

Science and Mathematics Education Centre

**Factors Affecting the Implementation
And Use of Technology in
Teaching Biology Courses in Florida's
Community Colleges**

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This thesis is presented for the Degree of
Doctor of Science Education
of
Curtin University of Technology

April 2003

ABSTRACT

Students are constantly immersed in Hollywood glitz, MTV music videos and fast-paced television commercials. For “better or for worse” the movement to make communication a multimedia presentation is upon us. Educational technology-multimedia/Internet - is playing an increasingly important role as a teaching and learning supplement in modern classrooms and has been suggested as an avenue to improve science education. Potential benefits of the Internet, CD-ROMS, Videodiscs, WebCT, course web sites and other computer-based resources include increased communication among students and between instructor and students.

Recently, although not a new idea for some, it has been demonstrated that for a significant number of students, learning occurs more readily if the material is presented visually as compared to verbally. Visual presentation is what multimedia is all about. Biology in particular seems to benefit from the application of technology in the classroom since rapid advances in the field make it nearly impossible for textbooks to remain current.

Many biology instructors are seeking to take advantage of these benefits by using technology as an increasingly integral part of the teaching experience. This research involves an investigation into how multimedia and the Internet are or are not being used in the teaching of biology courses at the community college level in the State of Florida.

A questionnaire was developed to elicit biology faculty perceptions of factors that encourage and those that inhibit their use of the Internet and multimedia in the classroom and in the laboratory. The Educational Technology Survey was designed for ease of response in order to encourage a high return, and respondents answered the survey via the Internet. The collected data were analyzed by using distributions of frequencies and percentages.

Perhaps the most outstanding feature noticeable as a result of this research is that instructor interest was the number one factor responsible for instructors using the Internet or any other form of multimedia. Without the resources, time, faculty

development, and technical support, teachers are less likely to use technology in their laboratory and classroom presentations. Educational technology offers exciting possibilities to advance and change teaching, and this research points out some of the factors affecting the implementation of such technology.

The study concludes with recommendations for faculty as well as administrators in their efforts to implement technology into the curriculum. Also included are suggestions for further research.

DEDICATION

This thesis is dedicated with love and appreciation to my wife, Gail, who has been patient and understanding during my quest for this doctorate. She not only believed in my capacity to undertake this work but also has been consistently supportive, encouraging and helpful from the time the project was started.

ACKNOWLEDGEMENTS

The completion of this thesis would not have been possible without the assistance of a number of people. It is not something that could have been accomplished in isolation.

I am deeply indebted to Associate Professor Cletus Poser of Central Florida Community College for his hours of arduous proof reading, editorial advice and general support.

I would like to thank my supervisor, Professor Darrell Fisher of Curtin University of Technology, for his expert guidance, clear direction, and thoughtful encouragement throughout the course of my doctoral undertaking.

My thanks too go to my colleagues who teach biology in the community colleges in Florida, without whose responses to the survey, this thesis would not have been possible.

To my son, Damien Millen, and my sister, Mary Cook, who have given me moral support and who, in the case of Damien, may someday find himself in a similar position.

To my parents, Dr. William and Clara Millen, who have always been interested in what I do and are supportive of my love for learning. Thank you for the many sacrifices that are now clear to me and also for instilling in me the value of knowledge and a passion for excellence.

Thank you to all of those who had a word of encouragement during the difficult times.

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CHAPTER 1

STATEMENT OF THE PROBLEM

1.1 Overview

Computers are everywhere – in most of our offices, in many of our classrooms, and appearing more and more in our laboratories. Many administrators see them as evidence of quality and proof of a high-tech/cutting-edge program. As professors, we have become dependent on computers. Even the less literate use them for record keeping, test banks, test generation, and communication. Increasingly in education, computers are also being used to facilitate student learning.

But just where do computers belong in biology education? In my office, usage of the computer is easily defined. I know when to use it - for word processing, email correspondence, grade databases, test construction or taking online courses, and when not to use it – certain listserves or junk mail. Defining the student/computer/class relationship within the context of biology education is a little more difficult.

1.2 One Side of the Coin

Many colleges and universities are putting increasing pressure on their faculty to use electronic technology in teaching. Some college administrators, as well as state legislators, believe that using technology will somehow make professors more productive. At the same time, producers of hardware and software are promoting their products on our campuses, adding to the pressure to use more technology in teaching. These pressures have resulted in some administrators requiring all faculty members to post their syllabi on the World Wide Web (Young, 1998), or requiring all students to demonstrate competency in computer use, whether or not it is relevant in their fields. Art majors for example, who will use computers primarily for graphics purposes, do not necessarily need expertise in the use of databases.

Many faculty members are slow to adapt to new technology simply because they are not convinced using it will improve their students' learning. Another reason faculty members are skeptical about endorsing technology is because proponents often seem to equate learning with the transfer of information from professor to student. They compare knowledge to a liquid that can be poured from one vessel into another. Those who adopt this model always prefer more information to less and, because the Internet provides access to an enormous amount of information, they believe that teachers should be required to use it in their courses (Neal, 1998). Unfortunately, most of those comfortable with this model have never taught a college class.

