (1990) mentioned that

"With access to analyses of this teaching and learning prepared by the teachers and other scholars, they will also be able to compare their hypotheses and ways of thinking with the thinking of both highly regarded practitioners and academic commentators on teaching and learning (e.g., psychologists, sociologists, anthropologists, mathematicians)." (p. 3)

Third, the project coordinators saw the opportunity of providing preservice teachers with a wholly new way of analyzing classroom practice. Lampert and Ball (1990) had sought to develop an environment which would contain resources for knowing, understanding, and reasoning in and about mathematics teaching and learning. In this context, knowing referred to being able to identity the resources available for use and, more importantly, being able to find the right resource when needed. Aside from providing prospective teachers with knowledge based on conventional teacher education, the environment would offer these students the necessary tools to help them map connections between their ideas of good teaching practice and their experiences in classroom life. According to the coordinators,

"There is no opportunity in conventional teacher preparation for learners to map the connections between analyses of good practice and the realities of life in classrooms; thus these two aspects of teacher preparation remain disconnected. It seems worth examining the potential of hypermedia to enable students *at least* to connect the territory of teaching and learning theory to the practice of teaching and *ideally* to support the learners' construction of maps that are informed both by the realities of practice and by the perspectives of others reflecting on practice using the tools of academic discourse." (Lampert and Ball, 1990, p. 4)

Exciting new roles for the teacher educators. Lampert and Ball (1990) also saw multiple possibilities by which instructors would be able to use the hypermedia environment as an effective teaching aid. Through the use of the hypermedia environment, teacher educators would be able to prepare for their class presentations ahead of time. On the actual class day, teachers educators would make use of the tools they would have prepared, like clicking on buttons to display a notebook page or run a video.

For teaching purposes, Lampert and Ball (1990) had envisioned that teacher educators for the most part would be utilizing the videotaped lessons. These teacher educators would be using the lessons in seminar-type classes. Through the use of hypermedia technology, they would be able to show videotaped lessons quickly and replay with much ease, as well, allowing no time to waste as teacher educators presented their topics or considered students' inquiries. In addition, they would find ease in connecting other ideas and examples. The primary goal in using the hypermedia environment for teaching is clear.

"By using videos of real-time teaching as a starting point, we seek to represent the complexities involved in the moment-by-moment problems of practice and thereby to influence novices' thinking about teaching and learning." (Ball, Lampert, and Rosenberg, 1991, p. 2)

The researchers envisioned that teacher educators would utilize a videotaped lesson in a way similar to a piece of literature or a historical event which people would try to decipher based on different analytical perspectives. Moreover, Lampert and Ball (1990) saw opportunities for teacher educators and students to be engaged with them in active reflection and research on mathematics teaching and learning.

Along the same lines as students being able to map connections between ideas of good teaching practice and actual teaching experiences, the researchers envisioned that student users (i.e., the prospective teachers) would be able to work on their own research investigations focusing on topics related to "how teaching and learning proceed in classrooms where a different kind of mathematics is being taught." (Lampert and Ball, 1990, p. 7). Teacher education students would be able to check various types of data, develop their ideas, and present their findings with supporting evidence.

The development of the hypermedia environment. As Lampert and Ball (1990) taught their classes, students gathered data of different sorts. By the end of the school year, they were able to collect numerous discrete pieces of qualitative data and a major challenge arose, that of . . . "Designing an integrated system of hardware and software that will provide teacher

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candidates educative access to this mass of qualitative data about new kinds of teaching and learning . . ." (Lampert and Ball, 1990, p. 5). In designing the hypermedia environment, the goal was to provide access to the data in their original formats. By doing this, the prospective teachers would gain a richer experience (than if they were observing in real classrooms) because, aside from having the original data on hand, these students would be able to relate pieces of data, like the teacher's journal and the children's portfolio, with one another.

The 'Student Learning Environment.' The hypermedia environment was named the Student Learning Environment (SLE). In its very early stage, the SLE was a collection of videotapes, student work, and interviews from the two math classes taught by Lampert and Ball throughout the school year. Then Lampert and Ball, together with a staff of graduate and undergraduate assistants, organized some of the data, such as events during the beginning of the school year and the class days when one instructor taught fractions, into sets to be used in the computer program known as SLE. In its final phase, the SLE was made up of three parts, namely, *databases, user's space*, and *tools*.

The databases were divided into two parts of Ball's class: *Beginnings* and *Fractions*. *Beginnings* includes data from the first month of the school year of the third grade class, and *Fractions* consisted of data when she taught the topic of fractions. Both data sets included Ball's teaching journals, children's portfolios from that class (which were a compilation of the children's class notebooks and their quizzes), transcripts of videos, which were available in laser discs, and video catalogs (which served as summaries of the transcripts or of the videos found in the laser discs).

Every user who entered the SLE, including the course instructors and the prospective teachers, got a personal notebook in the computer. This notebook was the user's space on the hard drive of the computer. Students could use their notebooks to do investigations within the Environment, to jot down their reflections, and to keep journals.

There were two types of tools available in the SLE. One type of tool was used to navigate to different pages within the Environment. The other set of tools was intended to help users collect items in their notebooks. These tools enabled users to copy entries from the various databases and paste them in their notebooks. Some of the tools were used to create graphics, write an annotation, or make a "vidbit" (i.e., a video button which, when clicked on, would show a specific video segment).

# Data gathering stage

Plans to gather data. With qualitative research, according to Hammersley and Atkinson (1992), the "research design should be a reflexive process operating throughout every stage of a project." This suggests that although the pre-fieldwork activities which a researcher goes through is not as rigorous as when doing an experiment, serious pre-fieldwork planning is needed so that there is a smooth transitional flow between the activities involved in an ethnographic research process. For this particular research, the pre-fieldwork activities were an iterative process which included deciding on a research topic, choosing the study participant, and coming up with the research questions, which served as a guide for the gathering of data. The research questions. Some researchers experience a challenge in formulating their questions. This challenging experience is not new (Hammersley and Atkinson, 1992). According to Hammersley and Atkinson, some questions may be "topical," which is descriptive of the questions I came up with because the issues I was interested in were concerned with the regular routines of a teacher in classroom teaching. Following are the research questions and subquestions:

To answer the question about the dynamics involved in a teacher's use and integration of state-of-the-art computer technology, I asked two major questions and several questions related to each major question.

I. What is the teacher's role as a *client* as she pursued her teaching tasks while incorporating the use of a technological innovation?

A. Who is the teacher educator?

Rationale: A teacher educator brings a lot of herself such as who she is, what her previous experiences are when making decisions in the classroom.

 What are the teacher educator's personal theoretical beliefs concerning classroom teaching and learning?
What are the teacher educator's ideas about technology use in classroom teaching and learning?
What teaching and research activities is the teacher educator involved with? 4) With whom has the teacher educator communicated and dealt on a deeper level regarding her personal theoretical beliefs concerning classroom teaching and learning, and the teacher educator's teaching and research commitments? How have other individuals influenced the teacher educator on these matters?

B. What does she bring to the use of computer technology?

Rationale: I have not come across a research study which looked at a teacher educator's background as a teacher and, at the same time, analyzed how these attributes relate to her use of computer technology in the classroom. Investigating this topic could lead me to this area of interest.

1) How do the teacher educator's attributes affect the use of computer technology?

2) With whom has the teacher educator communicated and dealt on a deeper level regarding technology use in everyday life? How have other individuals influenced the teacher educator on this matter?

II. How did the teacher portray her role as a *change agent* as she introduced the technological innovation to her students and helped them use it as a means to learn about the course's subject matter?

Rationale: Teacher educators have learned and used computers to teach in different ways. How did this particular experienced teacher educator learn and use computer technology to teach a mathematics methods course?

A. How does the teacher educator learn to use different pieces of technology?1) What kinds of technology does the teacher educator plan to use?

2) What is the teacher educator's present knowledge about these different kinds of technology and their uses?

3) What does the teacher educator do to learn how to use these kinds of technology?

B. How does the teacher educator plan for technology use in classroom teaching and learning?

1) In what ways does the teacher educator plan to use the technology?

2) For what purposes does the teacher educator plan to use the

technology or parts of it?

3) With what (types of) topics does the teacher educator plan to use the technology for and why?

4) In what ways does the teacher educator plan to have students use the technology?

5) For what purposes does the teacher educator plan to have students use the technology or parts of it?

6) How does the teacher educator plan to use the computer laboratory as a "social" space?

C. How does the teacher educator implement technology use in the classroom?

1) How does the teacher educator use the technology?

2) For what purposes does the teacher educator use the technology or parts of it?

3) With what (types of) topics does the teacher educator use the technology for and why?

4) In what ways does the teacher educator have students use the technology?

5) For what purposes does the teacher educator have students use the technology or parts of it?

6) How does the teacher educator use the computer laboratory as a "social" space?

D. How does the teacher educator assess technology use?

How did the teacher educator find using technology in class?
How did the teacher educator find having students use technology in class?

3) How did the teacher educator feel about using the computer laboratory as a "social" space?

<u>The mathematics course</u>. In the Teacher Education 401 course, the instructors planned that their students who were prospective teachers would discover more of themselves in relation to mathematics by exploring their thoughts, feelings toward and experiences with mathematics; understand how these various experiences would affect their teaching and learning of mathematics; and discern and develop their capacities as learners and teachers of mathematics. From the course handout given to the students, the instructors asked of the students that . . .

"You bring feelings, thoughts and experiences with mathematics . . . that shape how reading, writing, conversation, texts, quantity, chance and measurement figure in your own life. You also bring feelings, thoughts and experiences with teachers, teaching, learning, other human beings and our society that influence your perceptions and perspectives about learning to teach mathematics and . . . to diverse learners." (Handout: Course syllabus)

The instructors of this course aimed at providing the students with valuable opportunities to examine the different strands of the teaching practice and the means to achieve this was through investigations of discourse patterns in classrooms. The prospective teachers were able to look at least three real classrooms, namely, the mathematics class they were attending, their field placement classrooms, and the classroom found in the hypermedia environment. The instructors believed that "Learning to teach involves a combination of developing ways of seeing, inquiring, and critiquing and actually experimenting with the ideas from the inside--in working with real students, in a real classroom." (Handout: Course syllabus)

In the syllabus (see Appendix A), the instructors indicated that the course had five encompassing themes which directed the prospective teachers to the outcomes the instructors hoped the prospective teachers would gain in taking this course. The first theme involved realizing, understanding, and appreciating the task of helping students develop their individual mathematical abilities and, as a result, forming mathematics classroom communities which worked at understanding and appreciating similar cases which entailed supporting the development of multiple ways of knowing in classrooms and respecting the presence of diversity. The second theme supported the intent to help all students in a classroom make meaningful connections between their personal experiences and mathematics, and promoted understanding and acceptance of the problems that came with this choice. The third theme conveyed the importance of the teacher's role to develop a variety of instructional strategies to help all students learn mathematics. The fourth theme encouraged the development of assessment

strategies to be used as tools to help gain understanding of students' learning of mathematics and to check students' progress toward desired learning outcomes. Finally, the fifth theme was concerned with the need to be thoughtful in examining curriculum materials.

The study participants. At the time when I was thinking of pursuing this research study, the instructors who used the Student Learning Environment (SLE) program were focused on a small group of Mathematics teacher educators who taught prospective teachers how to teach mathematics. Because of this situation, the primary decision I made was who the subject participants would be.

•Focusing on one study participant - I decided to do a study about the experiences of one participant. This study's main purpose was to put this particular teacher's perspectives on her use of computer technology as a teaching aid on a pedestal. The analysis of her perspectives on the matter would be the key ingredients which would help answer the research questions. This specific research study is concerned with "using as a basic validity criterion the *immediate and local meanings of actions*, as defined from the actors' point of view ..." (Erickson, 1986, p. 119).

•Deciding on the study participant - The teacher educator who was the participant of this study was one of three instructors of an undergraduate teaching methods course. In this study, the participant is referred to as the teacher, and the other two teacher educators as instructors. The course was comprised of two content areas, namely, mathematics methods and literacy methods. The teacher and one instructor were responsible for teaching the mathematics methods portion of the course, while the other instructor taught the literacy methods. Because this study only looked into the mathematics portion, for simplicity, I referred to the mathematics methods portion as a course.

The teacher who was the subject of this study was an assistant professor of the Teacher Education department. Aside from her interests in mathematics education involving prospective elementary and practicing middle school teachers, this teacher was involved with qualitative methods instruction. Her areas of expertise included collaborative research in mathematics education reform, alternative assessment in mathematics, professional growth and development, diverse learners (race, gender, and class), and mathematics reform, especially on issues related to equity and access.

The mathematics methods co-instructor was a graduate student who was working on her doctoral degree in Teacher Education. Prior to this experience as a mathematics co-instructor, she had at least five teaching opportunities. Her most recent teaching experiences included having taught mathematics-related graduate courses to practicing K-12 teachers. In addition, the co-instructor had the opportunity to co-instruct with a mathematics department professor who taught prospective K-8 teachers. Finally, her earliest teaching experience was as a student teaching supervisor to prospective high school teachers at a professional development school. Both the teacher and co-instructor had mathematics education as their primary research interests. While the co-instructor had very recent teaching experiences before teaching the mathematics methods course, prior to this course, the teacher performed an administrative role prior to teaching this course. My decision to choose the teacher over the co-instructor as the participant of the study was due to my impression that the teacher was taking the lead role in teaching, while the instructor was assisting her.

#### Gaining access: Soliciting consent from various sources.

The M.A.T.H. project's primary investigator. According to Bogdan and Biklen (1992), one of the first problems which a researcher faces in doing fieldwork studies is obtaining permission to do a study. Having been part of the M.A.T.H. project team had opened the door for me to gain access to my own fieldwork. When I presented my initial ideas to do a research study in line with the M.A.T.H. project's interests, Ball had become the sole primary investigator and was interested in the research proposal.

<u>The study's main participant</u>. However, according to Bogdan and Biklen (1992), it is not enough to get permission from the top without obtaining approval from the people below. Thus, after obtaining permission from the primary researcher of the M.A.T.H. project, my next step was to decide who to observe from a pool of teachers who were planning to use the hypermedia environment in their classes in Fall, 1994. After having made up my mind to observe one teacher educator, I approached her and she obliged without hesitation. This was not a difficult task for me to do because, aside from the fact that I have one main study participant, the teacher educator also knew

about qualitative research which was the research path I intended to pursue. In addition, she had been doing research studies herself and was probably well-aware of the challenges qualitative researchers faced in general.

The other teacher educators. In the previous section under the heading "The study participants" and more specifically in "Deciding on the study participant," it is mentioned that the course had two other instructors, namely, the literacy instructor and the mathematics co-instructor and from whom I had to obtain permission to be present in the classes. Thus, I made an informal request to the literacy instructor to do informal observations in the first three classes of the semester which the literacy instructor co-taught with the two mathematics instructors. I had informed the literacy instructor that my research interest focused on the teacher educator and her use of the computer technology. Then I also approached the mathematics co-instructor and formally requested her permission to observe in the classes that she would co-teach with the teacher educator. In addition, I requested for permission to attend the planning sessions she and the teacher educator held together.

The students. The twenty-seven students who enrolled in this class were a big group and getting their approval seemed formidable to me at first. In order to let myself be known, I attended the first three introductory classes when the one Language and two Mathematics instructors convened. On the third day, the teacher who was the study participant introduced me in class. I was aware that the literacy class would ensue for some weeks before the mathematics classes began. Because of this schedule, I felt that the students and teachers would have time to assimilate my presence. Several weeks after

the introductory classes, the mathematics classes started. I went to all of these classes, even when the teacher was absent and the co-instructor took over. Some students had expressed concern about my presence to the teacher when she returned. The students had wondered that if I was doing a research study about the teacher, what was I doing when she was not present? The instructors had a session to discuss the issue regarding my presence and the presence of other observers in their classroom, and at that time I informed the students that I needed to see the flow of events in order for me to get a good picture of what I was studying. The instructors prepared a written letter for the students which included information about my presence as a researcher in their classrooms and asked for their approval to be included in my observations of the classes. Based on the return of signatures, every student gave their consent. I felt anxious for a few days after this incident, although I felt relieved that I could continue with my research without outright disapproval from the students and pursued what I had to do. Just as Bogdan and Biklen (1992) had mentioned, "While it may be particularly difficult at first, being a researcher grows on you." (p. 86). Later on, as I felt more comfortable in my role as a researcher as the weeks passed and as students got comfortable with my presence in the classroom, they included me in their greetings to the instructors.

Key people with whom the teacher came in contact while teaching the course. Throughout the course, the teacher, who was the main participant of my study, came in contact with several people, other than the ones mentioned above. A lot of them were colleagues and some were technicallyknowledgeable people who helped her with computer technology use. However, among the people with whom the teacher was in touch while she

taught the course, it seems that she consistently communicated with a few key people. They were: the co-instructor, who assisted the teacher in planning, implementing, and assessing classroom technology use; a colleague with whom the teacher discussed the software aspect of the technology, as well as inquired about the hardware portion; and a technical-resource person who mainly helped the teacher with the hardware aspect of technology use (see Table 3.1). (The software and hardware aspects of technology use pertain to Rogers' (1983, 1995) definition of technological innovation. Refer to table 4.1 and 5.1 on definitions of technological innovation which specifically pertain to the teacher's classroom experiences.)

# **TABLE 3.1**

# **KEY PEOPLE WITH WHOM THE TEACHER KEPT**

Key People with whom the Teacher kept in touch while Teaching the Course			
Persons	Roles		
Co-instructor	Assisted the teacher in planning, implementing, and assessing classroom technology use		
Colleague	Discussed with the teacher the software aspect of technology use and responded to the teacher's inquiries about the hardware portion		
Technical-resource person	Helped the teacher with the hardware aspect of technology use		

# IN TOUCH WHILE TEACHING THE COURSE

<u>Collection of data</u>. As I prepared to embark on the initial stages of my research study, I tried to respond to questions similar to the five questions Bogdan and Biklen (1992) mentioned. These questions helped me to clarify to myself and others why this research study had to take place. The first question is "What are you actually going to do?" Bogdan and Biklen (1992) mentioned two important pointers, namely, to be honest and to be concise when giving explanations. The second question is "Will you be disruptive?" I think that my main concern was not really that I had the intention to be disruptive, but that my presence and the means which I used to gather data could cause some disruptions. Thus, because I wanted to make use of electronic recording devices, specifically audio and video recorders, I clearly specified that I would remain in one spot when the class was going on. The third question "What are you going to do with your findings?" was easier to explain because the data would be for my own dissertation. In response to the fourth and fifth questions, "Why us?" and "What will we get out of this?", respectively, the teacher educator felt privileged in a way because after having done research studies herself on teachers, she would now have the opportunity to get a feel for how it was to be observed and studied.

<u>Settings</u>. There were two research sites: a regular classroom and a computer laboratory. Following are descriptions of both sites.

•The Computer Laboratory - The computer laboratory had eight hypermedia stations. Each station consisted of the following: a computer hard drive (Apple Macintosh Quadra 660 AV), a compatible two-page computer monitor, a laser disc player, a video cassette recorder/player, and a television monitor. There were 29 laser discs available for use and they were

located in the tall shelf closest to the door. There were two printers in the room and each hypermedia station was connected to at least one of them. In front of the room were white boards. Behind the room were two overhead projection screens which were available for instructors to use if they would like to project something from a hypermedia station. The left screen would project the computer monitor and the right screen would project the television monitor. (See Figure 3.1 for a bird's eye view of the computer laboratory.)

# FIGURE 3.1





•The classroom - The classroom had movable rectangular tables and chairs. In front of the room were blackboards. Surrounding the room on the left and back walls were shelves which were filled with books. The right side of the room were lined by windows. (See Figure 3.2 for a bird's eye view of the classroom.)

# FIGURE 3.2

#### THE CLASSROOM



<u>The researcher's role as an observer/participant</u>. According to Bogdan and Biklen (1992), the role that a researcher takes as participant/observer truly lies in a continuum. At one end of the spectrum is a researcher who chooses to be a complete observer and whose main role is to gather data. At the other end of the line is a researcher whose presence blends well with and whose role is indistinguishable from the participants of the study. In my study, my role as researcher began as a complete observer as I sat at the back of the room observing the classes take place. Later on in the course, as the teacher's role shifted from lecturer/discussant to guide/observer/advisor, I had the opportunity to blend somewhat with the teacher's role as I visited the groups with the teacher and helped answer some of the technology questions. My feeling of blending in was supported by the fact that some students had asked me questions beyond their dealings with the technology, just as if I was one of the instructors. As I pursued my role as participant/observer, I tried very much not to influence the teacher in any way, although I knew that that was impossible since the teacher knew that, aside from my being a researcher, I was also knowledgeable about the technical aspect of the hypermedia environment. However, according to Bogdan and Biklen (1992), it is important to be on guard with the way we portray our roles such that we remember the real reason that we are in the field and are aware that how we pursue our roles could influence the study participant's role, as well.

•Dealing with the study participant - According to Bogdan and Biklen (1992), "Questions concerning how much, with whom, and how you participate tend to work out as the research develops focus." (p. 89). At the start of my study, I had asked the study participant for permission to join her as she planned, prepared for and taught her classes, and to interview her several times throughout the semester. The study participant gladly obliged to these requests. However, as the semester progressed, there had been times when the teacher was not available to be interviewed based on the schedule I planned or I would not be able to show up when the teacher was involved in class preparations. Because of these unavoidable circumstances, I decided to revise the interview and observation schedules. I began to see what the teacher meant when she mentioned that she was busy during the semester that she taught the course. Thus, with her permission, I went ahead and interviewed the teacher every time when she was available after class. With the case of lesson planning, there were times when the teacher would decide to plan without informing me beforehand. When situations like this occurred, in my next interview with her, I would ask her to walk me through what she had done in her previous planning session.

Data collection procedures. I involved myself into doing several data collection techniques, namely, interviewing, observing, gathering and analyzing documents. Observing in the field took a more elaborate form as I took notes, audio and video recorded the class and some of the planning sessions. I was interested in acquiring a deep understanding of the teacher, who was the main study participant, and her use of a hypermedia system as an aid for teaching her classes. I wanted to understand the teacher from

where she was coming. According to Hammersley and Atkinson (1992), this research objective was possible as they explained that . . .

"According to naturalism, in order to understand people's behaviour we must use an approach that gives us access to the meanings that guide that behaviour. Fortunately, the capacities we have developed as social actors can give us such access. As participant observers we can learn the culture or subculture of the people we are studying. We can come to interpret the world in the same way as they do." (p. 7)

In order for me to understand the culture of the teacher, I also had to be mindful of my own experiences and views. I remembered my own educational experiences in school where, most of the time, the teachers taught while students listened. My past experience was largely different from the way the teacher in the research study had taught her course. By pursuing this research study, I had the opportunity to explore deeply ways of teaching where the teacher's role shifted from being a lecturer to a subject matter expert and guide, and the students were given several opportunities to express what was on their minds as part of their contributions to the class. Comparing these events with my own experiences helped me to understand this classroom culture and in turn helped me to pursue the main purposes of this research study and learn about the teacher's thoughts, insights, and decision-making strategies as a teacher educator who used hypermedia technology as a teaching aid. In pursuing this research study, I collected various types of data in order to be certain that I gather enough information to be able to answer my study's main questions (see Table 3.2).
## **TABLE 3.2**

## TYPES OF DATA USED TO ANSWER THE MAIN QUESTIONS

Types of Data used to Answer the Main Questions					
Main Questions	Inter- view	Audio tape	Video- tape	Arti- fact	Field- note
Question I. What is the teacher's					
role as a <i>client</i> as she pursued her					
teaching tasks while incorporating					
the use of a technological					
innovation?					
A. Who is the teacher educator?	x	x	x		x
B. What does she bring to the use					
of computer technology?	x	x	x		x

Question II. How did the teacher					
portray her role as a change agent as					
she introduced the technological					
innovation to her students and					
helped them use it as a means to					
learn about the course's subject	•				
matter?					
A. How does the teacher educator					
learn to use different pieces of					
technology?	x	Х	х	x	x
B. <u>How does the teacher educator</u>					
<u>plan for technology use in</u>					
classroom teaching and					
learning?	x	X	X	x	x
C. <u>How does the teacher educator</u>					
implement technology use in					
the classroom?	x	X	X	x	x
D. <u>How does the teacher educator</u>					
assess technology use?	x	x	x	x	x

In this research study, I utilized four formats of data collection, namely, interviewing, audio and video taping, gathering artifacts, and taking field notes. Following is a schedule of the data collection process which took place.

•Interviews - According to Bogdan and Biklen (1992), researchers who do qualitative studies have used interviews as either the dominant data collection technique or as an additional means in conjunction with other techniques. In my case, I used two interview formats which partly served as dominant data gathering procedures in conjunction with audio taping the classes. The first interview format was formal and took the form of a presemester, mid-semester, and post-semester interview. At these interviews, I had lists of questions at hand although I came to the sites with the expectation that my questions could change depending on the teacher's experiences based on her responses to the initial questions. From my perspective as a researcher, it was important to come to an interview prepared. Aside from not wanting to waste the interviewee's time, being able to convey my thoughts clearly in the form of questions would help interviewees respond to my questions better. Since my study was about a single participant, obtaining as much information from the interviews was very important since what the teacher said during an interview could verify what she said and did in class, and vice versa. For these reasons, interviews are "purposeful conversations" (Bogdan and Biklen, 1992). However, based on my experience, even as I planned for the interviews, sometimes not only did my questions change but so did the course that I had intended to take. According to Bogdan and Biklen, changes do occur during interviews as the conversation directs its own path. This idea also is supported by what Hammersley and Atkinson (1992) mentioned: all interviews, being largely dependent on both the researcher and interviewee, are reflexive rather than standardized.

The second set of interviews was more casual and took place after class. Initially, I had an interview schedule. However, I found out that the teacher could not be available on several occasions because she had other commitments or was not present in class. Thus, after a few class meetings, I decided to approach the teacher every time she was in and asked if she would be available for an interview after class. During these casual interviews, my questions were largely based on what had occurred in class that day and/or during a planning/learning session which took place right before class. Moreover, the types of questions which usually inquired about technology use called for relatively open-ended, non-directive responses. These questions were in accordance to what Hammersley and Atkinson (1992) mentioned when they said that an interview could consist of different types of questions which may be directive or non-directive depending on the interviewer's intentions. My intentions were to find out and clarify for myself what the teacher's knowledge was about technology and its use in her classroom. More specifically, I wanted to find out the teacher's background knowledge about technology use in the classroom and what she thought about using the hypermedia technology to teach with for the first time.

•Audio and video recording - I decided to gather data through electronic recordings because what the teacher said was of primary importance to this research study, and I had to analyze her words within particular contexts of social interactions. My reasons for recording are in accordance with Hammersley and Atkinson (1992) idea that the use of electronic recording techniques could be very useful if the analysis entailed looking at the social interactions in detail. I videotaped all but one of the classes and two planning/learning sessions and audio taped all of these events: all but one of the classes, the planning/learning sessions; the interviews, the unplanned meetings with students; the informal conversations with colleagues. In addition, I had asked a colleague to audio tape the teacher's discussion about her dissertation to her students in another class.

•Document Analysis - I requested copies of the class materials which the mathematics instructors handed out to their students. I also have copies of the instructors' and students' hypermedia notebooks. In addition, I requested permission to obtain copies of the electronic mail which the coinstructor sent to the teacher and students.

•Field Notes - I took notes all of the times that I observed although the time I spent observing in class was divided between writing notes and video recording as I tried to make sure that the camera recorded important events during class times. In taking down notes, I focused primarily on what the two mathematics instructors said. I thought that I could use these segments of conversations as pointers which would help me locate specific events in the audio and video recordings.

#### **Data Analysis**

In this section, I discussed how I handled the data after collecting them. From a practical perspective, the process of data analysis involved a combination of synthesis and analysis of information. In addition, I underwent the mechanisms of induction and deduction. The process that I went through to analyze the data could be summed up with what Bogdan and Biklen (1992) mentioned that . . .

"Data analysis is the process of systematically searching and arranging the interview transcripts, fieldnotes, and other materials that you accumulate to increase your own understanding of them and to enable you to present what you have discovered to others." (p. 153)

#### **Dealing with confidentiality**

While it was not possible to keep the teacher's identity anonymous, it was possible to keep the results confidential. The names of the teacher, coinstructor, and students were withheld. In addition, the exact title of the class was omitted.

#### Cataloguing and categorizing data

I began the process of data analysis by preparing a list of all the gathered information and their physical locations. Because I audio taped most of the events which I observed, I listened to each cassette tape, and transcribed data that I thought were pertinent to my questions, including the teacher's thoughts about the 'computer,' 'technology,' 'hypermedia,' and the 'Student Learning Environment.'

When I finished transcribing the contents of the cassette tapes, I organized the transcripts according to the following five groups: planning sessions, class events, interviews, class materials and other communications. First, information about planning consisted of two types, namely: 1) one type of session, where the teacher and co-instructor met to plan for the lessons and these took place toward the beginning of the semester, and 2) a second type of session, where the teacher learned to use the hypermedia system when preparing for class.

Second, the data group about class events consisted of five subtypes of class activities and these were the following: *whole-class discussion, group activity, whole-class activity, group work* (which referred to the hypermedia group project, which the instructors had given students two class days to work on, in addition to the times after class), and *group presentations* (which occurred when students presented their hypermedia group projects; each group had made two presentations).

Third, in the data group about interviews I included two subtypes: one type was interviews with the teacher on the two main strands of interview sessions: 1) the first set of interviews occurred after class; 2) the other set of interviews occurred at the start, middle, and end of the semester. A second interview type was the interview with the teacher about the final group presentations.

Fourth, in the data group about class materials I analyzed the course syllabus. In addition, I went over the handout about the hypermedia project.

Fifth, in the data group called 'other communications' I included information about what the teacher communicated with the co-teacher, students, and other colleagues at other times, such as asides with the coinstructor and other colleagues, after-class meetings with students, and electronic mail messages from the co-instructor to the teacher.

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In this cataloguing process, I called each piece of transcribed data an 'event.' I placed each event in a three-column chart (Please see below.), along with the date when it transpired and the name of the category, which I termed 'event type.'

Day	Event Type	Event

Data analysis underwent different phases. In my first attempt to synthesize data, I tried to group them according to themes that I recognized while reading through the data. Then, in my next attempt at data organization, I tried to fit the data into a generic instructional design model. My third try led me to organize the data based on the research questions that I came up with at the start of this research project. I arranged the questions in outline format, went through each data, and placed relevant data under the questions they answered. As part of this process, I wrote an interpretive commentary for each data that served as evidence for an assertion and another commentary which summed up all the data supporting a specific assertion. Before arriving at the final phase of data analysis, I realized the need to revise the original research questions.

#### <u>Changes in the original questions</u>

During the study's proposal stage, the two primary questions I had were: 'How do a teacher educator's past experiences, knowledge, and preparation serve to contribute to her use of computer technology as a teaching tool?' and 'How does the teacher educator use the computer to teach a course?' In the process of data analysis, I raised a subquestion to a substantial level so that, instead of two, I had three primary questions. As I continued to go through the processes of data analysis, I became more aware of the topic of *change* and, more specifically, the involvement of the more focused notion of diffusion of innovation. 'Diffusion of innovation' had occurred when the teacher made her decision to use the Student Learning Environment as a teaching aid for the first time. Simultaneously, the teacher seemed to have 'diffusion of innovation' in mind, whether consciously or subconsciously (or intentionally or not), when she decided that she would have her students use the Student Learning Environment to do their hypermedia investigations. This new focus led me to change the primary questions to how I have them right now, and these are: 'What is the teacher's role as a *client* as she pursued her teaching tasks while incorporating the use of a technological innovation?' and 'How did the teacher portray her role as a *change agent* as she introduced the technological innovation to her students and helped them use it as a means to learn about the course's subject matter?'

#### The concluding phases of data analysis

During the final phases of data analysis, I analyzed the data based on the two recent primary questions. To respond to the first primary inquiry, which looked at the teacher educator's role as a *client*, I specifically studied the data on what the teacher learned about hypermedia technology use. Then, in response to the second primary inquiry, which investigated the teacher's role as a *change agent*, I checked the data for information on how she planned technology use, implemented technology use, and assessed student technology use. In both types of change situations, I contended that the technological innovation that the teacher dealt with was *hypermedia*  *environment*. As a client, she adopted the hypermedia environment to teach her students. Then as a change agent, she wanted her students to adopt the same innovation and, in so doing, learn about learning to teach from using it.

However, further re-analysis of the data and continued assessment of the logic of the presentation of findings led me to counter some of earlier claims I made. I realized that up to this point I had been analyzing the data based on a perspective that I held before I even knew about the teacher and the class she taught. Further realizations led me finally to view the data based on what I thought to be the teacher's own thoughts, and her own ways of seeing and doing things in the classroom.

Briefly, in this course, the teacher's broad technological concern was to use the state-of-the-art hypermedia technology as a teaching aid. She planned some of her lessons with the available data within the hypermedia environment and the capabilities which the technology offered. In teaching the class, the teacher did not focus on technology use per se but on its application to the topics she taught. Thus, instead of viewing the teacher educator's 'use of the computer to teach a course,' I perceived her 'integration of hypermedia environment use into the purposes of the course.'

In view of the change in the researcher's perspective that transpired, I revised my earlier assertion about what the technological innovation was. This time, I contended that there were two technological innovations, and these were the value of teaching about learning to teach using the hypermedia environment and the value of learning "to explore teaching and learning in real time," when the teacher was a client and a change agent, respectively. As a client, the teacher adopted this innovation in her course as she taught her students. Then as a change agent, she taught about learning to teach using the hypermedia environment as she assigned students to work on their own hypermedia investigations. The teacher ventured in this novel way of classroom teaching, having realized the significant benefits which the hypermedia environment had to offer to the teaching of the course. It was mentioned in the course syllabus that

"Learning to teach involves a combination of developing ways of seeing, inquiring, and critiquing and actually experimenting with the ideas from the inside--in working with real students, in a real classroom. This semester is designed to engage you in ideas and activities in support of those needs." (Handout: Course syllabus)

Instead of bringing her students to a real classroom at the time that it was happening, the teacher brought to her students a real classroom which has been carefully and thoughtfully planned out and documented (Ball, Lampert, Rosenberg, 1991).

#### Criteria in using the categorical variables

Part of my data analysis was to use some of the categorical variables mentioned in the review of the literature in Chapter Two. My purposes were: one, to help set my frame of mind in analyzing the teacher's classroom situation based on a diffusion of innovation perspective. In order to do this, I defined the technological innovations adopted in the two processes of diffusion of innovation based on Rogers' (1983, 1995) definitions of the software and hardware elements. Table 4.1 in Chapter Four describes the technology which the teacher adopted when she assumed the client's role and Table 5.1 in Chapter Five describes the innovation which the teacher, as a change agent, helped students adopt. In addition, I analyzed the teacher's classroom situation based on Rogers' (1983, 1995) four components of the diffusion process. As I examined how each element was present in my study, I noticed that Rogers' focus was primarily based on an adoption process. This is dissimilar to the diffusion process which ensued when the teacher was acting as a client because she directed her actions toward stabilizing the use of the innovation.

Two, another purpose for using categorical variables mentioned in the review of the literature in Chapter Two was to analyze my study's findings specifically from an educational perspective, of which Havelock's framework is an example (see figures 6.3 to 6.19 in Chapter Six). Based on this analysis, I came up with three observations: First, while Havelock's framework consists of one diffusion process, my study indicated that two diffusion of innovation processes occurred simultaneously. Second, while Havelock's framework includes the category, *choosing the solution*, my study had *using* the solution. Third, Havelock's model focused on an adoption process, but my study was more directed towards stabilizing the client's use of the innovation.

#### Limitations of the Study

As a qualitative study the process depended largely on my perspective as a researcher. No matter how much I tried to set aside my own biases, they cannot be entirely removed during the times I gathered and analyzed data. Because of this fact, other researchers who repeat a similar study may not obtain as nearly similar findings. It is for this reason that I clearly specified why I pursued this research study: in the section, Origin of the Study, in Chapter 1, I indicated the reasons which led me to do this study; I specified in Chapter 2 the frameworks I used to perceive my data and the reasons for doing so; Chapter 3 contains rationales for my research questions and information on how I proceeded to analyze my data. My intention in providing these sets of information was to define clearly who I was as the researcher, on the occasions that questions pertaining to researcher's intentions would arise.

One possible criticism of this study is that it concerns only one participant and it would be very difficult to generalize the findings from this study to other settings (Firestone, 1993). Firestone (1993) would agree to this criticism if one posits an argument based on a 'sample-to-population extrapolation.' However, Firestone also indicated that it is possible to do an *analytic generalization* in which a person generalizes a set of findings to a theory. According to him, "To generalize to a theory is to provide evidence that supports (but does not definitively prove) that theory. Generalizing to a theory is different from generalizing to a population" (p. 17).

The primary purpose of this research work was to investigate the events that took place as one teacher used cutting-edge technology into her teaching. Based on an indepth set of findings, I was able to analyze the teacher's roles as a client and change agent. These well-founded assertions, which provide us with abundant information about the teacher's roles as a client and change agent, also support the general framework of diffusion of innovation in education.

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# CHAPTER FOUR FINDINGS (PART I): THE TEACHER'S ROLE AS A CLIENT IN A DIFFUSION OF INNOVATION PROCESS

#### Introduction:

## The Need for a Diffusion of Innovation in Education

It was mentioned in the previous chapter that the primary investigators of the M.A.T.H. project saw the complexities involved in the instruction about teaching and learning of mathematics. Breaking away from the traditional view of mathematics instruction, they envisioned that the use of a hypermedia environment could help in the instruction about mathematics instruction. Due to this novel perspective in mathematics education, the M.A.T.H. project investigators saw the need to help preservice teachers discern the new ways to teach and learn about mathematics.

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In view of this need, the M.A.T.H. project coordinators developed the hypermedia environment, a technological innovation, which they perceived would be useful in teaching preservice teachers. According to the project coordinators,

"By using a hypermedia system to link multiple kinds of information about teaching and learning mathematics in a third grade and a fifth grade classroom across an entire year, we hope to learn about the potentials of new technologies to support novices' construction of an image of teachers' work that adequately reflects the messiness of practice in the classroom." (Ball, Lampert, and Rosenberg, 1991, p. 2).

The project coordinators presented the innovation in several conferences and seminars which included a presentation for faculty and students at the College of Education in MSU.

The M.A.T.H. project group's primary objective was to help preservice teachers and the means to help them was through teacher educators. Thus, as a change agent system, the M.A.T.H. project group sought to help teacher educators adopt the value of teaching about learning to teach using the hypermedia environment in the instruction of methods courses. In turn, the M.A.T.H. project group hoped that teacher educators would provide students with opportunities "to explore teaching and learning in real time." According to the project coordinators,

"Hypermedia environments can provide tools that enable learners to explore teaching and learning in real time, to stop the tape to look at events more closely, as well as to relate real-time events to one another. It can enable teacher educators to assemble materials spontaneously in response to their students' assumptions and questions." (Ball et al., (1991), pp. 7-8) This second value became the technological innovation which teacher educators, as a change agents themselves, encouraged students to adopt as they taught the methods courses.

In this research study, the teacher was one of those teacher educators who agreed to teach using the hypermedia technology. With her acceptance, two things ensued, namely, that she became a client adopting the technological innovation, which is the value of teaching about learning to teach using the hypermedia environment., and that she also would assume a change agent's role as she encouraged students to adopt the value "to explore teaching and learning in real time."

So far, what had taken place was part of a pre-diffusion activity. What followed these incidents were two simultaneous diffusion of innovation processes in which the teacher was a client in one and a change agent in the other. Following is a diagram (see Figure 4.1) which summarizes the prediffusion activity from the time that the change agents perceived an educational problem to the time that the teacher would assume her dual roles as a client and change agent in two simultaneous diffusion of innovation processes:



This study closely examined the teacher's dual roles as a client and change agent. This chapter describes the teacher's role as a client in a diffusion of innovation process, while Chapter 5 describes the teacher's role as a change agent in a simultaneous diffusion of innovation process. Descriptions of both the client and the change agent pertain to the findings analyzed from the study's observation data.

## FIGURE 4.1

# An Examination of the Teacher's Role as a Client in a Diffusion of Innovation Process

This section describes an investigation of a diffusion of innovation process in which the teacher performed the role as a client. It is important to note that the change agent system was represented by the co-instructor, the colleague, and the technical personnel. This section consists of the following subsections: the components of the technological innovation, the components of the diffusion process, an assessment of how the teacher's views as a teacher educator matched with her perceptions of the characteristics of the technological innovation, and an assessment of how the change agent roles complemented the client's roles and needs.

#### <u>The components of the technological innovation</u>

Rogers (1983, 1995) mentioned that a technological innovation is comprised of two components, namely, hardware and software. According to him, there are occasions when the hardware aspect is more obvious than the software component but, at other times, the opposite occurs. This case of the teacher as a client is an example where the hardware component is more obvious because it is easily apparent and noticeable compared to its software aspect, which, being a value, is intangible (see Table 4.1). The software is a value on teaching about learning to teach using the hypermedia environment. The hardware component refers to three aspects of the hypermedia environment, namely, (a) the aspects of the Student Learning Environment, which include the *teacher's journal, children's portfolios* from that class (which were a compilation of the children's class notebooks and their quizzes), transcripts of videos, which were available in laser discs, and video catalogs (which served as summaries of the transcripts or of the videos found in the laser discs); (b) the tools used to operate within the hypermedia environment; and (c) the equipment used to run the hypermedia environment (see Table 4.1). In the following subsections, any mention of the innovation in general would be in reference to the software aspect and any mention of the hardware would include specific references to its aspects.

#### **TABLE 4.1**

#### TWO COMPONENTS OF THE TECHNOLOGICAL INNOVATION

Two Components of the Technological Innovation		
Commonant	Rogers'	Observation
Component	Theoretical Framework	Observation
software	the information aspect of the innovation	the <i>value</i> of teaching about learning to teach using the hypermedia environment
hardware	the embodiment which encases the innovation	•aspects of the Student Learning Environment: -teacher's journal, -children's portfolios, -videos, -transcripts of videos, -video catalogs; •tools to operate within the hypermedia environment; and •equipment to run the hypermedia environment

### The components of the process of diffusion

In this study, the components which describe the diffusion of innovation process were adapted from Rogers (1995) framework. There are four components, namely, innovation, communication channels, time, and the social system (see Table 4.2). The *innovation* consists of two parts: the software aspect refers to the 'value of teaching about learning to teach using the hypermedia environment,' and the hardware aspect refers to the elements of the hypermedia environment and the tools and equipment used to operate the environment. This was the innovation which the change agent wanted the teacher to adopt in teaching a mathematics methods course. From the teacher's perspective, this was a *new* innovation in the sense that it was her first time to use it in teaching a class.

#### **TABLE 4.2**

Four Components of the Diffusion Process		
Component	Adapted from Rogers' Theoretical Framework	Observation
innovation	a concept, thing, or a way of life which a person or social system intending to adopt perceives as new	This refers to the value of teaching about learning to teach using the hypermedia environment in a methods course and the aspects, tools, and equipment related to the use of the hypermedia environment.

#### FOUR COMPONENTS OF THE DIFFUSION PROCESS

communication channel		•Together, the teacher and co-instructor planned innovation
a. interpersonal channels	means to transmit information through	use.
	face to face interaction between two or more persons	•The <i>teacher</i> conferred with a <i>colleague</i> about ways to use the innovation.
		•The teacher sought help from technical personnel regarding uses of the tools and equipment related to the innovation.
		•The teacher discussed about technical assistance through the
b. media channels	means to transmit information through a tool or instrument	telephone and electronic mail.

time	the time spent on an innovation's	
	•software and	•The teacher spent a considerable amount of time to plan for innovation use.
		•The teacher spent a considerable amount of time to teach with innovation use.
	•hardware aspects.	•The teacher studied how to operate tools a few days before she needed them for class.
		•At times, the teacher spent time to study the environment tools when preparing for class, but at other times she simply asked a technical person to prepare a tool for her.
		•The teacher used innovation tools and equipment in class briefly, as it was necessary to show
		video, but not to teach about technology per se.

social system	an individual or a group of people who work collectively to achieve a common goal and which include the following:	
	•the change agent system and	•The change agent system included the M.A.T.H. project coordinators and students.
	•the client system.	•The teacher was the sole member of the client system.

With regard to the second component, there are two kinds of communication channels, namely, interpersonal and media channels. *Interpersonal channels*, which were prevalent in this diffusion process, refer to the means of transmitting information through face-to-face interactions between two or more persons. Instances in which interpersonal channels were present in the diffusion process are the following: First, the teacher and co-instructor together planned about innovation use several times throughout the course, like when they viewed a videotape to be used in class; when the co-instructor provided details on how she and the teacher would handle the next class; when the teacher and co-instructor were deciding whether or not to show a videotape of another classroom on fractions; and when the teacher and co-instructor planned to use the innovation on the coming class days (Transcripts: audio recording of planning of co-instructors, September 9, 1994; September 15, 1994; September 26, 1994; and September 28, 1994, respectively). In addition, the teacher conferred with another colleague, who also was a change agent, about the coin problem activity (Transcripts: audio recording of planning of co-instructors, September 9, 1994), about how engaging the coin problem was for students, and about the wording of the coin problem to be used (Transcripts: audio recording of planning of coinstructors, September 15, 1994). Moreover, the teacher sought help from technical personnel regarding uses of the tools and equipment related to the innovation. She asked someone to teach her to make video buttons, called vidbits (Transcripts: audio recording of after-class interview, September 28, 1994) and to help her prepare the hypermedia environment for class (Transcripts: audio recording of after-class interview, October 3, 1994).

The other type of channels, *media channels*, refer to ways of transmitting information through a tool or instrument. This diffusion process included media channels such as the telephone, when the teacher requested technical assistance (Transcripts: audio recording of after-class interview, October 3, 1994) and electronic mail, when the co-instructor informed the teacher that, instead of her, another colleague would provide technical assistance (Notes: copy of the co-instructor's electronic mail to the teacher, September 22, 1994).

*Time* is defined as the length of time the client spent to prepare or study about the software and hardware aspects of the innovation. Describing the teacher's experiences based on these subcategories, the teacher spent a considerable amount of time planning for innovation use. Together, both the teacher and co-instructor spent two planning sessions to discuss about the coin problem activity (Transcripts: audio recording of planning of coinstructors, September 9, 1994; September 15, 1994); both discussed whether to show a video on fractions or not (Transcripts: audio recording of planning of co-instructors, September 26, 1994). The teacher spent a considerable amount of time teaching with innovation use (Transcripts: audio recording of class observation, October 3, 1994; October 5, 1994; October 7, 1994), in addition to making sure that students understood what they had learned through innovation use (Transcripts: audio recording of class observation, September 26, 1994).

The teacher also spent time to learn about the hardware aspect of the innovation. According to the teacher, she had a full schedule and was adamant about the fact that she did not have the time to learn the hardware aspect of the hypermedia environment; it was not a matter of deciding not to spend time learning this (Transcripts: audio recording of after-class interview, November 30, 1994). The teacher learned about the hardware aspect on the following occasions: Within a few days before class, the teacher studied how to operate some tools useful for developing ideas in one's user notebook and tools to present the hypermedia environment on the projection screen (Transcripts: audio recording of mid semester interview, November 8, 1994). When preparing for class, sometimes the teacher spent time to learn to use environment tools, like when she was looking for a specific video and analyzing children's quizzes (Transcripts: audio recording of teacher planning, October 5, 1994), and at times she simply asked someone to prepare a tool she would need for class (Transcripts: audio recording of after-class interview, October 3, 1994). In addition, the teacher used the innovation tools and equipment in class briefly, as necessary to show video and its related aspects, and not to teach about the technology per se (Transcripts: audio recording of class observation, October 3, 1994; October 5, 1994).

Finally, social system refers to an individual or group of people who work collectively to achieve a common goal. In this specific case, there were two social systems, namely, the change agent and the client systems. The change agent system was composed of the M.A.T.H. project coordinators and students, including the co-instructor, the colleague, and technical personnel, who help the teacher adopt the technology. In addition, the teacher, as a single member client, formed another social system.