1.3 The Other Side of the Coin

Using the Internet as an information resource has become a desire for many science educators. They contend that students with access to the Internet benefit when they can use up-to-date resources pertaining to a wide variety of science subjects. The Internet can give students and teachers access to current data and resources, including databases, satellite data, museums, online libraries, research institutions, and other science classrooms all over the world. Students can experience live scientific explorations at remote sites and interact with scientific researchers in the field who serve as mentors and guide them through their scientific endeavors. Teachers and students can communicate through e-mail, chat areas, and even video conferencing. Teachers can take students on virtual field trips to research centers and science museums located thousands of miles away from the classrooms.

The Internet can also provide a place where students can publish their work on line. Students are thus able to share their work with other students and researchers from around the globe and to receive feedback from new sources (Nadelson, 1997).

1.4 United States Community College System

The primary mission of the U.S. Community College System is to respond to community needs for postsecondary academic and vocational education by providing instruction for the first two years for students going on to universities to complete their education,

workforce-training programs, student services such as assessment, counseling and remediation, and by promoting economic development through specialized job training programs (Florida Monitor, 2002, p. 1).

Many community college students go on to continue their education at four-year institutions, but community colleges also play an important role in workforce development, as they strive to provide employment solutions that work for area career seekers and employers. Through these partnerships between local business and the community colleges, employment and training are continuously improved.

2001 marked the official 100th anniversary of community colleges in the United States. The first public community college opened its door in Joliet, Illinois in 1901. “This uniquely American institution in education has developed into one of the greatest avenues for social mobility and educational development ever conceived. Today, more than 1,130 community colleges are serving 10.4 million students annually. In Florida, more than 800,000 students are served each year” (Dassance, 2001, p. 1).

1.5 Florida’s Community College System

Florida’s Community College System is made up of 28 locally controlled and independent institutions with over 135 locations such as campuses, centers, and other locations. The institutions are under the direct control of the local boards of trustees with system-wide coordination by the newly created Florida Board of Education located in Tallahassee. The Division of Community Colleges of the Department of Education serves as staff for the Board and implements the [community college related] responsibilities assigned to the board by statutes and rules. To carry out its mission to respond to community needs, Florida’s Community Colleges offer a number of different degree and certificate programs (Florida Monitor, 2002, p. 1).

The community college continues to evolve, but not without continued debate over its role and its mission. As they begin the 21st century, community college leaders still disagree on many fronts. Some push the transfer function as the colleges’ primary objective. Others lobby for a greater share of work-force training market, while still others advocate an even balance of all roles. The community college has taken its

place as an essential player in American higher education – one that continues to play an essential role in boosting the rate of college enrollment (Florida Monitor, 2002).

1.6 Purpose of the Study

The primary purpose of this study was to investigate to what extent Florida's Community College biologists are using multimedia and the Internet as part of their teaching tools. The study attempted to identify methods of Internet and multimedia access being used in Florida's Community Colleges, and to describe who is managing the use of the Internet, the technical resources, the planning, and the policies relating to technology use in these colleges. Through this description, it is hoped to establish a networking resource for community colleges designing their own implementation plans for educational technology.

1.7 Rationale for the Study

In virtually every professional journal, as well as daily newspapers and magazines, educators confront the need to introduce their students to the Information Superhighway before it is too late. Writers provide exciting scenarios of education in the 21st century in order to stir up the interest of both teacher and student in the potential of these new technologies. Think of hundreds of elementary children electronically responding to a plea from the Indianapolis Zoo for information about the care and feeding of a newly acquired koala (Cisco Systems, 1996). Picture middle schoolers communicating for four days with their counterparts in the former Soviet Union about world reaction to the 1991 counterrevolution attempt in Moscow after all radio and television communication was disabled (McCarty, 1995). How about high school students plugged into a Simon and Schuster satellite service talking to Wall Street stock traders, or actors in current movies (Lieberman, 1996)? Imagine college students interacting with doctors or scientists from around the world. This active, participative learning does indeed sound exciting, but many educators are still unsure of the purpose as well as the operation and management all this technology.

Before community colleges invest millions of dollars in educational technology initiatives, it is imperative that extensive planning takes place. Some colleges begin the planning process by designing courses in computer applications, video production and desktop publishing that require technology for implementation. Other community colleges begin the planning process by examining the existing curriculum and deciding how best to teach science by using technology as a resource. No matter what process colleges use for implementing technology, the amount of research relating to current technology initiatives is overwhelming and schools are still confused about how and where to begin.

In addition to the issues of hardware and software, another area of concern is teacher training and support. Teachers are concerned about learning the technology well enough to be comfortable using it in the classroom or laboratory. They are also anxious about the time needed to prepare lessons using this new educational technology.