#### Prior knowledge and experiences:

#### What the teacher brought with her to innovation use

In teaching the course, the teacher brought with her a pool of experiences, knowledge and interests which influenced her learning and use of the hypermedia. Based on the observed data, the findings are as follows: First, having used videos of Mrs. Ball's classroom in the past, the teacher brought with her knowledge she gained and comfort in using the information from the videos for classroom teaching. Because the teacher was familiar with the information aspect of the hypermedia technology (and not so much the technology aspect), she seemed to have handled this aspect with ease and comfort. The teacher mentioned that she used videotapes of Mrs. Ball's classroom in the past (Transcripts: audio recording of planning of coinstructors, September 15, 1994; audio recording of post semester interview, January 6, 1995). She said, "This is not my first acquaintance with the materials that . . . um and in fact over the last couple of years I have used several of [Mrs. Ball's] . . . videotapes . . . " (Transcripts: audio recording of post semester interview, January 6, 1995). In addition, she mentioned that she felt comfortable with this aspect of the hypermedia environment and with

thinking about what her students could learn from the environment. She said, "So at an intellectual level and thinking about what our students can learn . . . from the environment, that I feel pretty comfortable with." (Transcripts: audio recording of post semester interview, January 6, 1995). Moreover, the teacher mentioned things she already knew about Mrs. Ball's classroom. For instance, she knew that the way Mrs. Ball established a learning environment in her classroom was with the help of her third-grade students. To support this claim, she mentioned this observation:

"Um (pause) what she's not doing is saying, "You will do this." or "You will do that." What she's--what she does is to call their attention to certain ways of behaving and what's important about it. For example, I'm drawing on the last things that I remember. But she--but she draws their attention to the importance of listening and it's--it's not about being polite. You should listen to other people talk. That's what polite people do. It's that people have ideas and it can help you with your thinking. It's not an issue of politeness, it's an issue of--of learning. It's not an -- a negotiation in the sense that students have something explicitly out here and kid--and the teacher has something explicitly out there and so we're gonna figure out a way to compromise. It's not explicit at that level. But there are certain kinds of behaviors that kids come to class with that she's--she's trying to make some changes in that. But it's--it's for the purposes of learning. So there--there are--they are gonna be certain kinds--I mean if you think about what you often see when you go into a classroom you'll see a whole set of rules." (Transcripts: audio recording of planning of co-instructors, September 9, 1994)

As the teacher taught, her proficiency in using tapes of Mrs. Ball's classroom as a teaching aid was manifested in three ways. First, she had students view tapes of Mrs. Ball's classroom several times (Transcripts: audio recording of classroom observations, October 3, 1994, October 5, 1994, October 7, 1994 and November 9, 1994). Second and on a deeper level, she had purposeful uses for these videos. Deciding on a video depended on the

lesson objectives. In some situations, the teacher chose video in order to provoke her students to ask questions. Third, the bulk of the teacher's questions were technically focused. Her showing of videos seemed to have come naturally.

Second, the teacher brought with her an interest to learn about issues of diversity which could be present in Mrs. Ball's classroom. The teacher had a personal and professional interest in issues of diversity, race, gender, and she brought this with her to the mathematics class. In one instance, she raised questions concerning diversity issues which she hoped students would use to dig in the data about Mrs. Ball's classroom. Although she mentioned that she did not know whether these issues existed in the data, she would like students to be mindful about them as they observed Mrs. Ball's classroom. She said.

"And I think that we have to help them see some of these issues in the context of a mathematics classroom. And considering the participants in the discussion about Lin's conjecture--I wanted them to wonder--are there any issues at play here that might have something to do with race or ethnicity or gender? Would a teacher looking at who the youngsters were that were participating in this conversation make some decisions about how to negotiate or how to orchestrate the conversation based on some of these issues. Might they be in the back of [Mrs. Ball's] ... mind? I don't know if they are or not. But what I want to do is make real for them how some of these foundational issues crop up in subtle and not so subtle ways in the mathematics classroom." (Transcripts: audio recording of after-class interview, September 28, 1994).

On another occasion, as the teacher worked in her hypermedia notebook, one of the first things she did was to check on issues of equity and diversity, which she explained were the major issues she was interested in investigating. According to the teacher,

"The first thing ... I did ... spent time thinking about ... given a big issue ... of interest to me ... to see linkages of equity and diversity. I was curious about how the materials in the Environment help conduct my investigation ..." (Transcripts: audio recording of mid semester interview, November 8, 1994).

In pursuing her hypermedia investigation, the teacher said that she was inspired by some students who were able to link their observations of Mrs. Ball's classroom on video to the class readings. In class one day, the students reported these observations after watching a video of Mrs. Ball's class: As a third-grade Asian student was giving her answer in a class discussion, two African-American girls had their hands up. One of them said that she disagreed with the Asian student's response but did not push her belief. Later on, the other African-American girl also said, "I disagree." Right away, the first African-American girl looked at the second, seemingly saying that here was someone who was on her side (Transcripts: audio recording of class observation, October 7, 1994). The teacher stated that the students related their observation to what they read from a reading assignment, "Race and the Schooling of Young Girls" by Linda Grant (1991) who mentioned that African American girls relied on each other. The teacher reacted to the students' observation by saying that she did not have any idea about the relationship between the third-grade Asian student and the second African-American girl (Transcripts: audio recording of after-class interview, October 7, 1994).

Third, the teacher brought with her assumptions of how prospective teachers would relate with what they see on video. As the instructors were planning for the first few days of the mathematics course, the teacher had certain assumptions about the initial impressions her students would have on videos of Mrs. Ball's classroom. She based these assumptions on various past experiences she had in using the tapes and on what she knew about the courses which teacher education students had to take. First, based on the teacher's knowledge of a previous event which some of her students attended while other did not, she said that it would not surprise her if, when showing the video of Mrs. Ball's classroom, students would bring about notions of how the children were not idle on their seats and how the teacher asked a lot of questions (Transcripts: audio recording of planning of co-instructors, September 9, 1994). Second, based on her past teaching experience and observations of people who saw videotapes of Mrs. Ball's classroom, she thought that students would be uncomfortable the first time they view videos of Mrs. Ball's classroom (Transcripts: audio recording of planning of coinstructors, September 9, 1994). Third, the teacher also assumed that her students knew that regular teachers established the kind of learning environment they wanted on the first days of class. Based on the students' experiences as students, the teacher assumed that prospective teachers would be able to relate what they knew about this topic to what they would see on

video of one of Mrs. Ball's first core lessons. This assumption was present in a discussion between the teacher and co-instructor:

teacher: And that they certainly know from their own experiences as students that the first days of school are really crucial works in terms of establishing the kind of environment that--that you'd like to have in that classroom. Um and so-co-instructor: ...in it? teacher: Uh huh. Yup.
co-instructor: Do you think they know that? teacher: Um, yeah, cause I'll bet that they'll tell you things like, "You don't smile for the two--first two weeks of school..."....
co-instructor: Uh huh, uh huh. Somebody already said that.

(Transcripts: audio recording of planning of co-instructors, September 9, 1994).

Fourth, the teacher brought with her a desire to learn about the technical aspect of the hypermedia environment. This mathematics methods course was the teacher's first time to use the hypermedia environment as a teaching aid. As she introduced the hypermedia project to the students, she implied some discomfort in using the technology although she also mentioned that she continued to learn about it:

"You seem to be comfortable with technology than I am. I think this has to do with differences between our ages . . . and what you've grown up with and what I've grown up with . . . teachers are always learning. I am learning about this environment." (transcript of audio recording of class observation, November 9, 1994)

On a couple of occasions when observing groups of students working in hypermedia stations, she mentioned that she continued to learn how to use the system. In the first instance, the teacher happened to approach a group of students who were experiencing a technical problem. When the students consulted the teacher about their problem, she directed them to a technicalresource person. As a solution was given, the teacher mentioned that she was still learning (Transcripts: audio recording of classroom observation, November 21, 1994). On another occasion, as the teacher was with a different group of students, the researcher asked that her dialogue with the students be taped and the teacher added that "I'm learning something at every stop." (Transcripts: audio recording of classroom observation, November 21, 1994). At the end of the semester, the teacher confirmed her feelings toward use of the technical aspect of the hypermedia environment. She admitted that she still had things to learn about the environment and felt that she had not acquired the level of technical know-how to be comfortable in helping students with the technological aspect of the environment. According to her,

"Um so I feel like I still have some things to learn about the environment. Um to be helpful to students when students get stuck when they're at the computer . . . what to do or some things aren't working right for them . . . in my own knowledge to respond to the questions that are likely to arise . . . . You saw several examples of that when [the co-instructor] . . . wasn't there . . . you know what going on here. So there are--there are . . . aspects that I still don't feel comfortable with. I--I--I haven't learned enough and I haven't . . . in the environment myself . . . to feel like I could be the kind of technical resource that I . . . responding at one level." (Transcripts: audio recording of post semester interview, January 6, 1995).

Since it was the teacher's first time to use the hypermedia environment, this proved to be the big hurdle she needed to tackle in order to learn and use the technology. However, throughout the semester, she mentioned her interest in learning about use of the environment. The teacher learned to use the technology as the course progressed. However, she was frustrated by the fact that she did not reach the level of proficiency she desired. On one occasion, when the teacher could not answer the students' questions, she explained that she continued to learn how to operate the system.

Fifth, the teacher brought with her the desire to impart to students the relevance of collaborative work with colleagues. In a whole-class discussion, the teacher mentioned that the course was more of a "community preparation" which included other instructors of the same course (Class observation, September 19, 1994; Transcripts: audio recording of class observation, September 19, 1994). In addition, the teacher, who taught the course with a co-instructor, informed the students that both of them had become colleagues as they planned and taught together (Transcripts: audio recording of class observation, September 19, 1994). Moreover, the teacher mentioned that she and the co-instructor felt that scheduled lessons were not immutable because they would change previously-set plans when deemed necessary. According to the teacher,

"And I think that [the co-instructor] ... and I have--have tried to indicate a couple of times that while we have an overall scheme for the course at the end of each class we're thinking about what do we know about where you are right now and how can we use that information to decide what to do the next day." (Transcripts: audio recording of class observation, September 27, 1994).

To further support this claim, the teacher mentioned that she chose a specific video to show her students based on what she had learned about it from her colleagues. She pointed out an advantage of sharing ideas with others and learning from them as she said, "... it's a piece of the data that I've had to have--I've had the good fortune of having a conversation with other colleagues ... who've helped me to see some other things in it that I

wouldn't have seen." (Transcripts: audio recording of after-class interview, September 28, 1994).

Aside from giving her personal experiences, the teacher also encouraged her students to collaborate with one another. As she facilitated one small group discussion, the teacher encouraged her students to share and express ideas as she mentioned statements, like: "... you want to contribute something?" and Let's see. Others who haven't talked." (Class observation, September 19, 1994), She also wanted them to ask questions. After one student shared her experience, the teacher mentioned, "How about . . . if we open this up for people to ask questions." She thought that being in this small group was a good time for students to get to know each other better and help them form colleagues among themselves (Class observation, September 19, 1994; Transcripts: audio recording of class observation, September 19, 1994). Moreover, the teacher's strong belief in group sharing and collaboration seemed obvious because of the fact that she had required her students to do a group hypermedia project. This project, which took nearly half of the course's time, involved the students working in smaller groups. Upon her introduction of the project, the teacher gave students a handout where the instructors wrote:

"You will be working with a <u>small group</u> to frame and define a question and focus for your investigation. <u>Together</u>, you will use the hypermedia environment to create a collection of evidence or information related to your question .... On December 9th or 12th <u>your</u> <u>group</u> will make a short presentation in class based on your investigation." [Underline mine.] (Handout: <u>Project #3: An</u> <u>Investigation of Mathematics Teaching and Learning in Hypermedia</u>, given to students on November 9, 1994)

The teacher seemed to see the significance of collaboration since she had manifested this idea in her professional practice when she prepared for the course and as she taught her students. When preparing to teach, the teacher collaborated with colleagues at different times throughout this 401 course. First, before the semester began, the teacher's planning experience had been a collaborative effort with instructors who also taught the same course to other students. Second, throughout the semester, the teacher planned and taught collaboratively with her co-instructor. Third, the teacher decided to show some video segments to her students based on what she had learned about the videos from colleagues. As a teacher educator, the teacher encouraged group sharing. In one instance, she facilitated a small group discussion during which she abetted students to express their ideas, ask questions and mentioned that being in this small group could help them begin forming colleagues among themselves. The teacher also had her students form small groups as they worked on their hypermedia projects. Because the project comprised about half of the course's time, this shows the high regard that the teacher had for small group sharing.

#### Learning about the hardware aspect:

#### The tools and equipment to run the hypermedia environment

The teacher's role as a client consisted of two main aspects: integrating the information aspect of the hypermedia to the curriculum and learning about the technical aspect of the hypermedia. Because the teacher already knew how to do the first aspect, as was briefly explained in the previous section on prior knowledge and experiences (specifically on having used videos of Mrs. Ball's classroom in the past), this section on the teacher's role

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as a client focused on her learning about the hardware aspect which refers to

the tools and equipment to run the hypermedia environment (see Table 4.3).

# TABLE 4.3

## LEARNING ABOUT THE TOOLS AND HARDWARE

## TO RUN THE HYPERMEDIA ENVIRONMENT

Learning about the Tools and Hardware		
to run the Hypermedia Environment		
Main Questions	Observations	
What did the teacher	•how to use the tool to show video (called vidbit);	
learn about technology	<ul> <li>other operations (like keyboard-related</li> </ul>	
use?	operations when viewing video, such as starting,	
	stopping, and fast-forwarding video; the steps to	
	print a hypermedia page; and functions related to	
	copying and pasting graphics, making annotations	
	and adding a new page)	
Why did the teacher	<ul> <li>it was a useful presentation tool;</li> </ul>	
learn about technology	•in order not to be put on the spot in front of the	
use?	students	
When did the teacher	<ul> <li>a few days before she needed it for class;</li> </ul>	
learn about technology	<ul> <li>as she prepared for the class lessons;</li> </ul>	
use?	<ul><li>while she taught her students;</li></ul>	
	•while she observed her students work on their	
	hypermedia investigations	
How did the teacher	<ul> <li>through one's personal effort;</li> </ul>	
learn about technology	•through available help from technical-resource	
use?	people;	
	•through gradual and cumulative process	
Where did the teacher	•in a computer laboratory;	
learn about technology	•in a classroom;	
use?	•in a classroom used as a computer laboratory	
Who helped the teacher	•her co-instructor;	
learn about technology	•a colleague;	
use?	•a technical-resource person	
What happened as the	•she felt more comfortable when dealing with	
teacher learned about	aspects of technology;	
technology use?	•she learned to manage technology lack by taking	
	alternative actions;	
	•she also preterred to learn the more efficient	
	ways of doing things	
What did the teacher learn about technology use? As a client, the teacher learned several technical operations. She learned how to use the tool called vidbit, whose function is to show video. She also learned other operations, like keyboard-related operations when viewing video, such as starting, stopping, and fast-forwarding video; the steps to print a hypermedia page; and functions related to copying and pasting graphics, making annotations and adding a new page.

First, the teacher learned how to operate a video button on her own and understood how it worked. The teacher learned to operate a video tool called vidbit when she used it in class for the first time. The incident took place in this way: To prepare for class one day, the teacher asked somebody to help her make vidbits. In class, the teacher clicked on the vidbits to show video clips and was very pleased after having done this gesture. She said,

"I used the hypermedia environment that somebody had already set up for me.... So somebody got the appropriate videodisk and put it in the player. And all I had to do was click on the pieces that I wanted to show. So that's how I used technology. It was pretty minimal but I did it [laughter]." (Transcripts: audio recording of after-class interview, October 3, 1994).

In addition, the teacher learned the function of a tool within the hypermedia environment when she understood how the vidbit worked. A month later, she remembered what this tool was called and was able to mention precisely how it functioned. She knew that clicking on a vidbit was an efficient way to show a video clip because it would start and end on specified beginning and end frames. She said,

"What I got to thinking about was I know that you can do vidbits but I don't know how to do that. The only way I know to advance is doing fast forward. I don't want to do fast forward .... I knew there was a way to get exactly from beginning and end frame and just click it .... [A colleague] ... did it form me while I watched and I believe I could do it." (Transcripts: audio recording of after-class interview, November 9, 1994).

Although she did not know yet how to create a vidbit, she knew exactly how it worked. Thus, based on these observations, the teacher learned what a "vidbit" was and its function to show video.

Second, the teacher learned how to operate within the hypermedia environment. As the teacher worked on her own in the computer laboratory, she remembered and discovered how to operate tools within the hypermedia environment. At one time, she remembered how to initialize a laser disk after inserting it in its player, became comfortable using keyboard functions to start and stop video and learned how to use the fast forward key to run video. She also was able to print a hypermedia page by following instructions on her own (Transcripts: audio recording of teacher planning, October 5, 1994). At another time, the teacher was also able to copy and paste graphics, make an annotation and add a page in her hypermedia notebook (Transcripts: audio recording of mid semester interview, November 8, 1994). Finally, the teacher confirmed that she knew how to operate within the hypermedia environment when she said, "What's interesting is that if I sit at the computer and play around, I can figure out a lot of these things by myself..." (Transcripts: audio recording of class observation, November 21, 1994). The teacher mentioned this in reference to the technology-related questions which students were asking her.

Thus, as a client, the teacher learned several operations within the hypermedia environment. Aside from learning how to operate a vidbit and understanding how it worked, she learned keyboard-related operations such as starting, stopping, and fast forwarding video, and other functions related to copying and pasting graphics, making an annotation, printing a hypermedia page, and adding a new page.

<u>Why did the teacher learn about technology use</u>? As a client, the teacher had reasons for learning what she did. She wanted to learn how to use a video button because, based on what it could do, it was a useful presentation tool. She learned several other operations useful for doing hypermedia investigations in order to be of help to the students.

First, the teacher learned how to use a video button because it was the logical way to show videos in class. The teacher learned that the vidbit was helpful as a presentation tool. Even before the teacher knew the name of a tool, she already had an idea of how it worked and wanted to learn it. The event took place in this way: In one class, the teacher had observed that her co-instructor used a hypermedia environment tool to show video. At that time, she had not known the name of the tool but had an idea of how it

worked and she expressed why she would like to learn how to make one. She said,

"Um, and, uh, the logical thing would be to, um, I guess do what [the co-teacher] ... is doing. Now actually I was thinking that maybe um on Friday if we we're going to use this that you or [the co-instructor] ... might actually show me what it was that she did so that all she had to do was go over to that monitor and she clicked on something and the thing came up." (Transcripts: audio recording of after-class interview, September 28, 1994).

In this observation, the teacher explicitly said that what the co-instructor did, which was to go to the computer monitor and click on something to show video, was the logical thing to do. A month and a half later, the teacher wanted to pursue learning how to make a vidbit since she knew that clicking on one was more efficient than using the fast forward key to see video. She said,

"The technology today was enormously helpful in my negotiating today in the bits I wanted to use . . . in a way that if I hadn't been able to find somebody to help me create the vidbits--vidbits, right?--the vidbits, I think I would have fallen on what I knew, to do fast forward. But I would have been dissatisfied knowing there was much more efficient way to do it and that I hadn't made full use of the power of technology." Transcripts: audio recording of after-class interview, November 9, 1994).

This observation confirms what the teacher had said earlier, that using a vidbit was the logical thing to do.

Second, the teacher also knew that she had to learn other operations within the hypermedia environment so as not to be placed on the spot when students ask questions or experience technology-related problems. As the teacher began this course, she did not know much about technology use. At one time, she mentioned that her learning about the fancy ways the coinstructor used the environment would be her "first foray" into using the technical aspect of the environment (Transcript: audio recording of planning of co-instructors, September 28, 1994). As time passed, the teacher learned about and became comfortable using the environment on her own. However, she was not comfortable when students asked her technologyrelated questions and she felt fortunate that a technically-knowledgeable person helped her. She said,

"What's interesting is that if I sit at the computer and play around, I can figure out a lot of these things by myself .... I feel on the spot when somebody has a question .... I feel like I have to have the answer .... I'm certainly glad you're here." (Transcripts: audio recording of class observation, November 21, 1994).

At the end of the course, the teacher explicitly mentioned she still needed to learn more about the technology's tools in order to be of help to students. She said,

"... um so I feel like I still have some things to learn about the environment um to be helpful to students when students get stuck when they're at the computer ... what to do or some things aren't working right for them ... in my own knowledge to respond to the questions that are likely to arise ...." (Transcripts: audio recording of post semester interview, January 6, 1995).

In addition, she reiterated that she needed to learn more in order to be a technical resource to students (Transcripts: audio recording of post semester interview, January 6, 1995). Later in the interview, the teacher relayed a situation where things did not go as planned with technology use and she was very uneasy in front of students. She said,

"Um that there was something wrong. I know we had problems getting sound ... the videos. We couldn't get the headsets to work... different places. Um so that--and I feel so stupid. And I hate acting stupid in front of students. I... um but that was certainly a time when I felt very very uncomfortable ..." (Transcripts: audio recording of post semester interview, January 6, 1995).

In this observation, the teacher explicitly expressed that she felt uncomfortable when things went wrong and she could hardly do anything about the situation. This observation supported the previous ones with regard to the teacher's reasons for wanting to learn the environment's operations.

Thus, as a client, the teacher learned two sets of operations for specific reasons. First, she learned how to operate a vidbit as a presentation tool, in addition to understanding how it worked. The second information was important for her to know since it made sense to her that it was the efficient way to show video. Second, the teacher learned several operations helpful for a hypermedia investigator to know. She learned keyboard-related operations useful for viewing video and other functions which could be useful for pursuing an analysis, like copying and pasting graphics, making an annotation, printing a hypermedia page, and adding a new page. Learning these operations would help her be comfortable using them and be able to help her students when they asked technically-related questions.

When did the teacher learn about technology use? As a client, the teacher had a full schedule. She was adamant about the fact that she did not have the time to learn the technical aspect of the hypermedia environment; it was not a matter of deciding not to spend time learning this (Transcripts: audio recording of after-class interview, November 30, 1994). Because of a tight schedule, the teacher learned about technology use a few days before she needed to use it for class, as she prepared for the class lessons, while she taught her students and as she observed her students work on their hypermedia investigations.

First, the teacher learned how to operate something in the hypermedia environment within a few days before she needed to use it for teaching and the time she taught. Because of a tight schedule, the teacher learned to use some hypermedia operations within a couple of days before class and the time she taught her lesson. On one occasion, a couple of days before class, the teacher asked a technical-resource person to help her make video buttons. She informed her, "I felt . . . to set up something for me because I didn't have time to do it given the amount of notice I had so I felt I imposed on you when I called you yesterday . . . " (Transcript: audio recording of after-class interview, October 3, 1994). In class, the teacher used them for the first time to show video clips. A glimpse of the teacher's learning about and first-time use of the vidbit was captured in the following vignette:

interviewer:	"so what did you have to do when you were at the computer?"
teacher:	"Um, each of these, um, each of these segments that are marked on the transcript with a line is a different piece of
	data on a videodisk and so you have to click on to get each one of those that stops and then you have to move down to the next. Is this called a vidbit? I don't know what a vidbit is."
interviewer:	"Yeah, each one is a vidbit."
teacher:	"Okay, so that you have to, um, with the mouse select the vidbit that you want to show. So that's what I had to do today."

(Transcript: audio recording of after-class interview, October 3, 1994).

In this incident, the teacher seemed to know that the hypermedia environment tools she used in class were called vidbits, but it seems that she wanted confirmation that what she knew was correct.

In another incident, the teacher learned to do several things within the hypermedia environment two days before she introduced the environment and project in class. First, she began her own hypermedia investigation. She had two lines of inquiry, which were influenced by what her students observed in class. Explaining the first one, she said,

"... so one line of inquiry that I thought I might take is to follow one or two students. And I thought ... [the name of a student] ... or two African American girls in the class or to find ... the following: how they participate in class and when, what's the nature of their contribution ... how do others, including the teacher and other students, respond to their contributions ... kind of trying to figure out what might it feel to [the name of one student] ... and [the name of another student] ... to be a student in this classroom ..." (Transcripts: audio recording of mid semester interview, November 8, 1994).

The second line of inquiry was to follow a third grader whom she thought was an African American and whose work on a fractions quiz seemed meager towards the end of the school year (Transcripts: audio recording of mid semester interview, November 8, 1994).

Second, the teacher learned how to use the tools to help her pursue an investigation. She explained that

"So the first thing that I did was I cut and pasted his math ... in my notebook. Partly I was also testing my skill with the tools ... how to cut and paste from [a student's] ... notebook to my notebook. You'll see that I've got pages from his quiz." (Transcripts: audio recording of mid semester interview, November 8, 1994).

The teacher looked through the kid's notebook and analyzed his works. She also checked Mrs. Ball's Journal for references about this kid. Then she tried

to do an annotation. Then the teacher continued to explain what she did and did not do on her own. She said,

"Um part of what I was trying to do was can I do a cut and paste? Can I use ... sometimes it doesn't always work the way I think it should work .... Um can I do an annotation? I didn't do anything with videos last night ... I didn't do transcript either. I did [a student's] ... journal, [Mrs. Ball's] ... journal uh .... used--show tool box. Tell me if I got this right. This is transcript. This is vidbit ..." (Transcripts: audio recording of mid semester interview, November 8, 1994).

In addition, the teacher also asked for confirmation about how some tools were called.

Third, the teacher learned how to use presentation tools so that she would be able to type in big prints and show them on the projection screen. She said,

"... what I was playing around with was I --imagining tomorrow... environment and doing what I saw [a colleague] ... doing ... piece of videotape and then having a whole group conversation about what was interesting to them, what kind of question was raised? ... then I would type their comments and they'd be flashed up on the big screen [She types.] or something like that ... how do you get big prints on the big screen?" (Transcripts: audio recording of mid semester interview, November 8, 1994).

The teacher explained what her colleague taught her in making larger prints.

Two days after the teacher learned these things, she introduced the hypermedia environment and gave the hypermedia project to the students. As she did, the teacher also did the following things: First, she showed a video to help students formulate questions. Afterwards, on the big projection screen, she also showed her hypermedia notebook as she explained that each student would have a personal notebook, too. In addition, she mentioned that she was investigating a particular question. Second, the teacher informed students that she was going to type their questions in her notebook. Thus, as students came up with their questions, the teacher typed them and everyone saw them on the projection screen on the wall. Third, the teacher had students in small groups and had them sit in front of individual hypermedia stations, as she pointed to and explained what the environment was all about, including what it was comprised of, namely, Mrs. Ball's Journal, children's notebook, video, transcripts for the video, and video catalogs.

Second, the teacher learned how to operate within the hypermedia environment when preparing for class. The teacher learned how to use some of the tools within the hypermedia environment as she planned for her lessons, and this could be seen in the following events: As the teacher planned for class, she looked at a laser disc and, while viewing, she took note of segments of videos by listing several couples of frame numbers and describing what each segment was about. In addition, she looked at a quiz and checked how several children responded to item six of the quiz. The teacher mentioned that she intended to copy these hypermedia pages on to transparencies. As the teacher planned, she remembered how to initialize a laser disc after inserting it in its player, became comfortable using keyboard functions to start and stop video and learned how to use the fast forward key to run video. She also was able to print a hypermedia page by following instructions on her own (Transcripts: audio recording of teacher planning, October 5, 1994). Then, the teacher prepared for class before she assigned the hypermedia project to students. Being interested in a couple lines of inquiry, she began her own hypermedia investigation as she looked through a child's portfolio and Mrs. Ball's Journal. While pursuing her own investigation, she was able to copy and paste graphics, make an annotation and add a page in her hypermedia notebook (Transcripts: audio recording of mid semester interview, November 8, 1994).

Third, the teacher learned how to operate the hypermedia environment for classroom purposes as she used it to teach the course. The teacher continued to learn to use the hypermedia environment for classroom teaching and this was seen in the following events: For the first time, the teacher clicked on vidbits to show video clips in class and was very pleased after having done this gesture (Transcripts: audio recording of after-class interview, October 3, 1994). Then, as the teacher explained the video that students would be watching, she reminded them that she was still learning to use the equipment. She said, "Remember, I told you I'm learning how to use this equipment . . ." (Transcripts: audio recording of classroom observation, October 5, 1994). In another incident, after one class when the teacher showed video without handing out transcripts, she mentioned that she would not use video again without also giving students the corresponding transcripts because some voices were inaudible and, with a transcript, students would be able to refer back to previous events (Transcripts: audio recording of afterclass interview, October 5, 1994).

Fourth, the teacher learned how to use the hypermedia environment's tools for investigation purposes as she observed students work on their hypermedia inquiries. In the course of the semester, probably one of the biggest challenges the teacher had to face was having her own students work on the hypermedia project when she did not know much about how to operate within the environment and that it was the students' first time to use it. However, while she observed them, she also learned how to use the tools to pursue an investigation, and this was seen in the following instances: The teacher was observing a group of students when they noticed something strange happening to the picture on the computer screen. The teacher asked a technical-resource person if she could help solve the problem. As the resource person suggested a solution, the teacher mentioned that she continued to learn (Transcripts: audio recording of classroom observation, November 21, 1994). Then, as the teacher moved to observe a different group, she called herself an "ignoramus" and mentioned that she learned every time she observed another group (Transcripts: audio recording of classroom observation, November 21, 1994). As the teacher tried to help a student technically, she seemed to learn as she asked to confirm what she knew. An example is the following instance:

teacher: "If you want to cut something from [Mrs. Ball's] ... notebook, that's graphics, right? tech person: "Right." teacher: "So you need to click on graphics up here?" tech person: "That broken-lined box is fine." teacher: "Now why can't they get anything from the graphics menu?" tech person: "She has to box ...."

(Transcripts: audio recording of classroom observation, November 21, 1994).

As a client, the teacher learned about technology use when she had to or while teaching. Because of a tight schedule, the teacher learned to use technical operations a few days before she needed to use them to teach. The teacher also learned how to use tools within the environment as she planned for lessons. She continued to learn to use the hypermedia environment for classroom teaching as she used it to teach her students. While observing students as they worked on their hypermedia inquiries, the teacher also learned how to use the tools to pursue an investigation.

How did the teacher learn about technology use? As a client, the teacher learned from two types of human resources, namely, personal effort and available help from technical-resource people. In addition, the teacher's learning occurred as a gradual and cumulative process.

First, the teacher learned gradually and cumulatively. This assertion is supported by observations which occurred when the teacher learned about vidbits and the laser disc. Following are the teacher's experiences with vidbits: At the start of the course, the teacher did not know the name of a hypermedia environment tool which she saw her co-instructor use in class and would like to learn how to make one (Transcripts: audio recording of after-class interview, September 28, 1994). About a week later, the teacher got to know the tool's name but asked someone to create video buttons for her. In the following class, the teacher clicked on the vidbits and felt good about having done it. She said that this experience "... was pretty minimal but I did it ... is a little tiny step for me ... but it worked the way I wanted to use it." (Transcripts: audio recording of after-class interview, October 3, 1994). By this time, the teacher was able to use a vidbit in order to show video in class and felt good about having done this. Thus, the teacher gradually learned about vidbit use.

Not only did the teacher learn how to operate a vidbit as a teaching tool, but she also gained a deeper understanding of how it functioned in relation to other pieces of equipment. However, as with other types of learning, she started with not knowing much about how this tool functioned. After class one day, the teacher implied that she was not sure what a laser disc was when she said, "[A colleague] . . . had said to me I could just use a videotape of it. I didn't have to use the laser disc. It is a laser disc, right?" (Transcripts: audio recording of after-class interview, October 3, 1994). At this time, it was not clear what the teacher knew about the laser disc, although she asked for confirmation about its name. A couple of days later, as she prepared for class using the hypermedia environment, the teacher knew that she needed to insert the laser disc in its player and initialize it. But she asked for help to run it (Transcripts: audio recording of teacher planning, October 5, 1994). In the same planning session, the teacher learned about and became comfortable with starting, stopping and fast forwarding video (Transcripts: audio recording of teacher planning, October 5, 1994). The teacher continued to learn about aspects of video use. About a month later, the teacher inquired whether there was another way to go back to the beginning of the video without using the fast forward key. Although she knew how to run video using the fast forward key on the keyboard, she preferred to find out how to

use the vidbit in order to run a video clip from its beginning through end frames. She said,

"What I got to thinking about was I know that you can do vidbits but I don't know how to do that. The only way I know to advance is doing fast forward. I don't want to do fast forward .... I knew there was a way to get exactly from beginning and end frame and just click it .... [A colleague] ... did it for me while I watched and I believe I could do it." (Transcripts: audio recording of after-class interview, November 9, 1994).

She also mentioned that she believed she could make one. By this time, the teacher seemed to have learned a more indepth knowledge about the vidbit because she also learned how it worked in relation to other pieces of equipment and how it compared with other computer operations, as well.

The teacher also learned how to use a laser disc. After the teacher learned about the things she did regarding a laser disc (as mentioned earlier), about a month later, the teacher took the role as the main presenter of the hypermedia environment to the students. Included in her explanation, the teacher mentioned that a laser disc player had to be initialized when a user puts a disc in for the first time, and she showed how the initializing process went. Being able to explain how to use a laser disc supported her learning about it. When the course was over, the teacher seemed pretty comfortable using a laser disc, as long as she knew what video to show and had time to prepare. She explained,

"Um when I had control over choice of whatever it was we were going to use . . . my agenda and so there was a piece of video that we were going to show . . . that I wanted our students to have in mind as they look at the video . . . to go with the conversation following that . . . . That's a manageable thing for me to do and I can rehearse it . . . . I know which disc to pull out. I can already have the disc ready . . . push and how to do it." (Transcripts: audio recording of post semester interview, January 6, 1995).

It was evident from the observations that the teacher learned about the vidbit and laser disc use. Through a gradual and cumulative process, she learned several things about vidbit use, namely, how to use it, its worth as a tool, and how it worked in relation to the other hypermedia-related operations. In addition, the teacher remembered how to use a laser disc, from initializing it to operating keyboard-related functions to run video.

Second, on her own, the teacher learned through trial-and-error. As she worked on her own, the teacher remembered previously-learned operations and discovered novel features about using the hypermedia environment tools. On one occasion, while working within the hypermedia environment, she remembered to do initial operations, like initializing the disk after inserting it in the disc player (Transcripts: audio recording of teacher planning, October 5, 1994). Later in that session, the teacher became comfortable using some of the environment's features, like starting and stopping video from the keyboard. On her own, the teacher also learned how to fast forward the video using the keyboard and printed a page from a hypermedia notebook by following instructions (Transcripts: audio recording of teacher planning, October 5, 1994). As the teacher continued to do things through trial-and-error, she found out that there were times when what she did worked, and at other times what she did did not work. The teacher also was able to copy and paste her own graphics, make an annotation and add a page in her hypermedia notebook (Transcripts: audio recording of mid semester interview, November 8, 1994).

Thus, as the teacher worked on her own, she learned to do several of the hypermedia environment's operations. This observation was reinforced by her saying that "What's interesting is that if I sit at the computer and play around, I can figure out a lot of these things by myself . . . ." (Transcripts: audio recording of class observation, November 21, 1994).

Third, the teacher learned with help from others. When the teacher taught this course, she was informed that people were available to teach her about how to use and operate within the hypermedia environment and these environment-knowledgeable people included the co-instructor, a colleague who was also an instructor of a similar course, and the computer laboratory staff, who helped users with technical questions when no class was in session in the computer laboratory. In the course of the teacher's learning to use the hypermedia environment, she asked a lot of questions and sought help several times. When the mathematics instructors were planning for class, the teacher informed the co-instructor that she was going to learn how to use the hypermedia environment. She said, "... [a technical-resource person is]... going to show me Tuesday or Wednesday how to be fancy about this the way you do so all I have to do is to go to that monitor--and click something and by golly there it is!" (Transcripts: audio recording of planning of co-

instructors, September 28, 1994). Later, in class that day, she saw her coinstructor use a tool to show video. The teacher observed how the coinstructor used the video buttons and she reiterated her request to "show [her] . . . what it was that [the co-instructor] . . . did so that all she had to do was go over to that monitor and she clicked on something and the thing came up." (Transcript: audio recording of after-class interview, September 28, 1994). At this time, all that the teacher knew about this feature was how to use it and this was done by clicking on something on the computer screen to make video come up on the big projection screen on the wall; she did not know much more about the tool including its name and function. However, the teacher seemed to have made a clearer request the second time she mentioned her desire to learn about the vidbit. On another occasion, the teacher had asked someone to help her prepare for class so that she simply would click on vidbits to show video. After class, the teacher expressed that she felt good about being able to click on vidbits to show videos and that this experience "... was pretty minimal but I did it ... is a little tiny step for me ... but it worked the way I wanted to use it." (Transcripts: audio recording of after-class interview, October 3, 1994). By this time, the teacher gained firsthand knowledge in using a vidbit. Through her learning process, it seems that she had asked for help from others and it seems that this gesture helped her gain a deeper perspective about the vidbit.

It seemed that by asking questions the teacher learned to express her needs in more specific ways. In addition, as the teacher used the hypermedia environment in tiny steps, she gained more confidence in dealing with the environment. It was also noticeable that the teacher's knowledge about the environment's use, specifically about the vidbit, kept on adding up as she asked more questions.

Thus, as a client, the teacher learned about technology use in three ways, namely, through her personal effort, with help from others, and through a gradual and cumulative progress of knowledge acquisition. Through these ways, the teacher learned a lot about aspects of video use, like how a vidbit worked and its relation to the laser disc and other hypermediarelated operations.

Where did the teacher learn about technology use? As a client, the teacher probably learned about the hypermedia from working in the computer laboratory. While students and faculty used the computer laboratory as a venue to work on their hypermedia investigations, it also served two other functions, namely, as a *classroom* and as a *classroom* used as a computer laboratory.

First, the teacher learned in the computer laboratory when it was used as a classroom. The computer laboratory served two purposes, namely, as a classroom, where people met for class, and as a computer laboratory, where people worked in hypermedia stations outside of class time. On several occasions, the teacher's learning experiences occurred in the computer laboratory when it was used as a classroom. At one time, she observed how the co-instructor used the vidbit to show video in class and at another time, she used the vidbit herself (Transcripts: audio recording of after-class interview, September 28, 1994; October 3, 1994). She continued to learn video use as she used the equipment in another class (Transcripts: audio recording of classroom observation, October 5, 1994). Finally, the teacher also learned that it was important to give students transcripts if they viewed video because sometimes voices could be inaudible and, with a transcript, students would be able to refer back to previous events (Transcripts: audio recording of afterclass interview, October 5, 1994).

Second, the teacher learned in the computer laboratory when it was used as a computer laboratory. On two occasions, the teacher learned in the computer laboratory when it was being used outside of class times. At one time, she learned how to use different keyboard-related operations, like starting, stopping, and fast forwarding video, and how to print a hypermedia page (Transcripts: audio recording of teacher planning, October 5, 1994). At another time, she began her own hypermedia investigation, learned of inquiry-related operations, like cutting from and pasting to a hypermedia page, and asked about presentation tools, like obtaining bigger-size prints (Transcripts: audio recording of mid semester interview, November 8, 1994).

Third, the teacher learned in the classroom when it was used as a computer laboratory. The computer laboratory as a classroom also served as a computer laboratory, when people worked on their hypermedia projects during class time. The teacher worked in the classroom when it was used as a computer laboratory in the following instances: As the teacher was observing a group of students, she learned something when students experienced having a problem with the picture on the computer monitor (Transcripts: audio recording of classroom observation, November 21, 1994). Then, the teacher learned as she observed different groups work on their investigations (Transcripts: audio recording of classroom observation, November 21, 1994). As the teacher tried to help a student copy graphics, she also learned that she had to box the piece of graphics in order to have the option to copy or cut it (Transcripts: audio recording of classroom observation, November 21, 1994).

Thus, as a client, the teacher learned in three different venue types. She learned in a classroom when she observed her co-instructor use vidbits and when she used them herself. She also learned in a computer laboratory when she learned about video-related operations, investigation-type functions and presentation tools. Finally, the teacher learned in a classroom used as a computer laboratory while observing students work on their hypermedia projects.

Who helped the teacher learn about technology use? As a client, the teacher was aware that technical-resource people were available (Transcripts: audio recording of teacher planning with co-instructor, September 28, 1994; audio recordings of after-class interview, September 28, 1994, October 3, 1994; audio recordings of teacher planning, October 5, 1994, November 8, 1994). In the course of her learning about technology use, the teacher was able to learn from three different types of people, namely, her co-instructor, a colleague, and technical-resource personnel.

First, the co-instructor helped the teacher. The teacher learned from the co-instructor as she observed the co-instructor use video buttons to show video in class (Transcripts: audio recording of after-class interview, September 28, 1994). In a way, the co-instructor, who was advanced in her knowledge about use of the environment, served to encourage the teacher, who once described her co-instructor's use of the hypermedia as fancy (Transcripts: audio recording of teacher planning, September 28, 1994).

Second, a colleague helped the teacher. On two occasions, the teacher asked another colleague to teach her some of the environment's operations. At one time, in preparation for class, the teacher asked her to create vidbits which would be used in class (Transcripts: audio recording of after class interview, October 3, 1994). At another time, she observed her use the presentation tools and asked her how to use them herself (Transcripts: audio recording of mid semester interview, November 8, 1994).

Third, technology-resource personnel helped the teacher. This resource person helped the teacher when she prepared for class (Transcripts: audio recordings of after-class interview, October 3, 1994; audio recording of teacher planning, October 5, 1994) and when she visited groups as they worked on their hypermedia investigations (Transcripts: audio recordings of class observations, November 21, 1994 and November 23, 1994).

As a client, the teacher was fortunate to have found several helping hands as she learned the tools to run the technology. She learned with the help of her co-instructor who was advanced in her knowledge of the hypermedia environment and was comfortable using it. She also learned from a colleague who helped her make vidbits and show her the presentation tools. Finally, a technology-resource person helped the teacher prepare for class and answer technology-related questions posed by students. What happened as the teacher learned about technology use? Aside from learning how to operate within the hypermedia environment, the teacher also became apt in dealing with technology use. She became more confident about operating the technology. She learned alternative ways when technological support was not sufficient. She also preferred to learn the more efficient ways of doing things.

First, the teacher gained confidence in dealing with aspects of technology use. In the course of learning about technology use, the teacher acquired knowledge to the point of being confident when given the choice of what to prepare to teach using technology or responding to students' technology-related questions. On occasions when students asked for help, the teacher showed confidence when, after stating her comment to students who were doing something with graphics, she emphasized that what she mentioned was her solution. She said, "Why don't you paste the whole thing and delete what you don't want? That is my solution." (Transcripts: audio recording of class observation, November 21, 1994). The teacher continued to be in command as a technical resource to students as she informed them what to do (Transcripts: audio recording of class observation, November 21, 1994). On another occasion, the teacher felt confident when she could be in control in deciding what to prepare to teach. She said that she was comfortable in teaching with technology.

"... when I had control over choice of whatever it was we were going to use ... my agenda and so there was a piece of video that we were going to show ... that I wanted our students to have in mind as they look at the video ... to go with the conversation following that .... That's a manageable thing for me to do and I can rehearse it ... I know which disc to pull out. I can already have the disc ready ... push and how to do it. Um so when it's my agenda and I can control and I'm not going to do something very exotic...that's okay ..." (Transcripts: audio recording of post semester interview, January 6, 1995).

Second, the teacher learned to work around the imperfections related to technology use. As the teacher learned about technology use, she also managed to work around the system's imperfections. At one time, when the teacher found out that there was no way to improve the way a picture looked on the big screen, she thought of an alternative way to present the information to students. The event occurred in this way: The teacher showed a video of Mrs. Ball's classroom as the whole class watched from the huge projection screen on the back of the classroom wall. The teacher found out that the picture did not show clearly, and she tried to use the remote control to adjust the picture's clarity. One student inquired whether the teacher could show the video in individual hypermedia stations. She replied negatively, knowing that the equipment did not have that capability. To help the student, the teacher drew on the board representations which did not appear clearly on video (Notes: class observation, October 5, 1994; Transcripts: audio recording of class observation, October 5, 1994). In order to compensate for the blurry picture on the screen, the teacher utilized the blackboard and drew some representations which did not appear clearly on the big screen. On the following class meeting, the teacher wanted students to revisit Mrs. Ball's

lesson. Instead of having them view video on the big projection screen, she divided the class into three groups and each one watched from a hypermedia station. The teacher brought two copies on tape, as the third one was on laser disc (Transcripts: audio recording of class observation, October 7, 1994). Having learned from experience in the previous class, she came prepared with an alternative way to view video.

Third, the teacher preferred to learn better ways of doing things than being contented with what she knew currently. The teacher pursued learning about technology use in order to know better ways of doing things. She showed this attitude when she learned about the vidbit. Although she knew the keyboard operations to control viewing video, she preferred to learn the more efficient way to show video. With a positive tone, she said, "I believe I could do it," as she hoped to learn how to make a vidbit herself (Transcripts: audio recording of after-class interview, November 9, 1994). In the past lessons, the teacher had used the blackboard (Transcripts: audio recording of after-class interview, October 5, 1994) and overheard projector (Notes: class observation, October 5, 1994). In addition, she used the overhead projector to write down students' ideas (Notes: class observation, September 26, 1994). However, as she prepared to introduce the hypermedia environment and project to the students, the teacher learned how to use the computer in order to be able to type in big prints and thus be able to use them to type students' ideas in a discussion (Transcripts: audio recording of mid semester interview, November 8, 1994; audio recording of class observation, November 9, 1994).

Thus, as a client, the teacher learned a lot about technology use. First, she felt confident tackling technology issues, like in responding to some of the students' questions and when she is in control of what to teach which included technology use. Second, the teacher learned to deal with computer imperfections by coming up with alternative solutions, like to draw on the blackboard representations which did not appear clearly on the screen and to have students watch video at the hypermedia stations using videotape. Finally, the teacher opted to do the more efficient ways of doing things, like making a vidbit instead of using the fast forward key and using the computer to project students' ideas, instead of an overhead projector or the blackboard.

# CHAPTER FIVE FINDINGS (PART II): THE TEACHER'S ROLE AS A CHANGE AGENT IN A DIFFUSION OF INNOVATION PROCESS

#### Introduction:

#### The Need for a Diffusion of Innovation in Education

In the previous chapter, it was mentioned that the M.A.T.H. project investigators saw the need to help preservice teachers discern new ways to teach and learn about mathematics. Although the primary objective was to help preservice teachers, the means to help them was through teacher educators. In the previous chapter, the study presented findings which described the teacher educator's role as a client, as she adopted *the value of teaching about learning to teach using the hypermedia environment* in the instruction of methods courses. This chapter presents findings which describe the teacher educator as a change agent, as she provided students with opportunities "to explore teaching and learning in real time."

## An Examination of the Teacher's Role as a Change Agent in a Diffusion of Innovation Process

This section is about the teacher as a change agent, as she tried to accomplish the primary objective of her own change agent, the M.A.T.H. project group. The role as change agent occurred simultaneously with her role as a client. Just as a client, the teacher as a change agent was largely influenced by certain prior knowledge and experiences she had. They are similar to ones in the previous chapter.

#### The components of the technological innovation

This subsection analyzed the technological innovation based on the two components which Rogers (1983, 1995) described (see Table 5.1). The components of the technological innovation when the teacher was a client are closely similar to the components when she assumed the change agent role. The primary difference lies in the software component, which now has become the value of learning "to explore teaching and learning in real time." This is another case in which the hardware component is more obvious than its software aspect because it is easily apparent and noticeable compared to its software aspect, which, being another value, is intangible. The hardware component also refers to three aspects of the hypermedia environment, namely, (a) the aspects of the Student Learning Environment; (b) the tools used to operate within the hypermedia environment; and (c) the equipment used to run the hypermedia environment.

#### **TABLE 5.1**

#### TWO COMPONENTS OF THE TECHNOLOGICAL INNOVATION

Two Components of the Technological Innovation			
Component	Rogers' Theoretical Framework	Observation	
software	the information aspect of the innovation	the <i>value</i> of learning "to explore teaching and learning in real time"	
hardware	the embodiment which encases the innovation	•aspects of the Student Learning Environment: -teacher's journal, -children's portfolios, -videos, -transcripts of videos, -video catalogs; •tools to operate within the hypermedia environment; and •equipment to run the hypermedia environment	

#### The components of the process of diffusion

In this study, the components which describe the diffusion of innovation process were adapted from Rogers (1995) framework (see Table 5.2). There are four components, namely, innovation, communication channels, time and the social system. The *innovation* consists of two parts: the software aspect refers to the 'the value to explore teaching and learning in real-time using the hypermedia environment ,' and the hardware aspect refers to the elements of the hypermedia environment and the tools and equipment used to operate the environment. This was the innovation which the change agent wanted the teacher to adopt in teaching a mathematics methods course. From the teacher's perspective, this was a new innovation in the sense that it was her first time to use it in teaching a class.

#### **TABLE 5.2**

### FOUR COMPONENTS OF THE DIFFUSION PROCESS

Four Components of the Diffusion Process			
Component	Adapted from Rogers' Theoretical Framework	Observation	
innovation	a concept, thing, or a way of life which a person or social system intending to adopt perceives as new	This refers to the value to explore teaching and learning in real-time using the hypermedia environment in a methods course and the aspects, tools, and equipment related to the use of the hypermedia environment.	

communication channel		
a. interpersonal channels	means to transmit information through face to face interaction between two or more persons	<ul> <li>The teacher taught her students through innovation use.</li> <li>The students conferred with the teacher about ways to use the innovation.</li> <li>Students discussed with one another the findings they came up with through innovation use.</li> <li>The teacher and co-instructor planned, taught, and assessed student innovation use.</li> </ul>

b. media channels	means to transmit	•The teacher, with the
	information through a	co-instructor, used
	tool or instrument	handouts to provide
		students with
		information about
		requirements for
		innovation use.
		•The teacher, with the
		co-instructor, used
		handouts to provide
		information about the
		subject matter which
		was being taught
		through innovation
		use.
		•One student gave the
		teacher a handout about
		an idea she had in mind
		in relation to a topic
		from innovation use.
		The teacher used
		hunarmadia
		annironment materials
		to teach about learning
		to teach through
	·	innovation use
		innovation use.
		•Using hypermedia
		environment materials,
		the students presented
		their investigation
		findings through
		innovation use.
		•The teacher used the
		overhead projector, and
		hypermedia
		environment projection
		tools and equipment to
		transmit information
		related to innovation
		use.

time	the time spent on an	
	innovation's	
	•software and	•The teacher spent time to plan for student innovation use.
		•The teacher spent time to help students with innovation use.
		•The teacher spent time to assess student innovation use.
	•hardware aspects.	•The students studied how to operate tools within the hypermedia environment before working on their investigations.
		•They spent a considerable amount of time working to answer their inquiries.
social system	an individual or a group of people who work collectively to achieve a common goal and which include the following:	
	•the change agent system and	•The teacher was the primary member of the change agent system.
	•the client system.	•The students were members of the client system.