The literature review in Chapter 2 points out that, in spite of the growing number of educators using technology, no comprehensive picture is available as to the extent of its use in teaching biology in community colleges. Thus there was a need for this research study because it focused specifically on how the Internet and multimedia were or were not being used by Florida's Community College biologists.

1.8 Significance of the Study

It is hoped that the results of this study will provide information regarding factors affecting the use of multimedia and the use of the Internet in Florida's Community Colleges and that their biology instructors will be able to use this information in their technological planning. Technology implementation is a costly venture, and it is hoped that a description of factors which encourage and inhibit the use of educational technology, as well as the relationship among these factors, will provide a profile of what each instructor and college must do in order to provide this resource for its students. Another significant aspect of this study is that it will provide information regarding other areas of educational technology use that call for immediate research. A wealth of opportunity for further research exists in the areas of design, development,

utilization, management, and evaluation of this new technology as it relates to student learning. There is also a need to examine the way that students view the use of this technology. The use of modern technologies in community college education will continue to influence the field of educational technology, both in practice and in theory building.

1.9 Research Design

A study of the series Qualitative Applications in the Social Sciences (Converse & Presser, 1986; Kalton, 1983), along with suggestions by Borg and Gall (1989) in Educational Research, support the technique of using a written questionnaire for data collection in this type of study. The primary research question that generates this survey is “Where do Florida’s Community College Biology Departments stand in terms of Internet and multimedia use?” The Educational Technology Survey that I developed was designed around this question.

1.10 Research Questions

The aim of this research was to gather information about factors that encourage and those that inhibit instructors’ use of the Internet and multimedia both in the classroom and in the laboratory. A secondary objective was to find out who was responsible for developing the policies relating to technology and its use in community colleges.

An early part of this research was a pilot study given to a select group of community college biologists. As a result of that study a number of specific research questions were created and the Educational Technology Survey was developed. The information that I was interested in obtaining from this research helped answer the following questions:

- 1) To what extent are Florida’s Community College biology instructors using the Internet?
- 2) What factors encourage Florida’s Community College biology instructors to use the Internet?

- 3) What factors inhibit Florida's Community College biology instructors from using the Internet?
- 4) To what extent are Florida's Community College biology instructors using multimedia?
- 5) What factors encourage Florida's Community College biology instructors to use multimedia?
- 6) What factors inhibit Florida's Community College biology instructors from using multimedia?
- 7) To what extent are Florida's Community College biology instructors using WebCT?
- 8) What factors encourage Florida's Community College biology instructors to use WebCT?
- 9) What factors inhibit Florida's Community College biology instructors from using WebCT?
- 10) How do Florida's Community College biology instructors communicate with students outside the classroom?
- 11) Who manages the use, policies and long-range planning of technology for your community college?

1.11 Definition of Terms

Every discipline develops a working vocabulary, and the area of educational technology relating to the Internet has fostered a great many new terms and expressions. The following definitions are provided to facilitate an understanding of the terms used throughout this and other studies.

Acceptable Use Policy (AUP): A statement of acceptable procedures and rules to be followed when using the Internet.

Browser: Software that lets a user see Internet sites as graphic images, rather than just as text.

Compact-Disc Read-Only Memory (CD-ROM): A multimedia platform that can include presentations, animations, tutorials, quizzes and glossaries of key terms.

Constructivism: In education, constructivism is often discussed as a philosophy or instructional approach with the idea that knowledge is ‘built’ by the learner.

Email (Electronic Mail): Messages, usually text, sent from one person to another via computer. Email can also be sent automatically to a large number of addresses simultaneously.

File Transfer Protocol (FTP): On the Internet, a way of transferring files from one computer system to another by using settings and transmission procedures common to both system.

Hypertext: A way of linking text through keywords. If a word or image serves as a hypertext link, selecting it (i.e., clicking on it) sends the user automatically to another page.

Homepage: A location on the Internet which one can visit by entering its address. Homepage commonly refers to the main web page for a business, organization, person or simply the main page of a collection of web pages.

Hypertext Markup Language (HTML): A system of instructions used for telling browser software how to present text in the document and how the documents will be linked together on the Internet.

Internet: A worldwide network that connects many smaller networks through use of a common set of procedures (protocols) for sending and receiving information.

Laser Videodisc: A combination of photos, videos, experiments, animations, still graphics and movie segments on a twelve-inch diameter disc.

Listserv: The most common kind of mail list, “Listserv” is a registered trademark of L-Soft international, Inc.

Mail list (or Mailing List): A (usually automated) system that allows people to send email to one address, whereupon their message is copied and sent to all of the other

subscribers to the mail list. In this way, people who have many different kinds of email access can participate in discussions together.

Multimedia: Integrating the use of several media such as text, graphics, animation, audio and video.

Network: A set of connected people or computers.

Online: Being connected to the Internet.