With regard to the second component, there are two kinds of communication channels, namely, interpersonal and media channels. Interpersonal channels, which were prevalent in this diffusion process, refer to the means of transmitting information through face-to-face interactions between two or more persons. Instances in which interpersonal channels were present in the diffusion process are the following: The teacher taught her students through innovation use (Transcripts: audio recording of class observation, September 26, 1994; audio recording of class observation, October 5, 1994). The students conferred with the teacher about ways to use the innovation (Transcripts: audio recording of class observation, November 21, 1994). Students discussed with one another the findings they came up with through innovation use (Transcripts: audio recording of class observation, November 28, 1994; audio recording of class observation, November 30, 1994). The teacher and co-instructor planned (Transcripts: audio recording of planning of co-instructors, November 9, 1994), taught (Transcripts: audio recording of class observation, November 9, 1994; audio recording of class observation, November 11, 1994; audio recording of post semester interview, January 6, 1995), and assessed student innovation use (Transcripts: audio recording of class observation, November 21, 1994; audio recording of class observation, November 23, 1994).

The other type of channels, *media channels*, refer to ways of transmitting information through a tool or instrument. This diffusion process included media channels such: handouts which the teacher, with the co-instructor, used to provide students with information about requirements for innovation use (Handout: Project #3: An Investigation of Mathematics Teaching and Learning in Hypermedia, given to students on November 9, 1994); handouts which the teacher, with the co-instructor, used to provide information about the subject matter which was being taught through innovation use (Handout: A transcript: Excerpt from Mrs. Ball's third grade class, given to students on September 21, 1994); a handout which one student gave the teacher to inform her about an idea she had in mind in relation to a topic from innovation use (Handout: student gave to teacher on November 23, 1994); hypermedia environment materials, which the teacher used to teach about learning to teach through innovation use; hypermedia environment materials, which the students used to present their investigation findings through innovation use, and the overhead projector and hypermedia environment projection tools and equipment which the teacher used the to transmit information related to innovation use.

*Time* is defined as the length of time the client spent to prepare or study about the software and hardware aspects of the innovation. Describing the teacher's experiences based on these subcategories, the teacher spent time to plan, implement, and assess student's use of the innovation. As clients, the teacher noticed that students studied how to operate tools within the hypermedia environment before working on their investigations. But they spent a considerable amount of time working to answer their inquiries.

Finally, social system refers to an individual or group of people who work collectively to achieve a common goal. In this specific case, there were two social systems, namely, the change agent and the client systems. The teacher was the primary member of the change agent system. In addition, the students were members of the client system.
### Planning, implementing, and assessing student technology use

Table 5.3 represents a summary of the teacher's role as a change agent. It includes descriptions about her planning, implementing, and assessing student technology use. Each aspect is described below.

#### **TABLE 5.3**

# THE TEACHER'S ROLES AS A CHANGE AGENT: PLANNING, IMPLEMENTING, AND ASSESSING STUDENT TECHNOLOGY USE

The Teacher's Roles as a Change Agent: Planning, Implementing, and Assessing Student Technology Use			
Questions		Claims	
WHAT student use of technology did	teacher planning:	teacher imple- mentation:	teacher assessment:
the teacher plan, implement, and assess?	for students to use the hypermedia technology to work on their investigations	had students use the hypermedia technology to work on their investigations	how students planned and implemented hypermedia use to answer their group inquiries

WHY	teacher	teacher imple-	teacher
did the teacher	planning:	mentation:	assessment:
plan, implement,			
and assess	•for students be	wanted students	•to find out how
student	aware of videos	to learn about	students were
technology use?	as sites with	learning to teach	thinking about
	which to pose	from student	their questions;
	questions;	technology use	•to provide help
	•to find out how	•••	to students who
	students were		needed it to
	thinking about		pursue their
	their		investigations;
	investigative		•to know where
	questions because		students have
	of the judgment		reached in terms
	embedded in		of thinking about
	some of them		their topics for
			investigation
WHEN	teacher	teacher imple-	teacher
did the teacher	planning:	mentation:	assessment:
plan, implement,			
and assess	•early on in the	in the second half	•sometime after
student	course;	of the course	the teacher gave
technology use?	•during class		the hypermedia
	discussions;		project;
	•after feeling that		•around the
	her initial		middle of the
	observations		duration of the
	were insufficient		project;
			•as the time to
			finish the project
			approached

HOW	teacher	teacher imple-	teacher
did the teacher	planning:	mentation:	assessment:
plan, implement,	-		
and assess	•by using videos	<ul> <li>encouraged</li> </ul>	<ul> <li>by observing</li> </ul>
student	of Mrs. Ball's	collaboration by	groups;
technology use?	classroom as sites	providing	•by listening to
	for students to	students with	students as they
	pose questions	opportunities for	gave their works-
	about;	interaction;	in-progress and
	•by encouraging	<ul> <li>helped students</li> </ul>	final reports
	students to ask	by responding to	
	questions of	the technical	
	interest to them;	questions they	
	•by helping them	had;	
	learn about	•provided	
	learning to teach;	students with	
	•by finding out	suggestions to	
	how students	think about as	
	thought about	they worked to	
	their main	narrow their	
	project questions	investigations	
WHERE	teacher	teacher imple-	teacher
did the teacher	planning:	mentation:	assessment:
plan, implement,			
and assess	•in a classroom;	•in a classroom;	•in the classroom
student	•in a classroom	• in a classroom	used as a
technology use?	used as a	used as a	computer
	computer	computer	laboratory;
	laboratory	laboratory	•in the classroom
WHO	teacher	teacher imple-	teacher
helped the	planning:	mentation:	assessment:
teacher plan,			
implement, and	•the co-instructor	•the co-	the co-instructor
assess student		Instructor;	
technology use?		• a technical-	
		resource person	

What	•several students performed the triangulation process of
conclusions	investigation;
did the teacher	<ul> <li>a few looked at a single line of observation;</li> </ul>
arrive at	•students learned about learning to teach from doing
about student	their investigations;
learning after	•students based their topics on class discussions which
doing an	took place early on in the semester
assessment of	
student	
technology use?	

<u>Planning student technology use</u>. This subsection pertains to the teacher's role in planning student technology use. The descriptions about the teacher's role are responses to the following questions: What student use of technology did the teacher plan?, Why, when, how, and where did the teacher plan student technology use?, and Who helped the teacher plan student technology use? Table 5.4 summarized findings about this aspect of the teacher's role as a change agent.

#### **TABLE 5.4**

## **TEACHER'S ROLE AS A CHANGE AGENT:**

#### PLANNING STUDENT TECHNOLOGY USE

Teacher's Role as a Change Agent:		
Planning Student Technology Use		
Question	Claims	
What student use of	for students to use the hypermedia technology to	
technology did the	work on their investigations	
teacher plan?		
Why did the teacher	• for students be aware of videos as sites with	
plan student technology	which to pose questions;	
use?	•to find out how students were thinking about	
	their investigative questions because of the	
	judgment embedded in some of them	
When did the teacher	•early on in the course;	
plan student technology	<ul> <li>during class discussions;</li> </ul>	
use?	•after feeling that her initial observations were	
	insufficient	
How did the teacher	•by using videos of Mrs. Ball's classroom as sites	
plan student technology	for students to pose questions about;	
use?	<ul> <li>by encouraging students to ask questions of interest to them:</li> </ul>	
	•by helping them learn about learning to teach:	
	•by finding out how students thought about their	
	main project questions	
Where did the teacher	•in a classroom;	
plan student technology	•in a classroom used as a computer laboratory	
use?		
Who helped the teacher	•the co-instructor	
plan student technology		
use?		

What student use of technology did the teacher plan? As a change agent, the teacher had a clear purpose in mind. She wanted students to learn through first-hand use of the innovation. In her mind, the teacher planned for students to use the hypermedia technology to work on their

*investigations*. She mentioned about this plan during one of her earliest planning sessions with the co-instructor. The teacher said, "Part of the--the purpose I think of using these materials is they're wonderful sites for investigation. That's what we're gonna ask them to do in the second block of this course." (Transcripts: audio recording of planning of co-instructors, September 9, 1994). Then, towards the end of a discussion about the coin problem, as the teacher led students to assess what they already knew about learning to teach, she mentioned that they would have the chance to investigate a question they were interested in on the second half of the course (Transcripts: audio recording of class observation, September 26, 1994).

At a different time, as the teacher showed a quiz which Mrs. Ball gave her third graders, the teacher informed the prospective teachers that they would be able to check out the quizzes better as they worked on their own investigations in the second half of the course (Transcripts: audio recording of class observation, October 5, 1994). Then, as the teacher showed some of the third graders' answers to one item on the quiz, one prospective teacher posed a question about a child's work. In response, the teacher said that this question could be investigated in the second half of the course when the prospective teacher could follow the child in the videos available (Transcripts: audio recording of class observation, October 5, 1994). Thus, from these observations, it is clear that the teacher wanted her students to work on their investigations in the second half of the course. Why did the teacher plan student technology use? As a change agent, the teacher's main purpose for coming up with her plan was to achieve the purpose for teaching the course which was that the teacher wanted to help students learn about learning to teach through hypermedia use. In addition, the teacher had subgoals which supported the primary one:

First, the teacher planned that students be aware of videos as sites with which to pose questions. The teacher wanted students to be aware that videos of Mrs. Ball's classroom were sites about which they could ask questions. The teacher mentioned this in the following events: One, she said, "But we want--we're gonna start building that right now--that--that--one of the reasons for using these materials is that they're wonderful sites for us to ask some questions." (Transcripts: audio recording of planning of co-instructors, September 9, 1994). Two, on the day before the teacher gave the hypermedia projects, one of the things she planned for class the following day was to help students "to begin to think about how questions emerge when looking at a video." (Transcripts: audio recording of mid-semester interview, November 8, 1994). The teacher's purpose was to help students come up with their hypermedia investigation questions.

Second, the teacher wanted to find out how students were thinking about their investigative questions because of the judgment embedded in some of them. The teacher was curious about how students had been thinking about their questions which contained judgments. When she allotted two class days on Thanksgiving week for hypermedia work, the teacher's reasons for her plans surfaced in the following observations: One, as the teacher was about to observe one group, she mentioned that she wanted to visit the group whose question had a judgment embedded in it. She said,

"I think I want to see what questions I'm curious about. This one ... has embedded in it an evaluation .... So I'd like to hear them talk to me .... I want to find out if they're aware of this assumption ... not to tease them away from it .... So I'm going over to this group." (Transcripts: audio recording of class observation, November 21, 1994).

Two, that same day, after the teacher had been to a group, she mentioned that she would like to visit the same group at another time in order to find out more about how they were thinking about their question, which contained some judgment (Transcripts: audio recording of class observation, November 21, 1994). Three, the teacher mentioned that she was interested specifically in visiting groups whose questions contained assumptions and judgments (Transcripts: audio recording of after class interview, November 21, 1994). Four, after spending time with groups, the teacher felt that she would like to find out more about what students were thinking when they asked the evaluative questions (Transcripts: audio recording of after class interview, November 21, 1994).

As a change agent, the teacher came up with plans to help students formulate questions or to check on students' thoughts concerning the questions students came up with. First, she wanted students to be aware that videos of Mrs. Ball's classroom were sites with which they could ask questions. In addition, she was curious about how students have been thinking about their investigative questions which contained judgments. <u>When did the teacher plan student technology use</u>? As a change agent, the teacher planned several things about technology use at different times within the course's duration. These plans took place on the following occasions: early on in the course, during class discussions, and after feeling that her initial observations were insufficient.

First, the teacher planned about technology use early on in the course. The teacher wanted to help students cultivate ideas early on in the semester although the hypermedia activity, for which the planning was being done, was to occur in the second half of the course. Early on in the course, the teacher's plans about students technology use took place in the following events: while the teacher and co-instructor were planning for the coin problem activity (Transcripts: audio recording of planning of co-instructors, September 9, 1994); in class, towards the end of a discussion on the coin problem (Transcripts: audio recording of class observation, September 26, 1994); while the teacher was showing a quiz which Mrs. Ball gave her third graders (Transcripts: audio recording of class observation, October 5, 1994); and as the teacher was showing the third graders' answers to one item on the quiz (Transcripts: audio recording of class observation, October 5, 1994).

Second, the teacher mentioned of her plans about technology use during class discussions. The teacher interjected her plans about technology use during class discussions. These plans took place on the following occasions: in class, towards the end of a discussion about the coin problem, she mentioned that students would have the chance to investigate a question they were interested in the second half of the course (Transcripts: audio recording of class observation, September 26, 1994); as the teacher was showing a quiz which Mrs. Ball gave her third graders, the teacher informed students that they would be able to check out the quizzes better when they work on their own investigations in the second half of the course (Transcripts: audio recording of class observation, October 5, 1994). Then, as the teacher showed the third graders' answers to one item on the quiz, one prospective teacher posed a question about a child's work. In response, the teacher said that this question could be investigated in the second half of the course when the prospective teacher could follow the child in the videos available (Transcripts: audio recording of class observation, October 5, 1994).

Third, the teacher planned to observe technology use after she felt that she had not observed enough the first time around. The teacher seemed serious in finding out what students had in mind about their questions which contained judgments; thus, she intended to observe the groups again after she visited them the first time when they spent more time learning how to work their way around the environment technically. The teacher mentioned of this plan in the following occasions: One, after the teacher had been to one group, she mentioned that she would like to visit the same group at another time in order to find out more about the content of their project. When she observed the first time, the group spent most of the time on technical aspects (Transcripts: audio recording of class observation, November 21, 1994). Two, with the time she spent in groups, the teacher felt that she had not observed enough and would like to find out more about what students were thinking when they asked evaluative questions. She said,

"I don't think I've observed enough .... What I'd like to do on Wednesday is to spend a half hour with a group .... Today I saw a lot of cutting and pasting. I don't have a sense of their choices .... That's part of learning what the value of these materials are." (Transcripts: audio recording of after class interview, November 21, 1994).

Based on this observation, she intended to observe the groups again on the following class meeting and spend about a half hour with each one. Three, on the second class day which the teacher and co-instructor allotted for hypermedia work, as the teacher was about to visit a group, she said, "What I want to do is spend like half an hour with a group because I want to know what they do . . . ." (Transcripts: audio recording of class observation, November 23, 1994).

As a change agent, the teacher made different plans about student technology use throughout the course. She wanted to help students cultivate ideas early on in the course. She also interjected her plans about technology use during class discussions. Finally, the teacher planned to observe groups again after she was not able to obtain enough information during her first visits.

<u>How did the teacher plan student technology use</u>? The teacher planned student technology use in several ways and these were: by using videos of Mrs. Ball's classroom as sites for students to pose questions, by having students ask questions of interest to them, by helping them learn about learning to teach, and by finding out how students thought about their main project questions.

First, the teacher wanted students to be aware that videos were sites which could be used to pose questions. The teacher used videos of Mrs. Ball's classroom as sites for students to ask questions about. In one instance, while planning a lesson, the teacher and co-instructor were selecting a video segment to show in class because, according to the teacher, "... one of the reasons for using these materials is that they're wonderful sites for us to ask some questions." (Transcripts: audio recording of planning of co-instructors, September 9, 1994). Then on the day before the teacher gave the hypermedia projects, one of the things which she planned for class the following day was to help students "to begin to think about how questions emerge when looking at a video." (Transcripts: audio recording of mid-semester interview, November 8, 1994).

Second, the teacher wanted students to investigate questions of interest to them. The teacher would like students to ask questions of interest to them. This plan surfaced in the following events: While having a discussion on the coin problem, she mentioned that students would have a chance to investigate questions which were of interest to them (Transcripts: audio recording of class observation, September 26, 1994). Then, as the teacher showed a quiz which Mrs. Ball gave her third graders and their answers to one quiz item, one prospective teacher posed a question about a child's work. In response, the teacher said that this question could be investigated in the second half of the course when the prospective teacher could follow the child in the videos available (Transcripts: audio recording of class observation, October 5, 1994). The handout about the hypermedia project mentioned that the project was an opportunity for students to investigate issues of interest to them. According to the handout, "This project is designed . . . to give you an opportunity to define and pursue an issue of interest o you." (Handout: Project #3: An Investigation of Mathematics Teaching and Learning in Hypermedia, given to students on November 9, 1994).

Third, the teacher planned for students to learn about learning to teach. The teacher would like students to learn about learning to teach. This plan was manifested in the following events: One, when the teacher read in some students' journals that they still had not learned about learning to teach, she mentioned of her plan to find out what students have learned so far about learning to teach from their experiences in working on the coin problem (Transcripts: audio recording of classroom observation, September 26, 1994). Two, the teacher and the co-instructor mentioned of their intention for students to learn about learning to teach through working on the hypermedia project when they wrote in a handout that "It is crucial that you learn HOW TO LEARN from your own practice as a teacher and from the practices of others. This project is designed to help you develop your ability to do this ... ." (Handout: Project #3: An Investigation of Mathematics Teaching and Learning in Hypermedia, given to students on November 9, 1994). Three, when asked about her intentions for having students use the hypermedia environment, she said:

"I would want to be at the fore of any conversations while students were doing the investigations whether . . . or group or what I might have with groups of students uh . . . that this investigation is about learning something about learning to teach . . . . What question do they have about aspects of learning to teach that they might get smarter about in looking through the environment. So always keeping that in focus." (Transcripts: audio recording of post semester interview, January 6, 1995).

According to the teacher, she hoped that students were clear about the fact that they were doing the investigation in order to learn about learning to teach.

Fourth, the teacher planned to find out how students were thinking about their investigative questions. The teacher wanted to know how students were cultivating their ideas based on the main questions they came up with. She allotted two class days on Thanksgiving week for students to work on their hypermedia investigations; on these days, she manifested her plan in several occasions: One, as the teacher was about to observe one group, she mentioned that she would like to visit the group in order to listen to students talk about their investigation (Transcripts: audio recording of class observation, November 21, 1994). Two, on another occasion, after the teacher had come from observing one group, she mentioned that she would like to visit that same group at another time in order to find out more about how they were thinking about their investigation (Transcripts: audio recording of class observation, November 21, 1994). Three, at one time, the teacher said, "I wasn't interested in challenging them but find out what they mean. I was interested in a couple of groups, the questions they asked, what they mean, what they were thinking." (Transcripts: audio recording of after class interview, November 21, 1994). Four, the teacher felt that the time she spent observing groups was not enough and that she would like to find out more about what students were thinking (Transcripts: audio recording of after class interview, November 21, 1994). Five, on the second day allotted for hypermedia work, as the teacher was about to observe a group, she mentioned of her plan to find out what the students were thinking when she said, "What I want to do is spend like half an hour with a group because I want to know what they do ...." (Transcripts: audio recording of class observation, November 23, 1994).

As a change agent, the teacher had several plans regarding how her students used technology use. She wanted students to be aware that videos of Mrs. Ball's classroom were possible sites which students could use to pose questions. The teacher wanted students to investigate questions which were of interest to them. She wanted to help her students learn about learning to teach. Finally, the teacher was curious about how her students proceeded with their thinking based on their hypermedia project questions.

<u>Where did the teacher plan student technology use</u>? As a change agent, the teacher planned about technology use in a couple of venues. These were: in a classroom and in a classroom used as a computer laboratory.

First, the teacher mentioned of her plans about student technology use in the computer laboratory when it was being used as a classroom. The computer laboratory served two purposes, namely, as a classroom, where people met for class, and as a computer laboratory, where people worked at hypermedia stations outside of class time. On three occasions, the teacher mentioned of her plans about technology use in the computer laboratory while class was going on: towards the end of a discussion about the coin problem (Transcripts: audio recording of class observation, September 26, 1994); as the teacher showed a quiz which Mrs. Ball gave her third graders (Transcripts: audio recording of class observation, October 5, 1994); and as the teacher responded to a student's question about the work of a third grader (Transcripts: audio recording of class observation, October 5, 1994).

Second, the teacher planned to observe student technology use in the classroom when it was being used as a computer laboratory. The computer laboratory as a classroom also served as a computer laboratory, when people worked on their hypermedia projects during class time. On several occasions, the teacher planned about technology use in the classroom when it was used as a computer laboratory and these situations went as follows: As the teacher was about to visit a group, she planned to observe how students talked about their investigation (Transcripts: audio recording of class observation, November 21, 1994). After the teacher had come from observing one group, she mentioned that she would like to visit that same group at another time in order to find out more about how they were thinking about their investigation (Transcripts: audio recording of class observation, November 21, 1994). Then, as the teacher was about to observe a group on a different day, she mentioned of her plan to find out what students were thinking during a half hour visit (Transcripts: audio recording of class observation, November 23, 1994).

As a change agent, the teacher made plans about technology use in two types of venues. First, the teacher planned in a computer laboratory when it was being used as a classroom. Second, she planned in that classroom when it was used as a computer laboratory.

Who helped the teacher plan student technology use? As a change agent, the teacher planned student technology use with the co-instructor. After introducing the hypermedia environment and project to the students, the teacher and co-instructor both felt that they should give students further information on how they would proceed with their investigations (Transcripts: audio recording of planning of co-instructors, November 9, 1994). In their planning session, the co-instructor mentioned of her plans to deal with this on the following class, since the teacher would not be available on that day. In addition, both the teacher and co-instructor also talked about their plans to provide students with class times to work on their hypermedia investigations. They also made further plans about how the works-in-progress report ought to proceed. Thus, the teacher and co-instructor made several plans together about student technology use.

Implementing student technology use. This subsection pertains to the teacher's role in implementing student technology use. The descriptions about the teacher's role are responses to the following questions: What student use of technology did the teacher implement?, Why, when, how, and where did the teacher implement student technology use?, and Who helped the teacher implement student technology use? Table 5.5 summarized findings about this aspect of the teacher's role as a change agent.

#### **TABLE 5.5**

#### **TEACHER'S ROLE AS A CHANGE AGENT:**

#### IMPLEMENTING STUDENT TECHNOLOGY USE

Teacher's Role as a Change Agent: Implementing Student Technology Use		
Question	Claims	
What student use of technology did the teacher implement?	had students use the hypermedia technology to work on their investigations	
Why did the teacher implement student technology use?	wanted students to learn about learning to teach from student technology use	
When did the teacher implement student technology use?	in the second half of the course	
How did the teacher implement student technology use?	<ul> <li>encouraged collaboration by providing students with opportunities for interaction;</li> <li>helped students by responding to the technical questions they had;</li> <li>provided students with suggestions to think about as they worked to narrow their investigations</li> </ul>	
Where did the teacher implement student technology use?	<ul> <li>in a classroom;</li> <li>in a classroom used as a computer laboratory</li> </ul>	
Who helped the teacher implement student technology use?	<ul> <li>the co-instructor;</li> <li>a technical-resource person</li> </ul>	

What student use of technology did the teacher implement? As a change agent, the teacher was concerned that students learn about learning to teach from the materials found in the hypermedia environment. She had students use the hypermedia technology to work on their investigations. On the second half of the mathematics methods course, the teacher presented the hypermedia environment and project to the students (Transcripts: audio recording of class observation, November 9, 1994). The teacher and coinstructor provided students with a handout describing details about the project (Handout: Project #3: An Investigation of Mathematics Teaching and Learning in Hypermedia, given to students on November 9, 1994). Thus, as a change agent, the teacher had students learn about learning to teach from first-hand use of the hypermedia environment. Students would use this to work on their investigations.

Why did the teacher implement student technology use? As a change agent, the teacher wanted students to learn about learning to teach from student technology use. This objective was mentioned explicitly in the handout which the teacher and co-instructor provided about the hypermedia project. According to the handout,

"It is crucial that you learn HOW TO LEARN from your own practice as a teacher and from the practices of others. This project is designed to help you develop your ability to do this ...." (Handout: Project #3: An Investigation of Mathematics Teaching and Learning in Hypermedia, given to students on November 9, 1994)

In addition, the teacher mentioned that she hoped her students realized that the purpose for the hypermedia investigation was for them to learn about learning to teach (Transcripts: audio recording of post semester interview, January 6, 1995). Thus, as a change agent, her primary reason for student technology use was for students to learn about learning to teach. When did the teacher implement student technology use? As a change agent, the teacher implemented student technology use in the second half of the mathematics methods course. The teacher presented the hypermedia work as she introduced the environment to students (Transcripts: audio recording of class observation, November 9, 1994). The teacher and co-instructor had students work on their hypermedia projects in class on a couple of days (Transcripts: audio recording of class observation, November 21, 1994; November 23, 1994). Students gave their works-in-progress reports (Transcripts: audio recording of class observation, November 28, 1994; November 30, 1994) and their final reports (Transcripts: audio recording of class observation, December 9, 1994; December 12, 1994) regarding their work on the hypermedia investigations.

How did the teacher implement student technology use? As a change agent, the teacher implemented student technology use through various means. These were by providing students with opportunities for interaction, by responding to the technical questions they had, by giving suggestions to help narrow their investigations, and by keeping abreast with where they are at in their projects.

First, the teacher encouraged collaboration by providing students with opportunities for interaction. In addition to having students work together in small groups and as a whole class, the teacher also suggested that students ask help from and share ideas with one another, and this occurred at the following times: One, for the hypermedia project, the teacher and her coinstructor instructed students to work and accomplish things in small groups, and this information was mentioned in the handout which stated:

"You will be working with a small group to frame and define a question and focus for your investigation. Together, you will use the hypermedia environment to create a collection of evidence or information related to your question. You will analyze what you are finding, formulate a tentative conjecture about your question or about your topic, and support is with the evidence you have been able to uncover. Then you will organize your collection, arranging and annotating it to show your tentative analysis and findings." (Handout: <u>Project #3: An Investigation of Mathematics Teaching and Learning in</u> <u>Hypermedia</u>, given to students on November 9, 1994)

Based on the handout, the teacher provided students with suggestions on ways they could be involved and work together. Two, before the works-inprogress reporting began, the teacher reminded the class that this type of reporting was being done in order for each group to obtain feedback and other types of help from the rest of the class (Transcripts: audio recording of class observation, November 28, 1994). In this example, the teacher was clear with how she felt groups should interact with the rest of the class and vice versa. The opportunity to report was intended to open doors for groups to ask for feedback and the rest of the class to give suggestions. Three, on both days when groups presented their works-in-progress reports, the teacher asked the rest of the class whether they had questions for the group that reported (Transcripts: audio recording of class observation, November 28, 1994; audio recording of class observation, November 30, 1994). The teacher kept providing opportunities for interaction by continuously reminding the student audience to ask questions from the groups who reported. Second, the teacher helped students by responding to the technical questions they had. The teacher tried to respond to students' technical questions as they worked in the environment and these occurred in the following situations: One, the teacher gave answers to students questions regarding pasting graphics. One of the teacher's responses was: "Why don't you paste the whole thing and delete what you don't want? That is my solution." (Transcripts: audio recording of class observation, November 21, 1994). Two, the teacher suggested how a student would copy something from a transcript. Part of the procedure she suggested was, "Now go to the transcript menu and block what you want . . . ." (Transcripts: audio recording of class observation, November 21, 1994).

Third, the teacher provided students with suggestions to think about as they worked to narrow their investigations. The teacher tried to help students work on their investigations by providing them with suggestions, and this took place in the following occurrences: One, a group was not sure whether to focus on the depth or breadth of their topic. In response, the teacher gave students additional information about their topics of interest, asked them to define their topic to her, informed them to provide proper support as they shape their topics in a particular direction which they would need to decide on, and to make an initial decision which could be altered later on (Transcripts: audio recording of class observation, November 21, 1994). Two, the teacher observed a group at a time when they were narrowing their question. To help them, the teacher suggested for students to decide the specific aspect of topic they were really interested in, for them to check the data to find out what's available, for them to find out what about their topic Mrs. Ball worked to establish in her class (Transcripts: audio recording of class

observation, November 21, 1994). Three, a student needed help in describing a finding she made. To help, the teacher suggested that the prospective teacher focus on the third grader she observed, look for positive and negative effects which could have affected the third grader's understanding, and find out the type of learner the child was (Transcripts: audio recording of afterclass meeting with student, November 28, 1994). Four, a student wanted some clarification on how to describe a third grader's situation which, in turn, would help support her inquiry. The teacher suggested for her to look at the occasions the child was successful in dealing with the topic, to search for evidence regarding a child's thoughts as they related to the mathematical solutions she represented, and to analyze the work that she did (Transcripts: audio recording of after-class meeting with a student, November 30, 1994).

As a change agent, the teacher implemented student technology use through various means. First, as the teacher had students work in small groups and then give group reports to the rest of the class, she also suggested that students ask help from and share ideas with one another. Second, she tried to answer the students' technical questions. Third, she suggested how students could narrow their questions.

Where did the teacher implement student technology use? As a change agent, the teacher worked in the computer laboratory for the most part of the implementation process. At this time, the computer laboratory served two functions, namely, as a classroom and as a classroom used as a computer laboratory.

First, the teacher implemented student technology use in the computer laboratory when it was used as a classroom. The computer laboratory served two purposes, namely, as a classroom, where people met for class, and as a computer laboratory, where people worked at hypermedia stations outside of class time. On a number of occasions, the teacher's implementation experiences occurred in the computer laboratory when it was used as a classroom, and these were the following: when the teacher presented the hypermedia work as she introduced the environment to students (Transcripts: audio recording of class observation, November 9, 1994); when students gave their works-in-progress reports (Transcripts: audio recording of class observation, November 28, 1994; November 30, 1994) and their final reports (Transcripts: audio recording of class observation, December 9, 1994; December 12, 1994) regarding their work on the hypermedia investigations.

Second, the teacher implemented in the classroom when it was used as a computer laboratory. The computer laboratory as a classroom also served as a computer laboratory, when people worked on their hypermedia projects during class time. The teacher implemented student technology use in the classroom when it was used as a laboratory on the following occasions: when the teacher and co-instructor had students work on their hypermedia projects in class on a couple of days (Transcripts: audio recording of class observation, November 21, 1994; November 23, 1994); when the teacher met with individuals who asked for assistance after class times (Transcripts: audio recording of after-class meeting with student, November 28, 1994; audio recording of after-class meeting with a student, November 30, 1994).

As a change agent, the teacher implemented student technology use in two venues. These were the computer laboratory when it was used as a classroom and the classroom when it was used as a laboratory.

<u>Who helped the teacher implement student technology use</u>? As a change agent, the teacher implemented student technology use with a couple of people. They were the co-instructor and a technology-resource person.

First, the teacher implemented technology use with her co-instructor. According to the teacher, she relied on the co-instructor for technical knowhow because she, at that time, was working on her own hypermedia investigation in a study group whose focus was on faculty's use of the technology for classroom teaching. In addition, the co-instructor was responsible for giving students an indepth perspective on technology use. The teacher said,

"So with [the co-instructor] . . . and I working together on the course I think we fell into a division of labor where in part because [the co-instructor] . . . was doing her own investigation in the study group--I hadn't been able to participate at all in the study group--. . . . and the fact that um I was gone from class on uh a couple of days that were crucial to introducing the students in the environment and starting the students in the environment . . . I really relied on [the co-instructor] . . . for much of the technical know-how . . ." (Transcripts: audio recording of post semester interview, January 6, 1995).

The co-instructor was very much visible during the following times in the implementation process: when the teacher presented the hypermedia project to students, the co-instructor was available and also provided information about technology use (Transcripts: audio recording of class observation, November 9, 1994); the co-instructor provided students with detailed

information on how to proceed with their hypermedia projects (Transcripts: audio recording of class observation, November 11, 1994); according to the teacher, the co-instructor was very involved in implementing technology use. She said,

"... and help them to learn something about learning to teach ... that [the co-instructor] ... was pretty good in keeping them focused ... on who made comments in their notebooks after their first presentation. . . notebooks and made some comments. She was also available some evening lab times. .." (Transcripts: audio recording of post semester interview, January 6, 1995).

The teacher noticed that the co-instructor provided students with feedback and comments after they gave their works-in-progress reports. In addition, the co-instructor was available for student consultation in the evenings when students worked on their projects in the laboratory.

Second, the teacher implemented technology use with a technicalresource person. At times, the teacher responded to students' technical questions. At other times, she asked the help of a technical-resource person, and this took place at different times during the couple of class days when the students had the opportunity to work on their hypermedia projects (Transcripts: audio recording of class observation, November 21, 1994 and November 23, 1994). Being more confident when working on her own, the teacher was happy that a technical-resource person was available to answer students technical questions, too. (Transcripts: audio recording of class observation, November 21, 1994). Because she found the technical person's presence to be helpful, the teacher informed her that, "I'm certainly glad you're here." (Transcripts: audio recording of class observation, November 21, 1994).

As a change agent, the teacher implemented technology use with a couple of people. They were the co-instructor and a technical-resource person.

Assessing student technology use. This subsection pertains to the teacher's role in assessing student technology use. The descriptions about the teacher's role are responses to the following questions: What student use of technology did the teacher assess?, Why, when, how, and where did the teacher assess student technology use?, Who helped the teacher assess student technology use?, and What conclusions did the teacher arrive at about student learning after doing an assessment of student technology use? Table 5.6 summarized findings about this aspect of the teacher's role as a change agent.

# **TABLE 5.6**

# **TEACHER'S ROLE AS A CHANGE AGENT:**

# ASSESSING STUDENT TECHNOLOGY USE

Teacher's Role as a Change Agent:		
Assessing Student Technology Use		
Question	Claims	
What student use of	how students planned and implemented	
technology did the	hypermedia use to answer their group inquiries	
teacher assess?		
Why did the teacher	•to find out how students were thinking about	
assess student	their questions;	
technology use?	•to provide help to students who needed it to	
	pursue their investigations;	
	•to know where students have reached in terms	
	of thinking about their topics for investigation	
When did the teacher	•sometime after the teacher gave the hypermedia	
assess student	project;	
technology use?	•around the middle of the duration of the project;	
	•as the time to finish the project approached	
How did the teacher	•by observing groups;	
assess student	•by listening to students as they gave their works-	
technology use?	in-progress and final reports	
Where did the teacher	•in the classroom used as a computer laboratory;	
assess student	•in the classroom	
technology use?		
Who helped the teacher	the co-instructor	
assess student		
technology use?		
What conclusions	•several students performed the triangulation	
did the teacher arrive at	process of investigation;	
about student learning	•a few looked at a single line of observation;	
atter doing an	•students learned about learning to teach from	
assessment of student	doing their investigations;	
technology use?	•students based their topics on class discussions	
	which took place early on in the semester	

What student use of technology did the teacher assess? As a change agent, the teacher assessed how students planned and implemented hypermedia use to answer their group inquiries. The teacher assessed how students utilized the hypermedia environment for their work on the hypermedia project. However, her interest in students' technology use seems to be more focused on the utilization of data rather than on the use of the technical aspect, based on the following comments: One, after observing a group, she said that she planned on going back to the same group because, when she was there the first time, the students were working on the environment's technical aspect (Transcripts: audio recording of class observation, November 21, 1994). On another instance, she said that, when she observed in class one time, she saw students spend time learning to cut and paste data. Because she did not get a sense of students' choices, she would like to spend about a half hour each time with a group whose question caught her attention (Transcripts: audio recording of after-class interview, November 21, 1994).

The teacher assessed student technology use in the following situations: One, an example of what the teacher assessed is based on something she said she took a note of it:

"I'm making a note of what their question is. Their question is on [Mrs. Ball's]... demeanor.... They're looking at what that is in the classroom. They're looking for examples of positive and negative demeanor... and also how that affects the kids.... There are four persons in the group and each person has taken a different question to investigate." (Transcripts: audio recording of class observation, November 21, 1994)

Based on the teacher's notes, she was interested in the kinds of information students were looking for to answer their group inquiry. In this case, she

noted that students were planning to check examples which showed the third grade teacher's positive and negative demeanor and its effect on the children. In addition, she noted how each member were partaking in the investigation. Two, the teacher noticed how students of another group were not gathering the same types of information to answer their group's question and she was interested in finding out how they would pull things together at the end of their project (Transcripts: audio recording of after-class interview, November 21, 1994). Three, the teacher observed how students were going through a process of having hypotheses, looking for evidence to support them, revising the previous hypotheses and making a write-up concerning the decision to revise a hypothesis (Transcripts: audio recording of class observation, November 23, 1994; audio recording of after-class interview, November 23, 1994). In this situation, students were supporting their hypotheses with data from the environment.

Four, the teacher observed that one group worked on their question by looking at one third-grade child in the video and checked how she performed at different times in the school year (Transcripts: audio recording of after-class interview, November 23, 1994). Five, the teacher observed that students seemed to be attending seriously to the kinds of evidence they are looking for to support the claims they made concerning their topics (Transcripts: audio recording of after-class interview, November 28, 1994). Six, the teacher noticed that one group was answering the inquiry by looking at the beginning, middle, and end parts of a video (Transcripts: audio recording of after-class interview, November 28, 1994). Seven, she noticed that one group looked at a small piece of data to make an assertion, which she did not agree to (Transcripts: audio recording of interview about the final reports, December 13, 1994). Eight, in a detailed fashion, the teacher described how one group went from one type of data to another in search for answers to their questions. Her description went this way:

"The group looked at [the third grader's] ... quiz and tried to decide if there was a connection between how a student did on a quiz and the extent in which the teacher called this student. The group also looked through the videos for examples of [the third grader] ... being called on in class and then checked [Mrs. Ball's] ... Journal to look for things written about [the third grader's] ... understanding."

In this observation, the teacher mentioned what data type the group looked at and explained why she did this. Thus, as a change agent, what the teacher assessed was how students analyzed Mrs. Ball's classroom to answer their questions.

Why did the teacher assess student technology use? As a change agent, the teacher assessed student technology use for several reasons: to find out how students were thinking about their questions; to provide help to students who needed it to pursue their investigations; and to know where students have reached in terms of thinking about their topics for investigation.

First, the teacher assessed student technology use in order to find out how students were thinking about their questions. As a change agent, the teacher wanted to find out how students were thinking about the topics they planned to investigate, and this interest in checking student technology use was manifested in the following instances: One, as the teacher was about to observe a group while working on their project, she mentioned that she would like to hear the students talk in order to find out if they were aware of the assumption embedded in their question (Transcripts: audio recording of class observation, November 21, 1994). Two, the teacher expounded that she was interested in observing groups whose questions had judgments in them because she wanted, not to challenge them but, to know "what they mean, what they were thinking" (Transcripts: audio recording of after-class interview, November 21, 1994). Three, in addition, the teacher wanted to pose questions as an outsider and ask students the criteria that they are using in including judgments in their questions (Transcripts: audio recording of after-class interview, November 21, 1994). Four, in class, the teacher felt that she had not observed enough because she mainly saw students work on the technical aspect. At another time, she intended to spend a half hour observing groups again in order to understand what they are doing (Transcripts: audio recording of after-class interview, November 21, 1994). Five, before visiting a group for the second time, the teacher planned to observe for about a half hour to find out what students are doing in their investigations (Transcripts: audio recording of class observation, November 23, 1994). Six, as the teacher described her visits to groups, she mentioned that spending about a half hour in each helped her see where groups were going with their investigations (Transcripts: audio recording of class observation, November 23, 1994).

Second, the teacher assessed student technology use as a way to provide help to students who needed it to pursue their investigations. As a change agent, the teacher would like to know if students needed assistance as they worked on their projects and to provide that help. This concern was manifested in the following situations: One, before the groups presented their works-in-progress reports, the teacher mentioned the general plan for them to proceed, including the part when students ought to mention if they needed help with something, because this occasion was an opportunity for them to obtain feedback from the rest of the class. According to the teacher,

"Each group will report for fifteen minutes . . . give us question you're investigating . . . where you are in terms of progress report and if there are some things you need help with let us know so we'll see if there are ways we can provide some assistance . . . . This is not polished work. This is works-in-progress . . . . But it's a chance for you to get feedback and help from others." (Transcripts: audio recording of class observation, November 28, 1994)

In this observation, the teacher informed the students that because this was a works-in-progress reporting, it did not mean that students' works were supposed to be done. Through giving a report at this time, students had been privileged with the opportunity to ask for assistance and obtain feedback from others. Two, as the first group reported, one group member asked for suggestions and questions. After some classmates responded, the teacher once again asked if others had questions. Then she too gave a couple of suggestions (Transcripts: audio recording of class observation, November 28, 1994). Three, as another group presented, the teacher asked one presenter, "Tell us what kinds of things you're still puzzling over." After the student responded, the teacher suggested a question which the group could look into (Transcripts: audio recording of class observation, November 30, 1994). Four, as one presenter mentioned an assertion she came up with, the teacher cautioned her to be careful about making very strong interpretations and led her to consider a more appropriate one (Transcripts: audio recording of class observation, November 30, 1994). To help the student interpret observations

properly, the teacher further questioned her, as seen in the following conversation:

teacher: "But look at that next to the drawings that [the third grader has] ... made. I'm not confident about the assertions as I look at the full context that that is written--how is the statement connected to the drawings that he made?"
presenter: "Based on an interview that [Mrs. Ball] ... had with him ...."
teacher: "What conclusion could you draw from that?"
presenter: "But we're not seeing him grow as much as the kids that can speak English well."
teacher: "That's what I was pushing for."

(Transcripts: audio recording of class observation, November 30, 1994)

In this situation, the teacher guided the student to come up with a better claim based on the observations they made from the data.

Third, the teacher assessed student technology use in order to know where students have reached in terms of thinking about their topics for investigation. As a change agent, the teacher wanted to determine how far students had developed their inquiries, and she observed the following events: One, the teacher mentioned that although some groups began their investigations with judgments embedded in their inquiries, through their work in the project students' perspectives got deeper as they realized that teaching was a far more elaborate matter than what they initially observed. According to her,

"... in a couple of instances the questions were framed in a way that suggested that students already had taken a particular perspective on the classroom or the teacher or the students .... For example, that it was a competitive classroom environment ... or that [Mrs. Ball] ... intervened in ways that were disruptive or not helpful ... or some suggestions about a particular demeanor or tone that she had that ... students found problematic. And in almost all instances and certainly across them ... I think that those questions got reshaped in ways that reflect our students coming to see classrooms as far more complex places and teaching is a much more complex activity that they had probably thought." (Transcripts: audio recording of interview about the final reports, December 13, 1994)

In this circumstance, the teacher specified examples of the earlier types of questions groups came up with which included judgments. Two, the teacher noticed how one group's understanding about selection and use of manipulatives got deeper compared to their initial claims. She said,

"Another piece that stands out for me and this comes from one particular group is that selecting and using physical representations, manipulatives, is also much more complex than they had originally thought . . ." (Transcripts: audio recording of interview about the final reports, December 13, 1994).

Although the teacher disagreed with the claim the group came up with and seemed bothered that the assertion was based on a small piece of data , she

was glad that the group members began to look at decisions for choosing manipulatives and their use. According to her,

"Now I don't buy that argument about that particular episode. I don't think that the coins did stand in the way of children's learning. In fact, they probably were quite helpful... in getting out on the table what it was some kids didn't know about the coins. But at least they've begun to ask themselves about the choices that you make about manipulatives, whether they're always useful or automatically useful . .." (Transcripts: audio recording of interview about the final reports, December 13, 1994).

In this incident, the teacher mentioned why she did not agree with the assertion which one group came up with.

Three, according to the teacher, students mentioned to her that, through the hypermedia project, they learned about things which they had not thought of in the past. She said,

"Another theme that cut through several of the projects was that this was a task that helped them to think about and learn some things that they really hadn't thought about before. That varied ... what the things were varied across the projects but that statement of "I learned about some things that I had never thought about before." ... was something that a number of students said." (Transcripts: audio recording of interview about the final reports, December 13, 1994)

Then the teacher named a student who was among the first ones who gave this comment and who elaborated that she became more aware of her learning process, being conscious of the mental steps she took (Transcripts: audio recording of interview about the final reports, December 13, 1994).
Four, the teacher noticed that one group shifted their focus from the initial question of "How does the teacher call on students?" to figuring out why, when, and how Mrs. Ball called on two students (Transcripts: audio recording of interview about the final reports, December 13, 1994). Five, another group initially looked for instances when Mrs. Ball thought kids were engaged or less engaged. Later on, the group also tried to figure out what it means when students are engaged and took account of the types of questions Mrs. Ball asked when she called on students (Transcripts: audio recording of interview about the final reports, December 13, 1994).

Six, one group's topic which began from examples of Mrs. Ball's positive and negative demeanor shifted to Mrs. Ball's techniques which were motivating or inhibiting. Two group members moved further along in their investigation when they checked the mathematics standards and used them as a framework to analyze how Mrs. Ball taught. According to the teacher,

"So in that group . . . both drew heavily on the standards . . . as a framework to look back at how [Mrs. Ball] . . . establishes a classroom . . . environment and what role she plays in promoting a particular kind of discourse in the classroom." (Transcripts: audio recording of interview about the final reports, December 13, 1994)

Seven, the teacher mentioned that while she initially was worried about one student, she felt that the student asked "amazing questions," like

"Why does the teacher introduce a particular representation, like rectangles over circles?. When does she take the lead in making suggestions?. When does a teacher have a right to insist on a representation that's different from a child's?" (Transcripts: audio recording of interview about the final reports, December 13, 1994) Thus, as a change agent, the teacher assessed student technology use for several reasons and these were the following: to find out how students were thinking about their questions; to provide help to students who needed it to pursue their investigations; and to know where students have reached in terms of thinking about their topics for investigation.

When did the teacher assess student technology use? As a change agent, the teacher assessed student technology use throughout the second half of the mathematics methods course. She assessed the students' work about the beginning, middle and end of the hypermedia project's duration.

First, the teacher assessed student technology use shortly after she gave students the hypermedia project. As a change agent, the teacher wanted to find out how students have been thinking about and working on their investigations shortly after she gave them the project. She and the coinstructor gave students two class days for them to work on their hypermedia projects (Notes: class observation, November 21, 1994; class observation, November 23, 1994; Transcripts: audio recording of class observation, November 21, 1994; audio recording of class observation, November 23, 1994).

Second, the teacher assessed student technology use after she gave students some time to work on their hypermedia projects. As a change agent, the teacher sought to know where students were at in their hypermedia work towards the middle of the duration of the project. For two class days, groups gave detailed reports of how they have thought about their work (Notes: class observation, November 28, 1994; class observation, November 30, 1994; Transcripts: audio recording of class observation, November 28, 1994; audio recording of class observation, November 30, 1994).

Third, the teacher assessed student technology use as the time to finish the hypermedia work approached. As a change agent, the teacher desired to know what students learned from doing the hypermedia project. She and the co-instructor reserved two class days for groups to give final presentations on what they reached in terms of thinking about and working on their investigations (Notes: class observation, December 9, 1994; class observation, December 12, 1994).

<u>How did the teacher assess student technology use</u>? As a change agent, the teacher assessed student technology use by listening to students as they conversed and asked questions about their own investigations and by observing students' works.

First, the teacher assessed student technology by visiting groups as they worked on their hypermedia projects. To find out how students were doing on their projects, the teacher as a change agent approached groups while they were working on their investigations (Notes: class observation, November 21, 1994; Transcripts: audio recording of class observation, November 21, 1994; audio recording of class observation, November 23, 1994).

Second, the teacher assessed student technology use by listening to groups as they reported in class. In order to know what students had accomplished by the middle of the project's duration, the teacher listened as groups gave detailed reports about their investigations (Notes: class observation, November 28, 1994; Transcripts: audio recording of class observation, November 28, 1994; audio recording of class observation, November 30, 1994). Although listening per se is difficult to prove, as a result of the teacher's listening to student reports, she provided relevant input in class, like in the following situations: One, the teacher gave suggestions about the descriptive terms students used. She said,

"I'm very interested in the words that you use .... The fact that you talked about one of the management strategies as being 'inviting children to participate.' If you just think about what that--that image of management suggests--invitation to participate--rather than trying to maintain control ... I think that that's a very interesting way that you've chosen to describe something .... So one of the things that you might think about in your reflections ... what is the management of classrooms?" (Transcripts: audio recording of class observation, November 28, 1994).

By listening to this group's report, the teacher suggested a focus which students could include in their reflections.

Two, by listening to a student report, the teacher was able to reiterate a student's concern about their group's investigation. She said,

"... so part of what you're puzzling over is why the move toward this rectangular representation when there's clearly some students in this class who have some sort of preference towards a circular representation ..." (Transcripts: audio recording of class observation, November 28, 1994).

In addition, the teacher took notes about the student reports (Transcripts: audio recording of after-class interview, November 28, 1994). When asked about the reports, the teacher gave very detailed information about what she heard students reported about (Transcripts: audio recording of after-class interview, November 28, 1994; audio recording of after-class interview, November 30, 1994; audio recording of interview about the final reports, December 13, 1994).