Online Service: Services such as America Online, CompuServe, Prodigy, the Microsoft Network and independent Internet Service providers (ISPs).

PowerPoint: A complete presentation graphics package.

Protocol: An agreed upon set of rules by which computers exchange information.

Server: A host computer serving a special function or offering resources for client computers, whether as a storage device in a local area network or providing information, files and web pages.

Uniform Resource Locator (URL): A format for indicating the protocol and address for accessing information on the Internet.

WebCT: A web-based set of course tools designed to deliver online learning.

Web Page: A single screen of information that may contain text, images, animation, and perhaps sound and video.

World Wide Web (WWW): A system, on the Internet, that displays sites as graphic images and connects information among and between sites through hypertext link.

1.12 Summary

This chapter has provided an introduction to the study with particular reference to the pros and cons of educational technology. There are some who say that information technology is simply another educational fad, and that, just as so many things before it, the technology will end up gathering dust while colleges continue to grapple with the real business of teaching and learning. Ultimately, colleges will stop spending money on computers and start buying something else. Well, if history can be a predictor, the experts might just be correct. But this does not have to be the case. If educators can establish clear goals for technology's use as a tool for teaching and learning and they prove to be effective in their curriculum, then the technology will survive.

1.13 Thesis Overview

The objectives of this thesis have arisen out of a review of the literature on Educational Technology. Chapter 1 has stated the problem, outlined a background and rationale for the study that highlighted research issues relevant to the study, and presented the specific focus of the study. The eleven research questions that guided the study were outlined along with the study's significance and limitations. Terms used in technology were defined and an overview of the thesis concluded the chapter.

Chapter 2 includes a critical review of the literature related to the research questions identified. The chapter discusses the Internet and multimedia and explores the factors that encourage and inhibit their use as Educational Technology. The chapter ends with a review of the educational philosophy of constructivism and how technology may provide tools that can help teachers implement constructivist practices.

The research design and the methodology are outlined in Chapter 3. The Chapter describes how the written survey was developed and tested and outlines the population sample, data collection and treatment.

Chapter 4 focuses on the results of the research, together with analyses of the results.

The final chapter, Chapter 5, draws together the strands of the study and summarizes the findings of the research questions and any implications that flow from them. It also notes recommendations for administrations and faculty and makes suggestions for areas of further research.

The collection of references and appendices comprise the final sections of the thesis.

CHAPTER 2

REVIEW OF LITERATURE – TECHNOLOGY IN EDUCATION

2.1 Overview

Educational technology is dramatically changing the lives of both teachers and students. By the term educational technology, I am referring to a family of associated technologies, all of which involve information storage, retrieval, processing, and display. At a more tangible level, the term includes the use of computers and educational software in the classroom and in the laboratory, the Internet and other forms of telecommunication, CD-ROMS, videodiscs, internal email, voice mail, and video production and display.

Technology is, in fact, becoming an agent of change as schools examine methods for restructuring their programs and their overall philosophies. Many educators believe that it is increasingly important to provide students with challenging questions and to teach them the skills needed to access worldwide resources, and the networking skills that they might use to answer the questions presented to them. Sapp (1996) believed that educators must teach students to search, retrieve, collect and exchange information, and then to analyze and assimilate the information and to write their own research findings. “These skills will enable students to become lifelong learners, rather than students who ‘complete’ their education when they leave the halls of learning” (p. 5). The extent to which educators and administrators are able to understand the implications of technology in learning will also determine how much financial support is dedicated to this.

Educational technology is also proving to be an exciting and effective way of giving students of all abilities and backgrounds more educational opportunities. For instance, assisted or remedial technology may permit a child with cerebral palsy to move a cursor through eye movement, or provide a safe way to communicate for an autistic child for whom face-to-face contact is difficult.

Technology is neither good nor bad in itself, nor should it dictate educational goals. A pencil can be used to write number one best sellers or to copy someone else's homework. The Internet can be used to produce enlightenment or hatred. Multimedia can be "canned" presentations that are available from publishers or well thought-out presentations designed by instructors. Before embracing any new technology, we need to declare our educational goals and to demonstrate how a particular technology can help us to achieve those goals (Gardner, 2001).

This chapter is divided into three parts. Part one (2.2), reviews the Internet and the World Wide Web. Although the Internet and the World Wide Web are separate identities, they work together to bring global information into the classroom and laboratory. Part two (2.3), discusses the use of multimedia and WebCT in educational technology and identifies factors that encourage and those that inhibit their use in the classroom. Part three (2.4) suggests how technology can be used in a constructivist learning environment.

2.2 The Internet and World Wide Web's Role in Educational Technology

2.2.1 Introduction

The Internet has revolutionized communications, bringing about new relationships between ordinary people, business enterprises, government agencies, and all other consumers of ideas and products throughout the world.