<u>Where did the teacher assess student technology use</u>? As a change agent, the teacher assessed student technology use in the computer laboratory. At that time, the computer laboratory was a classroom or a classroom used as a laboratory.

First, the teacher assessed student technology use in the classroom when it was used as a computer laboratory. The teacher had her class occupy a computer laboratory to be a classroom. However, for a couple of days, she and her co-instructor had students work on their hypermedia projects during class time. Thus, during both days, the classroom was used as if it were a computer laboratory (Notes: class observation, November 21, 1994; class observation, November 23, 1994; Transcripts: audio recording of class observation, November 21, 1994; audio recording of class observation, November 23, 1994).

Second, the teacher assessed student technology use in the classroom. The teacher regularly spent class time in a computer laboratory; thus, in this case, it was used as a classroom. On two occasions, the teacher assessed student technology use and these occurred when students gave their worksin-progress and final reports (Notes: class observation, November 28, 1994; class observation, November 30, 1994; class observation, December 9, 1994; class observation, December 12, 1994; Transcripts: audio recording of class observation, November 28, 1994; audio recording of class observation, November 30, 1994).

Thus, the teacher assessed student technology use in the computer laboratory. However, during these times, the room was used either as a classroom or a classroom which was used as a computer laboratory.

Who helped the teacher assess student technology use? As a change agent, the co-instructor helped the teacher assess student technology use. The teacher and co-instructor co-taught the course. In the process, the coinstructor also assessed the students, as seen in the following events: One, she also visited groups as they worked on their hypermedia projects during class time (Transcripts: audio recording of class observation, November 21, 1994; audio recording of class observation, November 23, 1994). Two, the coinstructor gave suggestions to groups who reported in class (Notes: class observation, November 28, 1994; Transcripts: audio recording of class observation, November 28, 1994). What conclusions did the teacher arrive at about student learning after doing an assessment of student technology use? First, the teacher observed that several students performed the triangulation process of investigation. After visiting a couple of groups, the teacher seemed very pleased with what she had observed. She said,

"... I'm pretty impressed .... In the two groups, they weren't making statements that weren't supported by evidence .... I heard the word "evidence". That's really encouraging to me. They seem to ... have interesting ideas about what kinds of data might be looked at ... listen to Safriman ... look in the notebook .... What I didn't see them do ... I didn't see them really look at answers to the problem. But I think that they're trying to do. The fact that they're revising ...." (Transcripts: audio recording of after-class interview, November 23, 1994).

On another day, the teacher mentioned that she noticed that the students were determined to support their claims with pieces of data as evidence. On the day when the students presented their works-in-progress presentations, the teacher told her students that she observed them practice the process of triangulation in which they supported their hypotheses with pieces of data which students looked for in different places in the data set of the hypermedia environment. In explaining the triangulation process and how the students were following it, she said,

"In qualitative research, we call it triangulation of data. And what it means is you're looking for some examples of evidence or pieces of data that you can gather in different places from different sources at different times. But you're looking for something around the same question or the same theme or you're looking for some patterns. So what I was listening to particularly at what you talked about was the ways in which you moved from looking at something in the video to going to [Mrs. Ball's] . . . journal, to going to the kids' notebooks, and looking at the kids' notebooks in two different times. That's the process of triangulation that you've got some idea that you're looking for and you're looking for it in different places. Everybody's doing it. It's a wonderful skill to have in trying to pursue some line of inquiry so I think you've done very well in without somebody teaching you that." (Transcripts: audio recording of class observation, November 30, 1994).

After class, the teacher strongly reiterated what she had observed in the group presentations, and that was that the students practiced the process of triangulation by supporting their hypotheses with pieces of data which students looked for in different places in the data set of the hypermedia environment. She said,

"I was serious though when I talked about the triangulation of data. I think they've done a pretty interesting job of having a hunch about something they see on a videotape and then going to [Mrs. Ball's] ... journal around that time to see if that provides them some additional information looking at student work so that ... looking across the data ... within that particular time frame ... I think is ... they're making good use of the environment and having a pretty good intuitive sense about searching data so ... that was nice to see ...." (Transcripts: audio recording of after-class interview, November 30, 1994).

Second, although the teacher strongly felt that the students were doing the process of triangulation, she also felt that there were a few students who were not doing it. Based on the data, there was evidence which supported the counter assertion that the students had not utilized the multiple data sources in order to support their hypotheses. After class when the students had given their works-in-progress presentations, the teacher wondered whether a couple of groups were applying the process of triangulation in their work because, for instance, in one group, the students only looked at one videodisk for evidence. The teacher mentioned that

"I'm wondering about a couple of groups to what extent they're investigating beyond the videos that we used in class. There seems to be an awful lot of attention and focus on this [one videodisk] . . . which I . . . think is an interesting piece. But it feels like in one or two cases there are some conclusions being drawn on the basis of some episodes in that particular day that I think if they looked across a number of sessions those hunches might be called into question." (Transcripts: audio recording of after-class interview, November 30, 1994).

Third, the teacher noticed that students learned about learning to teach from doing their investigations. The teacher felt that if she had not asked the question regarding what students learned about learning to teach, they would not have mentioned anything about it in their reports. However, when she raised the question, students responded (Transcripts: audio recording of class observation, December 12, 1994). In addition, based on the teacher's observations about students' reflection papers on their hypermedia work, she said: "Um almost everybody in their reflections on the hypermedia environment . . . talked about what they have learned about learning to teach ... uh sort of the power in being able to look across a set of data. " (Transcripts: audio recording of post semester interview, January 6, 1995). Then the teacher read some comments which students wrote. The teacher provided a detailed explanation of how she observed students learned about learning to teach. She said:

"Um I think that . . . they did a pretty good job of crafting a question out of their own interest. . . that was appropriate to the environment. I think they crafted a question that was appropriate to our course which is learning to teach mathematics . . . . Um almost everybody -- they played the role of researcher um and they looked across data. And I think they were pretty . . . thoughtful about how to use data gathered in different ways. . . so they they were inquirers. Um I think a large number of them made some linkages between asking questions which is a part of this assignment . . . and good teachers are always asking questions. Um and finally I think nearly everyone was able to be quite explicit about one aspect of learning to teach . . . . They they know more about or understand complexity the way they didn't understand before . . . and are pretty articulate about that." (Transcripts: audio recording of post semester interview, January 6, 1995).

Based on the teacher's observations, the students were able to develop questions of interest to them. She noticed that students were thoughtful as they sought for data within the hypermedia environment to answer their inquiries. The students inquired about several things, seemed to have a better understanding of the complexities of a classroom environment, and were clear about what they learned about learning to teach.

Fourth, the teacher had helped her students come up with ideas for their investigation questions before the students worked on their hypermedia projects. On the day when the teacher gave the hypermedia project to the students, the teacher informed the researcher that on class that day she picked a specific video clip to show to the class in order to get the students' interests and help them generate questions. The teacher thought that the students would find the video segment interesting because they had not seen Mrs. Ball in the front and center of her classroom when she taught. (Transcripts: audio recording of class observation, November 9, 1994). One student wrote in her hypermedia notebook that she based her research query on her observations of Mrs. Ball in the video shown in class. In the video clips that were shown in class, the student noticed that Mrs. Ball appeared "to be short tempered and sharp with the students" (Notes: student reflection). This observation led the student to decide to investigate Mrs. Ball's demeanor and its consistency throughout the school year. On the day when the students gave their works-in-progress presentations, the teacher felt that the students already had notions about their investigation questions when they began their hypermedia projects because, based on the students' comments, their questions came from observations which they had done in class before they worked on the hypermedia project. The teacher explained,

"What I found interesting was almost everybody I think in talking about their question also made a comment about where the question came from and in most of the cases it was a question that emerged from things that they had already seen in work that we had done in the class. So almost everybody had a place to start. There was at least something in this Environment that was familiar . . . " (Transcripts: audio recording of after-class interview, November 30, 1994).

Then when the teacher was asked about the students' final presentations, the teacher mentioned that she thought that one group looked into a third grade kid because of what the students had observed in an earlier class discussion

before they worked on the hypermedia project. The teacher explained why she thought the group decided to look into this child's performance.

> "My hunch about the reason that they picked on [the third grade child]. .. was ... when we have looked earlier in the semester ... at some of the quiz papers I think we spent quite a bit of time looking at [the third grade child's]... work on the quiz because I remember a couple of students saying 'This is at the end of several weeks of working on fractions and he doesn't seem to have much of a clue." ... I think somebody said, "How could a teacher let a student get to this point and not be able to do these?" So I think that's probably one reason why [the third grade child]... becomes a focus ... " (Transcripts: audio recording of interview about the final reports, December 13, 1994).

Thus, based on the observations, the teacher arrived at several conclusions about student learning after doing an assessment of student technology use. The teacher observed that students performed the triangulation process of investigation. However, although she made this observation, the teacher also noticed that a few students had not utilized the multiple data sources in order to support their hypotheses. Moreover, the teacher noticed that students did learn about learning to teach from doing their investigations. Finally, the teacher realized that she had helped her students come up with ideas for their investigation questions before the students worked on their hypermedia projects.

#### **CHAPTER SIX**

### SUMMARIES, CONCLUSIONS, AND RECOMMENDATIONS

### Introduction

The two previous chapters, chapters 4 and 5, discussed the findings from the study. This chapter begins with a presentation of a model based on the findings. This is followed by an adaptation of Altamirano's model to Havelock's framework on diffusion of innovation in education. Then what follows is a brief subsection on comparing the study's findings with Havelock's and Rogers' theoretical frameworks. Finally, discussions on conclusions and recommendations, and implications for future research end this chapter.

#### Altamirano's Model:

The Teacher's Dual Roles as a Client and Change Agent in the Adoption and Teaching of a Technological Innovation

Based on my study's findings, I developed a model--that is, the Altamirano Model--which I discerned to be representative of the larger connected picture. Altamirano's model begins with a pre-diffusion process (see Figure 6.1) which was described in Chapter 4. In that chapter, it was mentioned that the primary investigators of the M.A.T.H. project saw the complexities involved in the instruction about teaching and learning of mathematics. Breaking away from the traditional view of mathematics instruction, they envisioned that the use of a hypermedia environment could help in the instruction about mathematics instruction. With this novel perspective in mathematics education, the M.A.T.H. project investigators saw the need to help preservice teachers discern the new ways to teach and learn about mathematics. In view of this need, the M.A.T.H. project coordinators developed the hypermedia environment.

#### FIGURE 6.1





Because the way to preservice students was through the teacher educator, the M.A.T.H. project group, as a change agent system in one diffusion process, sought to help teacher educators, as clients of the same diffusion process, adopt the value of teaching about learning to teach using the hypermedia environment in the instruction of methods courses. In turn, the M.A.T.H. project group hoped that teacher educators, as change agents of another diffusion process, would provide students, or the client system, with opportunities "to explore teaching and learning in real time" through using the hypermedia environment. In this research study, the teacher was one of the teacher educators who agreed to teach using the hypermedia technology. With her acceptance, she assumed both roles as a client in one diffusion process and the change agent in another diffusion process. Both processes took place simultaneously as the teacher educator taught the course. (For simplicity, the teacher educator is being referred to as the teacher in this chapter, as it has been the case in the earlier ones.)

So far, what had taken place was part of a pre-diffusion activity. What followed these incidents were two simultaneous diffusion of innovation processes in which the teacher was a client in one and a change agent in the other. Following is a diagram(see Figure 6.2) which summarizes the two diffusion of innovation processes:



Legend:

Events which already appeared in the pre-diffusion process

Events which had not appeared in the pre-diffusion process

### The teacher's prior knowledge and experiences

Both diffusion processes were influenced highly by what the teacher brought with her to technology use. As the teacher, she brought with her several things: First, the teacher had experience integrating videos of Mrs. Ball's classroom in her past classes. Because of this previous experience, she brought with her knowledge she gained and comfort in video use for classroom teaching. Second, the teacher brought with her an inquisitive disposition regarding topics of personal and professional interest to her. She was interested to learn about issues of diversity, race, and gender which she thought could be present in Mrs. Ball's classroom. Third, the teacher brought with her a desire to learn about the technical aspect of the hypermedia environment. Through informal conversations with her, the teacher definitely described herself as not being a technology person. She feared using technology on her own, being afraid of experiencing glitches and not knowing what to do. Although this may be so, she seemed to present a positive disposition to learn about the tools within the hypermedia environment. Fourth, the teacher brought with her the desire to impart to students the relevance of collaborative work with colleagues. Fifth, the teacher brought with her assumptions of how prospective teachers would relate with what they see on video.

These were the things which the teacher brought with her to the mathematics methods course. They influenced her roles both as a client and a change agent, which occurred simultaneously as she taught the course. Each role is described separately, as follows:

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### The teacher as a client

The teacher's role as a client in innovation use is comprised of three subsequent phases: the adoption of innovation use, the integration of innovation use to the lessons, and the learning of tools and equipment use in relation to innovation use. The client's role began when the teacher adopted *innovation* use. Adoption meant that the teacher assumed responsibility to teach the course using the technological innovation. In this case, the technological innovation was 'the value of teaching about learning to teach using the hypermedia environment.' Upon her acceptance of the innovation, the client proceeded to integrate the materials within the hypermedia environment to the instruction of the lessons. The teacher planned and taught some lessons while incorporating certain aspects of Mrs. Ball's classroom. It was clear from the teacher's role as a client that the teacher integrated innovation use to the lessons before she learned to use the innovation's tools and equipment. Although this was the case, subsequently, the two processes occurred simultaneously and iteratively. As the teacher used the hypermedia environment to prepare for class, she also learned to use the related tools and equipment. Similarly, as the teacher used the hypermedia environment to teach, she also used the necessary tools and equipment. There were times when she learned as she used the tools in class.

Questions may be raised regarding the idea that adoption took place right away, that is, the teacher adopted the innovation before she taught with the hypermedia environment. To pursue this discussion, I would like to begin by providing definitions of adoption. According to Rogers (1983), adoption means "a decision to make full use of an innovation as the best

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course of action available" (p. 21). In addition, Havelock (1982) defines the adoption process as follow:

"After trial the client is in a position to decide whether to adopt or reject the innovation, but a decision to adopt is not the end of the story. The adopter may still encounter difficulties in trying to carry out his intention, and the change agent must be prepared to provide further training and encouragement. He must help the individual to adjust to the new situation, and he must be ready to provide his services when problems and unexpected obstacles arise." (p. 116)

Based on both definitions, the client was an adopter at the start of the course and was right in the process of adoption.

#### The teacher as a change agent

It was mentioned earlier that the teacher's role as a change agent occurred simultaneously as she assumed the client's role. In addition, the teacher's prior knowledge and experience influenced her role as a change agent. As a change agent, the teacher primarily focused her tasks on planning, implementing, and assessing student technology use.

The implementation of student technology use took place in the second half of the course when the teacher had students use the hypermedia technology to work on their investigations. The teacher prepared students for this activity as early as the first half of the course. The teacher prepared students by using videos of Mrs. Ball's classroom as sites for students to pose questions about and by helping them learn about learning to teach from their lessons. In addition, the teacher encouraged students to ask questions of interest to them in the first half of the course and through its second half. As students were working on their projects, the teacher made plans to find out how students thought about their project questions.

As the teacher implemented student technology use, she did the following: encouraged collaboration by providing students with opportunities for interaction; helped students by responding to the technical questions they had; and provided students with suggestions to think about as they worked to narrow their investigations. The teacher also proceeded with formative assessment of student technology use. She did this by observing how groups of students thought through their inquiries and how they searched for information from Mrs. Ball's classroom. In addition, the teacher listened and provided feedback to students as they gave their works-inprogress and final reports.

# An Adaptation of Altamirano's Model to Havelock's Framework on the Diffusion of Innovation in Education

I found it interesting to adapt the study's findings to Havelock's framework because Havelock's model specifically focuses on the educational arena. Havelock's framework is comprised of six phases, namely, building a relationship, diagnosis, acquiring relevant resources, choosing the solution, gaining acceptance, and stabilizing the innovation and generating selfrenewal. Taking each phase at a time, below is a discussion on how the Altamirano's model adapts to Havelock's framework. The figures were also adapted from Havelock's.

### The teacher as a client

<u>Building a change agent/client relationship</u>. In this study, the teacher had significant relationships with three representatives of the change agent system. They were the co-instructor, a colleague, and technical-resource personnel. Each of these relationships is discussed further:

As a client, the teacher taught with a co-instructor, who belonged to the change agent system (see Figure 6.3). The co-instructor knew how to use the tools and equipment to run the hypermedia environment. In some classes, the co-instructor taught using the hypermedia environment. Not knowing much about using the environment's tools, the teacher observed how the co-instructor used the vidbit tool to show video on the projection screen. In addition, the teacher seemed comforted by the fact that the co-instructor did not experience glitches. Thus, as a client, the teacher observed the co-instructor since she did not know much about using the environment's tools to show video. Although the co-instructor might not be aware at that time, she helped the teacher based on her need to know how the hypermedia's tools and equipment were to be used to teach.

#### **BUILDING A RELATIONSHIP:**

### **CO-INSTRUCTOR AND TEACHER**

(The study's findings viewed through Havelock's model)



As a client, the teacher had the opportunity to discuss with colleagues about hypermedia environment use in teaching. The teacher conferred several times with one of them, who belonged to the change agent system (see Figure 6.4). Through the colleague's help, the teacher was able to gain two types of information: insights about the colleague's experiences from having used and knowing about the hypermedia environment, and help in using the tools and equipment needed to run aspects of the hypermedia environment.

### **BUILDING A RELATIONSHIP:**

### **COLLEAGUE AND TEACHER**

(The study's findings viewed through Havelock's model)



As a client, the teacher learned that technical-resource personnel was abundant and available to help her with technology-related questions. The teacher consulted with them several times throughout the course (see Figure 6.5).

#### **BUILDING A RELATIONSHIP:**

### **TECHNICAL-RESOURCE PERSONNEL AND TEACHER**

(The study's findings viewed through Havelock's model)



<u>Diagnosis of the need</u>. The relationships that the teacher had as a client seemed to be built largely around her needs regarding use of the hypermedia environment materials, and the tools and equipment needed to run the environment. Each of the change agent's three representatives had specific roles in dealing with the teacher's needs, and these are explained, as follows:

As a client, the teacher conferred with her co-instructor about hypermedia environment use for teaching (see Figure 6.6). Both of them spent planning sessions together to discuss related matters. In addition, the teacher also consulted with the co-instructor about technical-related needs. The co-instructor helped the teacher or made sure another colleague would be able to help.

### **DIAGNOSIS OF THE NEED:**

### **CO-INSTRUCTOR AND TEACHER**

(The study's findings viewed through Havelock's model)



As a client, the teacher conveyed her needs to a colleague (see Figure 6.7). She consulted about the use of hypermedia materials, and the tools and equipment to operate the environment. In turn, the colleague spent time to explain things to the teacher during her planning sessions alone and with the co-instructor.

### **DIAGNOSIS OF THE NEED:**

### **COLLEAGUE AND TEACHER**

(The study's findings viewed through Havelock's model)



As a client, the teacher consulted several times with technical-resource personnel regarding technical-related questions (see Figure 6.8). The teacher was able to obtain help to run video and check materials within the hypermedia environment while she prepared for her classes; to prepare video tools which she would use to teach in class; to use the environment's tools and equipment while she taught; and to answer students' technical questions.

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### **DIAGNOSIS OF THE NEED:**

### **TECHNICAL-RESOURCE PERSONNEL AND TEACHER**

(The study's findings viewed through Havelock's model)



Acquiring relevant resources. The change agent system provided the teacher, as a client, with two main types of resources, namely, human and informational (see Figure 6.9). The teacher availed help from the following human resources: the co-instructor, the colleague, and technical-resource personnel. In addition, the change agent organized a Teacher Educator Study Group, with the purpose of "helping one another develop a pedagogy of teacher education based on inquiry" (Heaton, 1995, p. 24). Although the teacher attended its first session, she decided to withdraw from the rest of the group's meetings due to a very busy schedule. The teacher availed of another type of resource, the materials within the hypermedia environment, which supported her teaching practice.

## ACQUIRING RELEVANT RESOURCES TO USE THE HYPERMEDIA ENVIRONMENT FOR TEACHING PURPOSES

(The study's findings viewed through Havelock's model)



Using the solution. According to Havelock's model, this stage is called *Choosing the solution*. However, with the study's observations, the client system, the teacher, did not choose the solution. It was there already. Thus, instead of choosing, I decided to call the phase *Using the solution*. In this phase, as the teacher used the solution, which is the hypermedia technology, she performed her dual roles as a client and change agent in two different diffusion processes (see Figure 6.10). While using the technology, the teacher continued to diagnose her needs as a client of one diffusion process and the needs of her students as clients of the other diffusion process. In addition, the teacher continued to acquire resources, both human and informational, as she performed both roles.

### **USING THE SOLUTION**

(The study's findings viewed through Havelock's model)



<u>Gaining acceptance</u>. As a client, it seems that the teacher gained acceptance and eventual adoption of the innovation after the awareness phase (see Figure 6.11). These events took place before the course started. Then the integration stage ensued.

### **GAINING ACCEPTANCE**

(The study's findings viewed through Havelock's model)



Stabilizing the innovation and generating self-renewal. As a client, the teacher made use of the hypermedia materials right away and applied them to her lessons (see Figure 6.12). Simultaneous to this integration phase as a client, the teacher was also performing her role as a change agent. In the course, she taught students the subject matter through innovation use and also required student innovation use while she guided them through the activity.

### STABILIZING THE INNOVATION AND

### **GENERATING SELF-RENEWAL**

(The study's findings viewed through Havelock's model)



### The teacher as a change agent

Building a change agent/client relationship. In this study, the teacher, as a change agent, utilized the hypermedia environment for classroom purposes in two ways: she used the environment's materials to teach and she required students to work on their own hypermedia investigations (see Figure 6.13). In the first type of instructional situation, the students observed the teacher as she provided students with information. In both first and second types of situations, the students asked questions. The teacher provided answers mostly related to innovation use.

### **BUILDING A RELATIONSHIP:**

### **TEACHER AND STUDENTS**

(The study's findings viewed through Havelock's model)



Diagnosis of the need. As clients, the students expressed needs in the form of technical questions and contextual concerns (see Figure 6.14). The teacher responded to some of the technical questions and had a technicalresource person reply to other questions. But the teacher answered to contextual concerns addressed to her. To attend to a group's needs, she visited one group at a time, observed, and provided feedback. In cases where she could not observe their thinking initially, she decided to visit the same groups again.

#### **DIAGNOSIS OF THE NEED:**

#### **TEACHER AND STUDENTS**

(The study's findings viewed through Havelock's model)



Acquiring relevant resources. As clients, the students had two main types of resources: human and informational (see Figure 6.15). Human resources included the teacher, co-instructor, other instructors visited the class, technical-resource personnel, and other students. The teacher, coinstructor, and other instructors provided students with technical and informational help. Technical-resource personnel helped students with the technical aspect of the environment. In addition, students received encouragement from the teacher to become resources for one another through collaboration. The other type of resource was informational. The students availed of this from the materials within the hypermedia environment.

## **ACQUIRING RELEVANT RESOURCES**

### FOR STUDENT TECHNOLOGY USE

(The study's findings viewed through Havelock's model)



Using the solution. According to Havelock's model, this stage is called *Choosing the solution*. However, with the study's observations, the client system, the students, did not choose the solution. It was there already. Thus, instead of choosing, I decided to call the phase *Using the solution*. In this phase, as the students used the solution, which is the hypermedia technology, they were adopters in the diffusion process (see Figure 6.16). While using the technology, the students continued to seek for help regarding technology use from the teacher, who is the change agent, and other human and informational resources.

### **USING THE SOLUTION**

(The study's findings viewed through Havelock's model)



Gaining acceptance. As the change agent, the teacher proceeded to help students adopt the innovation through the following activities (see Figure 6.17). The teacher promoted/informed students about innovation use. At the start of the course, she informed students that they would be working on their own hypermedia investigations. In the first half of the course, the teacher integrated parts of the materials within the hypermedia environment into her lessons. Through this, the teacher demonstrated to students how they might use the same materials to pursue their own investigations. Then as the first half of the course was almost over, the teacher showed students the aspects and general use of the hypermedia environment. On the following class, the co-instructor provided students with more detailed information on doing investigations. As students were working on their projects, the teacher observed groups, listened to their reports, provided feedback, and met with individual students regarding their projects.

### **FIGURE 6.17**

### **GAINING ACCEPTANCE**

(The study's findings viewed through Havelock's model)


<u>Stabilizing the innovation</u>. Towards the end of the course, the teacher had students give final reports and submit written reflections about their work on the hypermedia projects (see Figure 6.18). In both instances, the teacher noticed how students learned about learning to teach from using the hypermedia environment.

#### **FIGURE 6.18**

#### **STABILIZING THE INNOVATION**

(The study's findings viewed through Havelock's model)



#### The teacher's dual roles as a client and change agent

In teaching the course, the teacher experienced two simultaneous diffusion processes taking place (see Figure 6.19). In one process, she was a client and in the other she was the change agent. In both cases, the teacher's relevant prior knowledge and experiences were found to be of help as the teacher pursued her dual roles. While a client, the teacher received the following types of support from the change agent: in-service training, support from colleagues, software/hardware guidance and help, availability of equipment, and allowance of time to learn. These kinds of support helped the teacher even as she pursued her role as a change agent. Because of this, her role as a change agent was largely focused on: learning from the insights of colleagues and focusing on innovation use.

#### FIGURE 6.19

#### THE TEACHER'S DUAL ROLES AS A

#### CLIENT AND CHANGE AGENT:

#### TWO SIMULTANEOUS DIFFUSION PROCESSES

#### OCCURRING DURING CLASSROOM INSTRUCTION

#### (The study's findings viewed through Havelock's model)



TRADITIONAL EDUCATION

# Comparing the Study's Findings with the Theoretical Frameworks

In this section, I compared the study's findings with Havelock's (1982) and Rogers' (1983, 1995) theoretical frameworks. Specifically, I based this comparison on the analyses I did of my study's findings using Havelock's guide to innovation in education model (see figures 6.3 to 6.19), and Rogers' model of the components of a technological innovation (see tables 4.1 and 5.1) and his model of the components of a diffusion process (see tables 4.2 and 5.2). Through these analyses, I observed that there were instances when the study's findings did not support the categories and assumptions of the theoretical frameworks.

First, the comparison showed a lack of detail in Havelock's model. More specifically, while Havelock's framework consists of one process of diffusion of innovation, based on my study, I observed that two diffusion of innovation processes were occurring concurrently. In one of these diffusion processes, the teacher was a client and the M.A.T.H. project group was the change agent and, in the other diffusion process, the teacher was the change agent and her students comprised the client system. These specific observations do not support the categorical nature of Havelock's and Rogers' frameworks. Based on my observations, there was a flow from the teacher's role as a client to her change agent role which supports the view that the world is fluid and dynamic. The edges of a categorical nature were not as clear based on what the teacher did when she taught the course. Second, the comparisons revealed variations to Havelock's and Rogers' models. While Havelock's framework includes the category, *choosing the solution*, based on my study, I did not observe this category in both diffusion processes in which the teacher was involved. When the teacher was a client, she used the provided solution, which was the hypermedia software and equipment available in the computer laboratory. In the same way, when the students comprised the client system, they used a similar solution with which the teacher provided them.

In addition, while Havelock's and Rogers' frameworks focused primarily on whether or not a client would adopt an innovation, based on my study, when the teacher was a client, she adopted the technological innovation before she taught the course. Thus, in this instance, the diffusion process largely focused on stabilizing the innovation use. I found this point to be clearly evident when I examined the components of the diffusion process based on Rogers' framework. Rogers (1983, 1995) defined the concept of time based on three aspects of a diffusion process (see subsection on 'Components of a diffusion process' in Chapter Two). These aspects of time are focused on the duration of time which starts from the moment a client learns about an innovation through the moment the client adopts or rejects the innovation. In my study, the time element pertains to the duration of time while the teacher worked to stabilize innovation use. This time element occurred after she adopted the innovation.

Based on the last two instances above, I discovered that some of my findings did not fall into two categories which were part of Havelock's and Rogers' frameworks. Specifically, my study's findings did not fall into the

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category of 'choosing the solutions' in Havelock's model of diffusion of innovation in education. Instead, the teacher's experience would fall under the category, 'using the provided solution.' In addition, the time aspect related to the teacher in my study did not fall into the concept of time in Rogers' framework on components of a diffusion process. Instead of focusing on whether or not the teacher would adopt an innovation, the teacher directed her activities on stabilizing innovation use. These analyses seem to relate to Zaltman and Duncan's (1977) observation that "models are good descriptions of overt, but not covert, behavior . . ." (p. 226). The authors referred to several models of innovation adoption processes which included Rogers' model.

Eventually, I arrived at a perspective of a client who was active, autonomous, and assertive in her role in the diffusion process. Rogers and Havelock seem to assume a passive role for the client. Even the term 'client' connotes a passive actor. In addition, Zaltman and Duncan (1977) noticed the role of the passive actor in the adoption process. However, the teacher I studied was an active implementor and learner of computer technology use. As an implementor of technology use, the teacher did much planning involving technology use in her lessons and inquiring from colleagues who had used similar aspects of technology. In addition, when her co-instructor could not teach on a certain day when the technology had to be used, the teacher took the responsibility on short notice. As a learner of technology use, the teacher acquired knowledge on her own and, at the same time, did not hesitate to ask questions of others regarding aspects of technology use helpful in her role as teacher.

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#### **Conclusions and Recommendations**

The conclusions primarily focus on the duality of the teacher's roles as client and change agent, the timeliness of support she received, and the unusual role she fulfilled as a client. The recommendations which follow provide important suggestions for teachers when they go through situations similar to the teacher's classroom experience of utilizing hypermedia technology.

#### Main conclusions

Based on the findings we may conclude, the teacher brought to the course past knowledge and skill which enabled her to build on what the hypermedia technology offered. When the teacher taught the course, she was familiar with some of the information about Mrs. Ball's classroom available through the hypermedia environment. In addition, she had used similar information, specifically those found on videos, in her past teaching experiences. Because of this, the teacher felt comfortable with this aspect of the hypermedia technology and with thinking about what her students could learn from technology use. From these past experiences, the teacher also brought to the course some of her notions about how her current students might react to videos of Mrs. Ball's classroom when seeing them for the first time. Finally, the teacher also desired to impart to her students the relevance of collaborative work. She mentioned how fruitful her interactions with colleagues were in teaching the course. Thus, she encouraged students to participate in collaborative work by providing them with opportunities to interact as they worked on their hypermedia investigations.

The teacher also brought to the course strong attitudes which provided her with the motivation and interest to use the technology. On both personal and professional levels, the teacher was very much interested in issues of race, diversity, and gender. She brought her interest on these issues to the course with the hope that students would also find out for themselves how these issues crop up in a mathematics classroom. As the teacher prepared to introduce the hypermedia projects to students, she pursued her own hypermedia investigation using the topics on race, diversity, and gender. Moreover, as the teacher taught the course, she brought with her a desire to learn about the technical aspect of the hypermedia environment. She continued to express her interest as she observed and helped students use the technology for their investigative work.

In teaching the course, the teacher portrayed dual roles as she experienced two simultaneously occurring diffusion of innovation processes. In one process, the teacher adopted the value of innovation into her teaching and learned relevant technological tools to help her proceed with an innovation. Second, the teacher, as a change agent, implemented student technology use so that students might adopt the value of learning to teach in real time. This was the main reason that the M.A.T.H. project group used the hypermedia technology.

Throughout the two diffusion processes, the teacher sought out and received timely, focused support to aid her with software and hardware. (The terms 'software' and 'hardware' pertain to Rogers' (1983, 1995) components of a technological innovation as explained in Chapter Two.) As a client, the

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teacher was in touch with several representatives of the change agent system, who provided her with just the right help and guidance for the moment. Among them, the key persons with whom the teacher communicated regularly were the following: her co-instructor, with whom the teacher planned, implemented, and assessed innovation use; another colleague with whom the teacher discussed aspects of innovation use and inquired about technological tools; and a technological-resource person from whom the teacher mainly inquired about use of technology tools. These key persons, as well as other representatives of the change agent system, were available to provide the teacher with just the aid she needed pertaining to innovation use when she needed and requested it.

The help which the teacher received while being a client also supported her needs as she pursued her role as a change agent. The teacher did not need much help with integrating innovation use to the purposes of the course as she had related experiences in the past. However, she needed considerable help in learning about the technological tools to help her with innovation use. Although the teacher was not quite familiar and comfortable with these tools, she was able to proceed with her instructional tasks in a timely manner because she only learned technological tools which were relevant to her use of the innovation and she also received the help she needed in a timely fashion. Because of this, the teacher's instructional role primarily focused on gaining a better perspective of innovation use through interactions with colleagues and learning from their similar experiences. In addition, the teacher was able to direct her attention on innovation use while teaching the course. Finally, the teacher's portrayal of her role as a client went well beyond being a passive recipient of information. Ordinarily, the term 'client' suggests dependency and passivity. However, the teacher was an active, autonomous, and assertive user of innovation and learner of technological tools. Upon adoption of innovation use, the teacher immediately proceeded to integrate innovation use into the planning, implementation, and assessment of instructional tasks. In addition, as a learner of technology, she studied tools on her own through trial-and-error, and requested help when needed.

#### **Recommendations**

On coping with fear and building an interest in technology use. Based on the study's findings, the teacher experienced fear and uneasiness when learning about and using technology tools. Although this was the case, she pursued certain approaches which helped her proceed with her instructional tasks in a timely manner. Based on these observations, I arrived at the following recommendations for a teacher understanding technology: One, *revisit past teaching experiences related to computer technology use*. Findings revealed that the teacher's past experiences included having used videos of Mrs. Ball's classroom for classroom teaching. Because of this valuable experience, the teacher was able to integrate similar videos to the instructional tasks of the course that I observed her teach.

Two, seek help regarding the software and hardware aspects of technology use, when necessary. This was exactly what the teacher did in this study. Although experienced in integrating video to the lessons, she discussed her plans with colleagues and got more information from these

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conversations. In addition, the teacher did not hesitate to inquire about use of the technological tools and, as a result, learned more about them.

Three, utilize the same equipment when you plan for, learn about, and teach with technology. The teacher did most of her learning about hypermedia-related tasks in the computer laboratory. Having done this probably helped her get used to the equipment and probably brought about comfort as she utilized them for classroom teaching for the first time.

Four, attend to your personal and professional interests related to teaching and education, in general. The teacher brought with her to the course personal and professional interests on issues of race, diversity, and gender. In addition, she wanted to find out how these issues were represented in Mrs. Ball's classroom situations. As the teacher practiced working on her own hypermedia investigation, she pursued this interest of hers.

On preparing to teach with computer technology use. The course was the teacher's first time to use the hypermedia technology. Although this was the case, she seemed to have handled student issues very well. It seems that this was largely due to the preparations she made before the course began. Based on these observations, I arrived at the following recommendations for a teacher adopting technology: One, assess how students might respond to the content of the innovation before classes begin. Before the teacher and her co-instructor began to teach the mathematics class, the teacher already had some ideas about how students might respond to videos of Mrs. Ball's classroom. The teacher formed these notions based on how others reacted to the videos in the past and what she knew about her students' educational backgrounds. Thus, when students expressed concern that they had not yet learned about learning to teach, the teacher led a class discussion in which she encouraged students to express what they learned about learning to teach from a previous lesson on the coin problem. Based on the discussion, the teacher concluded that students did learn about aspects of learning to teach with aid from innovation use.

Two, *learn about student technology use ahead of time*. As the teacher planned for her lessons in the first half of the course, she also learned about various keyboard-related operations. In addition, before she introduced the hypermedia project to the student, the teacher also began her own hypermedia investigation. The teacher did these things in order not to be put on the spot in front of the students.

On teaching students through innovation use. In the course's second half, the teacher had students work on their hypermedia investigations. Based on my observations on how the teacher dealt with student technology use, following are the recommendations I came up with for a teacher using technology: One, be flexible with your plans to observe student technology use. As the students worked on their investigations, the teacher made plans to observe their ways of thinking through their investigations. When the teacher visited groups for the first time, they were focused on learning the technological tools available. The teacher understood that students had to learn this aspect of innovation use and went to plan her next visit. The second visit proved helpful since the teacher was able to gather valuable information about how her students thought about their investigation questions.

Two, be available to students. This course was also the first time that students used the hypermedia environment. Because of this, it was especially important for the teacher to be available to students for inquiries about various aspects of innovation use. That was what the teacher did. As she visited groups, she was available for students' inquiries, whether regarding the technological tools or the content aspect. In addition, the teacher made herself available to students after class and on appointment basis.

Three, prepare students ahead of time. Although student technology use took place in the second half of the course, the teacher introduced details about the hypermedia project during the first half of the course. As students raised inquiries about the videos that they saw or about other related materials, like children's quizzes and Mrs. Ball's Journal, the teacher informed students that they could ask these questions which were of interest to them in their hypermedia investigations. At the end of the course, the teacher realized that the investigative questions which several students raised were based on their exposure to the hypermedia environment in the first half of the course.

On working on a limited amount of time. Although the teacher expressed that she did not possess the luxury of time, she was able to plan for her lessons where innovation use was involved. Based on my observations of how the teacher worked around a limited time schedule, I arrived at the following recommendations for a teacher using technology: One, *learn to use* 

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technological tools as necessary. One of the technological tools which the teacher learned first was how to show video on the projection screen. This tool, also called the vidbit, was useful as she integrated videos into the lessons. The teacher preferred to learn this tool instead of simply using keyboard-related operations because the vidbit functioned very efficiently. However, in one class, one video segment showed poorly on the projection screen. In the next class when the teacher had to have students view the same video, she inquired about her situation and found out that she could have students view the same video in front of the hypermedia stations.

Two, learn about innovation use on every occasion that you can. The teacher learned about technology use while performing various instructional tasks. In the first half of the course, she learned as she prepared for class lessons and while she taught her students. In the second half of the course, the teacher learned while she observed her students work on their hypermedia investigations.

#### **Implications for Future Research**

It is hoped that this research will expand the investigation of the duality of roles of a teacher as both a change agent and a client. Earlier studies separately shed light on the definitions of the terms 'change agent' and 'client' systems. Previous research also indicated the different characteristics and attributes of change agent and client systems. Furthermore, many studies emphasized the relevance of the symbiotic relationship between a change agent and client system. In my study, I went further by examining the way an individual--a teacher--can be both a change agent and a client in diffusing computer technology.

Future studies can delve into a deeper understanding of the 'internal' relationship of the duality of being a change agent and a client that can transpire within the same individual. Considerations for future research may include the ethical dilemmas and challenges of teachers assuming the dual role of change agent and client. Researchers may wish to conduct longitudinal or cross-sectional studies:

a. Longitudinal studies- - looking closely at the teacher as he or she goes through time in the transition of moving from a client system to a change agent as he or she adopts and diffuses a computer technology.

b. Cross-sectional or comparative studies- - examining deeply a group of teachers as they assume the roles and transitions of being both a change agent and client system. Comparing the classroom environments of each teacher and how they are affected.

### A Concluding Note

It is hoped that this research will serve as a stepping stone for future studies to take a closer look at the dual roles of the teacher as a client and change agent in diffusions of educational innovation. A more thorough examination of this facet could pave the way for further discoveries related to the roles that teachers portray as innovators. Teachers are not passive, but active, autonomous, and assertive individuals. Exploring the duality of their roles in the use of a particular educational technology will shed light on the many roles that a teacher can assume in the diffusions of innovation. A successful look at the duality of teacher's roles will theoretically and practically assist the diffusions of educational innovation into the classroom environments.

APPENDIX

# **APPENDIX A**

# TE 401: Teaching of Subject Matter to Diverse Learners

# **Mathematics Blocks**

Mathematics Block: September 19-October 14

Theme #1: What is entailed in creating learning communities in mathematics classrooms?

One of the outcomes for this course is that you develop a commitment to construct a kind of mathematics classroom community which supports the development of multiple literacies and which reflects respect for diversity. This involves becoming sensitive to the norms, patterns of interaction, values, kinds of activity and ways of talking about it that characterize any mathematics classroom. It involves developing insights, understandings, and skills to create a kind of classroom environment that supports students' development of mathematical power. And it involves coming to understand and appreciate some of the dilemmas of trying to develop a kind of classroom community which supports and legitimates the development of multiple ways of knowing and which reflects respect for diversity within the community.

In this section of the course we will consider key aspects that are embedded in fostering particular kinds of norms and patterns in the mathematics classroom.

Classroom culture

- What are some crucial dimensions of classroom culture?
- How does using the concept of culture help us to understand mathematics classrooms?
- In what ways does the culture of the mathematics classroom shape students' opportunities to learn?
- How is classroom culture developed and shaped?

• What role does pedagogy have upon the culture of the mathematics classroom?

#### **Discourse**

- What is discourse?
- What are the available modes of discourse in the mathematics classroom?
- How do modes of discourse affect student's opportunities to learn?
- How do relations among students affect the discourse of the classroom?
- How does the discourse affect those relationships?
- How do the patterns of discourse shape teachers' perceptions of students and their opportunities to learn about students?

#### Knowledge and Authority for Knowing

- What does it mean to know something in mathematics?
- What forms of representation and expression are available, legitimated, encouraged?
- Who or what has authority for knowing in the mathematics classroom?

Readings from the Standards:

National Council for Teacher of Mathematics. (1991). Standard 5: Learning Environment; Standard 4, Tools for Enhancing Discourse. Professional Standards for Teaching Mathematics. Reston, VA: Author, (pp. 56-61; pp. 52-56).

Readings from the packet:

Lampert, M. (1990). When the problem is not the question and the solution is not the answer. Mathematical knowing and teaching. American Educational Research Journal, 27, 29-63.

Singer, E. (1993). Usages of Discourse. East Lansing, MI: Michigan State University, (unpublished paper).

Class Activities:

Working on some mathematics problems Viewing video tapes of mathematics lessons in grade 3 and grade 6 classrooms Reflecting and discussing

Assignments:

Mathematical autobiography

# Theme #2: What does it really mean to help "all students" learn? Learning about students

An outcome for this course is that you develop the disposition, skill, and sensitivity to learn about children and to make meaningful connections between their experiences and mathematics. This involves coming to appreciate the dilemmas embedded in respecting and legitimating children's experiences in helping all students to learn. This commitment leads to important pedagogical questions about what underlies the slogans about helping "all students" develop mathematical power.

• What does it mean to learn about students and about their ideas, beliefs, ways of thinking?

• What is entailed in talking with and listening to students?

• How do students' identities come to be?

• How do our perceptions, our orientations and our own identities shape what we think we know about a child and our interactions with her/him?

• How are issues of race, ethnicity and racism linked to helping all students learn mathematics?

• How are issues of gender and sexism linked to helping all students learn mathematics?

Readings from the Standards:

National Council of Teachers of Mathematics. (1989). Overview; Standard 1, Problem solving; Standard 2, Communication; Standard 3, Reasoning; Standard 4, Connections. *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: Author, (pp. 15-19; K-4, 23-35; Gr. 5-8, 75-86).

NCTM. (1989). Fractions. Curriculum and Evaluation Standards for School Mathematics. (K-4, pp. 57-59; Gr. 5-8, pp. 87-89).

Readings from the packet:

Labinowicz, E. (1987). Children's right to be wrong. Arithmetic Teacher, 35 (4), 2-3.

Sleeter, C. (1993). How white teachers construct race. In *Race, identity* and representation in education. New York, NY: Routledge (pp. 157-171).

Grant, L. (1991). Race and the schooling of young girls. In J. Wrigley, (Ed.), *Education and gender equality*. Washington, DC: Falmer Press (pp. 91-113).

Class Activities:

Working on mathematics problems Viewing video tapes of Mathematics classrooms

Field Assignments:

You will observe and interact with a small group of students who interest you. You will choose a couple of problems involving fractions to do with your students to learn as much as you can about how they are thinking about the problems (by talking to them, by listening to them, by observing them as they work on the problems, by examing the products of their work and their explanations of what they did), what kinds of tools or ideas they use and why, and how they decide that a problem is finished and whether it is correct.

Theme #3: What is the teacher's role in helping "all students "learn?

Another outcome for this course is that you develop the knowledge of a variety of instructional strategies for helping children learn mathematics with understanding. This entails understanding that mathematical knowledg is constructed socially and in context and that the mathematics classroom should be a place where students and teacher together are actively engaged in sense-making. In this section of the course we will explore how you as a learner and a teacher can develop for yourself and your students a set of mathematical tools and a disposition to engage with others in problem solving and problem posing.

• What might be the roles of teachers and students in classroom learning?

• What might it mean to respect what students think while helping every student learn?

• What might it mean to facilitate the learning of mathematics and what are some ways in which teachers can make ideas and ways of thinking about mathematics accessible to students?

• When and how might teachers tell, ask questions, lead, stand back and let students grapple with an idea?

• What does a teacher take into account when making judgments about what is most helpful to whom and when?

Readings from the Standards:

NCTM. (1991).First Steps; Overview; Standard 2: The Teacher's Role in Discourse; Standard 3: Students' Role in Discourse. *Professional Standards for Teaching Mathematics* (pp. 11-51). Readings from the packer:

Ball, D. (1993). Halves, pieces, and twoths: Constructing representational contexts in teaching fractions. In T. Carpenter, E. Fennema, & T. Romberg, (Eds.), *Rational Numbers: An Integration of Research* (pp. 157-196). Hillsdale, NJ: Erlbaum.

Erlwanger, S. (1975). Benny's conceptions of rules and procedures in IPI mathematics. *Journal of Mathematics Behavior*, 1, 157-283.

Wilcox, S, and Wagner, P. (1994). Sense making in middle school mathematics. In C. Thornton (Ed.), Windows of Opportunity: Mathematics for Students with Special Needs. Reston, VA: National Council of Teachers of Mathematics (pp. 367-376).

Ball, D. (1992). Magical hopes: Manipulatives and the reform of mathematics education. *American Educator*, 16 (2), 14-18, 46-47.

Class Activities:

Viewing video tapes of mathematics lessons in grade 3 and grade 6 classroms Reflecting and discussing

Assignments:

You will be doing notebook assignments that extend or preview work we are doing together in the class.

# Theme #4: What is assessment, what are the purposes for assessing what students are coming to understand, and how might assessment be carried out in the mathematics classrooms?

Another outcome for this course is that you develop a variety of assessment strategies for gathering information about students' learning in mathematics. Assessment is a powerful, yet under-used tool in improving teaching and learning in the mathematics classroom. In traditional practice, assessment is used by teachers primarily to assign grades and to identify students who are successful and "those who are not." However, when used in a broader and more constructive way, assessment can help teachers gain a better understanding of students' learning. By using assessment as an ongoing activity in the mathematics classroom, teachers can guage students' progress toward desired learning goals. And teachers can use assessment of student learning to shape and reshape their own instructional practices.

• How can teachers collect information about student learning in formal and informal ways?

• How can teachers document their informal assessments?

• What claims do teachers make about student understanding and what do they take as evidence for the claims?

• How is assessment linked to curriculum, teaching, and learning?

• How can teachers use the information gathered from students and their analysis of it to decided where to go next?

• What is the potential of different kinds of tasks to reveal information about multiple dimensions of students learning?

Readings from the Standards:

NCTM. (1991). Standard 6: Analysis of Teaching and Learning. *Professional Standards for Teaching Mathematics*, (pp. 63-70).

NCTM. (1993). Use of the Assessment Standards for Different Purposes; Purpose 1: Making Instructional Decisions; Purpose 2: Monitoring Student Progress in the Classroom. Assessment Standards for School Mathematics: Working Draft. Reston, VA: Author (pp. 57-111).

Class Activities:

Comparing various kinds of assessment tasks and response modes for what they might reveal about what students are coming to understand.

Assignments:

You will be doing notebook assignments that extend or preview work we are doing together in class.

Mathematics Block: November 9, 11; November 21-December 2

Theme # 5: What is entailed in being able to thoughtfully choose, create, appraise, and critique the curriculum?

In this section of the course we will be attending to issues embedded in developing your capacity to choose, create, appraise and critique the objects, contexts and vehicles of the curriculum. This includes learning to be thoughtful in examining mathematical tasks, texts, and materials, with an eye on whose knowledge is being represented, and whose is not. It also means examining how the modes of representing ideas support particular children's learning, and how they lead to differential access to knowledge.

We will work in three contexts:

- doing mathematics ourselves in the 401 class;
- conducting investigations in the hypermedia environment;
- analyzing mathematical activities and tasks in your field classroom.

Readings in the packet:

Eshelman, A. (1993). The teaching and learning of problem solving. Unpublished manuscript, Michigan State University.

Assignments:

You will conduct an investigation in the hypermedia environment and make a brief presentation to the rest of the class on some issue in which you become involved. You will also be doing smaller notebook assignments that extend or preview work we are doing together in class. BIBLIOGRAPHY

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- Edwards, S. (1997). <u>A writing box for every child: Changing strategies for</u> <u>teaching writing in a first and second grade classroom</u>. Unpublished doctoral dissertation, University of Massachusetts.
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