The Internet offers an interactive means of connecting teachers with multimedia resources, peers, and professional development leaders. For example, two web-based projects at the Harvard Graduate School of Education connect teachers and professional developers with research-based resources, teacher-designed curriculum models, and forums for collegial exchange. One project, *Active Learning Practices for Schools* (2001), aims to support teachers in using educational approaches developed through research at Harvard's Project Zero. The second, *Education with New Technologies* (2001), developed at the Educational Technology Center at Harvard by faculty and graduate students, uses a research-based framework called

Teaching for Understanding as a structure for integrating new technologies with practice.

The Internet is a gateway for a rich source of potential teaching aids that can be used to enhance the biology classroom lecture as well as the laboratory. The majority of the material can be accessed free of charge or for a small registration fee. In addition, most of the resources can be displayed with a computer and some form of projection system.

2.2.2 What is the Internet?

Lubka and Holden (2000) described the Internet as “the world’s biggest computer network, connecting millions of people and organizations in a ‘global information society’” (p. 28). In its most basic definition, the Internet is a network of networks (Kindall, 1994).

The Internet came into being in 1969 when the U.S. government and the academic community created a set of unifying protocols and tools that allowed them to interlink computer networks. Other interest groups built their own networks using similar communication protocols, while researchers began to investigate means through which these networks could communicate (Kroll, 1992).

During the early years, scientists and institutions that had government contracts made up most of the users. By the mid – 80’s however, many businesses, and educational and commercial networks had come on board as access became more widespread and as thousands of individuals began using the Internet. Today it is estimated that there are over 200 million Internet users. Eighty percent of the participants are North Americans, but every continent is now on the ‘Net’ – even Antarctica (Lubka & Holden, 2000).

Alden and Curyea (1994) portrayed the Internet as an interconnection of thousands of computers through telephone and cable lines that enables users to send and receive large volumes of information at phenomenal speeds throughout the world. Users find their way to the information highway through commercial on-line

services, such as CompuServe, Prodigy, and America Online, or through public networks, such as state departments of education and military networks. Independent bulletin board services that have a specific focus, such as school districts, are also popular services. Consumers can share research findings and other types of information with anyone on the network. The shared vision of those who designed the Internet is for this resource to connect individuals, businesses, educational resources and homes around the world.

The number of individuals, companies, schools, and communities gaining access to the Internet is growing so dramatically that it is nearly impossible to maintain current statistics. In a project called “Basic Education Connection,” cable giant Tele-Communications Incorporated and Bell Atlantic Corporation joined to provide 26,000 U.S. schools with connections to the national information highway (Salvador, 1994b). A number of cable companies have begun to offer educational services via Internet, hoping that more schools will access networks via cable rather than telephone lines (Salvador, 1994a). In addition, Americans with phones in their homes are charged a federal universal service fee that goes toward connecting all U.S. schools to the Internet.

In practical and functional terms, the Internet is:

- A 24-hour nonstop global forum and communications system
- An online library and international information system
- A business and corporate communications medium
- A distance learning and remote education system
- A commercial transactions medium
- A multimedia delivery system for news and entertainment
- A government information service
- All of the above simultaneously (Irvin, 1997, p. 2)

The ‘Net’ has helped create the electronic ‘global village’ that the early users imagined in the late 1960s. With a simple mouse click, anyone connected to the Internet can access information from across the world more quickly than it takes a

TV set to warm up. The Internet is a tremendous resource for science educators, providing experimental data, software, multimedia technologies, and communication links with libraries and scientists. It can be a stimulating instructional aid in both the classroom and laboratory. The resources found on the Internet can greatly assist biology instruction by making lecture and laboratory more interesting, challenging and thought provoking, and thus ultimately promoting student outcomes.

2.2.3 What is the World Wide Web?

It is hard to pick up a magazine or watch the news and not find references to the World Wide Web. Every major corporation and information service now commonly advertises addresses for Web pages (their URLs). Many newspapers and magazines are available on the Web in multimedia versions that have no print equivalent. Website URLs have replaced fax numbers and even email addresses as priority information on business cards.

The World Wide Web [WWW] or “the Web,” as it is often called, is the fastest growing service on the Internet. It is truly a multimedia presentation. A web page has all the aspects of sophisticated desktop publishing: diverse typefaces, charts, icons, integrated graphics, sound, movies and now 3-D or virtual reality graphics. In just a few years, it has become an integral, and for some, an indispensable part of the culture. Irvine (1997) defined the Web as the Internet’s interactive multimedia delivery system. The Internet is about moving information efficiently and reliably across a large network, and the World Wide Web expands on this principle by creating a uniform way of delivering and displaying this information.

Some people, however, still don’t quite realize that the Internet and the World Wide Web are not the same thing. The confusion is understandable; since “WWW” seems to appear everywhere these days and even non-computer users know it refers, somehow, to the Internet. The Internet itself is the underlying communications framework, a massive network of hardware and software. On the other hand, the World Wide Web, like Email, is an application – a specific use built atop the communications facilities provided by the Internet (Irvine, 1997).

Students have the opportunity to more actively use the communication potential of the Internet by publishing their work on the “Web.” Students are thus able to share their work with students and researchers around the globe and to receive feedback from new sources. The students’ web pages have the added benefit of serving as an electronic portfolio, something that students can continually update.

The Web has shattered the boundaries of traditional communications. Email and online discussion groups allow everyone to communicate with a wide range of people. In addition to reaching friends and acquaintances, one can easily connect with people one doesn’t know but with whom one shares an interest.

Teachers, students, parents, and administrators can present their own ideas, their teaching and learning strategies and materials, for the entire world to see. In doing so, they are creating a large body of educational material. It is possible to publish graphics, animations, videos and sound as well as multicolored text (Klotz, 2001). In all educational subjects, this diverse potential can serve the needs of a variety of users.

Researchers all over the world are now using the World Wide Web not only as an efficient source of information but also as a repository for their own data. This creates an enormous database of the most up-to-date information, which can be easily accessed by classes with an Internet connection (Seitz & Leake, 1999). The ease-of-use factor and the move from text-based to graphical interface has made the WWW a driver for the tremendous leap in Internet use.

2.2.4 Who is Using the Internet and the World Wide Web?

The issue of **who** has access to the Internet is becoming more critical each school year. One concern for those in administrative positions is the issue of equity. In his 1993 book, *Big Dummy’s Guide to the Internet*, Griffin posed the question, “If we live in an information age, are we laying the seeds for a new information underclass, unable to compete with those fortunate enough to have money and skills needed to manipulate new communications channels?” (as cited in Proctor & Allen, 1994). Recent studies by Lance and Krsahen exploring the impact of the

availability of library resources and voluntary student reading on academic achievement have reached a powerful conclusion: student achievement is directly linked to the availability of resource materials (as cited in Giagnocavo, Mclain, DiStefano, & Sturm, 1995). These studies have tremendous implications for those interested in the equity issue. Are the poorer or smaller community colleges that either do not have access or have limited access to these worldwide resources destined to produce students who leave their schools and move on to universities or into the workforce with an automatic handicap? In a 1995 Time Magazine article, reporter Suneel Ratan quoted Mitch Kapor, co-founder of Lotus Development Corporation and now president of the Electronic Frontier Foundation, as saying, “those who do not have access to the Internet will be highly correlated with the general have-nots. Early in the next century the Internet will become the major conduit through which we conduct our lives. Any disenfranchisement will be severe” (p. 25).

2.2.5 How Are the Internet and the World Wide Web Being Used?

Another concern to educators is **how** students are using the Internet. Chris Dede (O’Neil, 1995) maintained that classrooms are already overwhelmed by too much information. The challenge is to translate access to vast archives of information into personal knowledge in a generative way. That is, the learner must investigate, collaborate, and construct knowledge for him/herself. While assimilation of knowledge is necessary, it is only the beginning step in learning. Students have the opportunity through the Internet to make more decisions, about their own learning. Many students are participating in international research projects, multimedia research papers, global discussion groups, transcontinental art projects, and writers’ groups.

The Internet generally falls into three broad categories: (1) communication, (2) information access, and (3) file transfer (Alden & Curyea, 1994). The problem for teachers becomes how to bring this technology into the classroom using the most educationally sound practices.

(1) Communication. The most common method of communicating online is through email. The “e” in email stands for electronic. Email allows everyone to communicate with a wide range of people. Although the use of electronic mail has been common among college faculty since the mid-1980s, more and more teachers are communicating via web pages, not only among themselves but also with students.

Faculty use web pages to present syllabi, homework assignments, and other information about their courses and themselves; to spark lively and learning-filled online discussions among students; to assign and receive homework, and even to administer homework and tests; to communicate teaching materials; and to deliver the content of entire courses.

Users may transmit personal messages from one person or user group to other individuals or groups. The sender may include files, sound and graphics with the e-mail message, and it is transmitted instantly (Proctor & Allen, 1994). In the area of communication, the Internet provides the greatest potential for a true global classroom (Caudell, 1994). Instant access to news, entertainment and services is already commonplace, and the walls of the classroom could literally disappear as the world itself becomes the classroom for our students.

One of the advantages for students working with email is that electronic communication can be a great equalizer. What students say and how they say it, is more important than superficial qualities such as socio-economic standing, looks and skin color (Alden & Curyea, 1994). The use of this technology encourages the independence and autonomy necessary for students to achieve in their learning process (Proctor & Allen, 1994).

Another benefit from students communicating online is that they can practice their reading and writing skills on a daily basis, reinforcing classroom lessons. They can also experience and practice collaborative learning through this participatory design approach (Silva & Breuleux, 1994). Electronic publishing through the Internet enhances and expands the learning process as students realize that others in the global Internet community, as well as in their immediate communities, are viewing

their published works. Giagnocavo et al. (1995) believed that this realization empowers students and encourages them to strive for excellence in their work.

The same process, by which a single email message can be directed to another person, can also be used to distribute documents to groups. This process is known as a mailing list. Individuals subscribe by email and receive material periodically via email. One such program is called a LISTSERV and is usually administered by a computer (Kurland, Evers, & Santo, 1997). Mailing list programs commonly archive active correspondence in log files that can be retrieved by email. Professional groups, online newsletter and magazines, and other information and advocacy services use mailing lists.

Through mailing lists, a single person or central authority produces documents for distribution to subscribers on a fairly regular basis. Discussion groups offer another form of Internet communication. They are more like a giant “bull session.” Anyone can contribute a message, which is then forwarded to all subscribers. Any group of people with a common interest can form a discussion group. Groups have been formed to discuss new software programs, research interests, hobbies or political issues (Kurland et al., 1997). Some discussion groups forward all correspondence, some are moderated by an individual to assure the relevancy of the discussion, while others incorporate messages into a periodic newsletter. Some groups are open while some have membership restrictions (via password).

Newsgroups offer yet another form of Internet communication. Mailing lists and discussion groups are emailed to individual subscribers, and then posted on a variety of independent networks for anyone to read and respond. Newsgroups provide a forum through which people can read, gossip, debate, and discuss shared interests.

Talk and chat programs are two Internet communication programs that do not rely on e-mail. Although somewhat similar in their effect, talk programs allow two people to “talk” by typing remarks back and forth without exiting their screens while chat programs are simply group talk programs. Participants can often choose from a list

of available chat groups. They can enter or exit a discussion at will, identified only by a nickname they have selected.

(2) Information access. The Internet expands the walls of the school building by offering access to resources from around the world. Individuals and organizations today can access literally billions of pages of information from all over the world. Students as well as teachers are able to tap into databases, library catalogs, national poll results, and many other sources, downloading files onto their own computers. Students are able to understand the concept of global cooperation first hand, as they speak to experts in their research domain who may even happen to live in another country. Imagine the excitement and learning opportunities of a community college science student researching AIDS treatment, speaking in real time to a French research physician working in a laboratory. Access to these resources can yield individual and group projects, collaboration, curriculum materials, and idea sharing not found in schools without Internet access (Proctor & Allen, 1994). Problem-solving activities become more dynamic pursuits for students as the world opens to them through information searches, simulations, and social action projects accessible through the Internet (Harris, 1994).

One of the concerns in the area of information access is the question of appropriateness of materials. Schools are wrestling with technical codes of conduct and use policies as well as revisiting policies concerning censorship (Flanders, 1994). While a wealth of wonderful material is available on the Internet, profane and pornographic material is also easily accessible. In a science course, the accuracy and validity of what is presented as science is also an issue. Censorship of the Internet involves the same basic question as other types of censorship in schools. Who decides what is appropriate? Denying access to parts of the Internet has proven ineffective, as students have been able to by-pass the expensive and sophisticated computer security systems of major corporations and government agencies (Maddux, 1994). Public schools have been more successful when involving parents with school personnel as well as students in developing an "Acceptable Use Policy" [AUP] that includes goals and philosophies, acceptable use rules, and penalties for violations. Typically, the AUP is signed by the student

and the parent and is kept on file as a legal and binding document (Giagnocavo et. al., 1995).

(3) File transfer. Through file transfer, users can copy files from one computer to another. Teachers of Biology, as well as teachers of other subjects, can share curriculum materials, survey instruments, in-service plans, acceptable use policies, and any other file they may wish to send or receive. Researchers can download huge documents to study in-depth in their own homes. Large files can be compressed and expanded later if they are connected to a commercial or independent Internet service provider. Again, the problem of appropriateness of materials becomes an issue, as students are able to download pictures and text materials that are targeted at adult audiences. The “Acceptable Use Policy” may be an important element in the design of an Internet use plan for biology and science students.

2.2.6 Why Become an Internet and World Wide Web User?

In addition to knowing who is using the Internet and how, educators have to ask themselves **why** they should become users of this new technology. Sapp (1996) said, “Students need access to the technology and information of today to know how to benefit most from tomorrow’s information and technology sources” (p. 5). While the idea of change itself is sometimes threatening to educators, resistance to advanced technology use is more complex. The overriding question for educators is always, “How will this innovation impact on student learning?” A great deal of new research is available on issues relating to learning. In the 6th edition of the *Encyclopedia of Educational Research*, Jones (1992) identified eight variables in learning and instruction: 1) a vision statement; 2) The tasks that ultimately define the nature and level of achievement as well as the curriculum; 3) the assessment principles and practice; 4) the instructional model; 5) the characteristics of the learning context including the nature of the learning environment, and the nature of the relationship among teachers and students; 6) grouping arrangements; 7) the learner roles; and 8) the teacher roles. The Internet becomes a force, not only for those collecting research concerning its role in education, but also in its relationship to each of the eight variables in Jones’ study.

According to a recent Appalachia Regional Educational Laboratory study (Balow, 1998), classroom use of the Internet isn't just a glitzy, expensive way to access information; it has a place in meaningful instruction. Student and teacher accounts argue that the 'Net' provides more timely information and allows for more authentic learning tasks than do texts. Balow (p. 2) gives the following reasons for introducing the Internet into the classroom:

- Accessing timely information
- Providing authentic learning tasks
- Making connections with the material and social worlds
- Learning through extended information
- Interacting with local communities
- Improving students' language and writing skills
- Energizing students' learning
- Encouraging exploration
- Stimulating inquiry

2.2.7 Factors That Encourage Internet and World Wide Web Use

Three areas of research important to this study are the phenomenon of change, the process for diffusion of innovation, and staff development. While these areas of research are distinct in their focus, they are also interrelated as they are applied to Internet use in schools. As educators and administrators attempt to identify which factors encourage the use of new technologies in education, they must understand the phenomenon of change, the processes for effectively instituting change and introducing innovation in their programs and the need for staff development.

(1) Change Agents. In many cases, the use of new technologies starts with a school improvement focus. In other cases, the innovation is introduced by a single teacher who then brings another teacher along and so on, until innovation becomes permanent in the curriculum. A change agent must be present in the organization in order for an innovation, such as Internet use in the curriculum, to occur. Whether by mandate or voluntarily, the change agent must (1) develop the need for change, (2)

establish a change relationship or rapport, (3) diagnose the problem or situation that necessitates the change, (4) create an intent to change, (5) translate that intent into action, (6) stabilize change and prevent discontinuances, and (7) achieve a terminal relationship (Rogers & Shoemaker, 1971). It is important for the change agent to understand his/her role and to familiarize himself/herself with the characteristics of the innovation, the communication channels in his work environment, the time needed for the diffusion of the innovation, and the social system in which the innovation is occurring (Rogers, 1983). Many times, one person in a school environment, whether a teacher, a media specialist, or an administrator, can serve as this initial change agent. Modeling behavior that excites students and provides invaluable enhancement to existing programs is an excellent stimulus for change.

(2) Innovation Diffusion. It is one thing for an individual or group to champion change by modeling the desired utilization of an innovation, but it is quite another matter to be able to move that innovation into the entire organizational structure. In order to diffuse innovations, the change agent must understand the various stages involved in an organization's acceptance of a new process or procedure. A number of studies describe the stages in the process of diffusion of innovation. These studies focus on diffusion at a micro level as well as diffusion within large organizational structures. Other studies consider the elements of the innovation itself, and attempt to predict the adoption or rejection of an innovation. The change agent, whether an individual or a group of educators, must be cognizant of the elements involved in the diffusion of innovations, both at an individual level and at an organizational level. The following definitions provided by Rogers (1983) will explain the terms in this study:

- Innovation – an idea, practice, or object that is perceived as new by an individual or other unit of adoption.
- Diffusion – the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a kind of social change, defined as the process by which alteration occurs in the structure and function of a social system. When new ideas are

invented, shared, and are adopted or rejected, with unpredictable consequences, social change occurs.

Rogers (1983) further identified a process of diffusion that he called “The Innovation-Decision Process.” This model addresses diffusion of innovation directed toward individuals. The five stages in this model are as follows:

- Knowledge – when an individual is exposed to an innovation and develops some conceptual or practical knowledge of how it functions. At this stage, an individual seeks information which will answer basic questions such as what is the innovation and how does it work.
- Persuasion – when the individual forms an attitude toward the innovation. The individual seeks evaluative information to reduce concerns about the expected consequences of the innovation. The individual is concerned with more detailed information, such as advantages and disadvantages of the innovation, and how it might affect the individual personally.
- Decision – the individual chooses to either accept or reject the innovation. This choice is generally the outgrowth of practical experience with the innovation itself. Decisions made during this stage are sometimes reversed later.
- Implementation – when an individual puts an innovation into use in a real world situation. It is at this stage that behavior changes occur as a result of the innovation.
- Confirmation – when the individual seeks reinforcement of a previous decision relating to adoption or rejection of the innovation. It is important that the change agent offers continuing support at this stage, because change is not a linear event, but a cycle of more questions and additional decisions.

Several other studies are available which describe the diffusion process. Levine (1980) identified the stages associated with diffusion at the organizational level:

- Recognition of the need for change
- Planning and formulating a decision
- Initiation and implementation of a plan
- Institutionalization or termination of the innovation.

Molenda (1993) described three stages of diffusion of innovation:

- Usage – the spontaneous, one-time use of an innovation
- Installation – adopting an innovation as a permanent part of the curriculum or procedure
- Institutionalization – embedding the innovation into the organization.

According to Fullen (1982), most researchers now recognize three broad phases in the diffusion process:

- Phase I – the phase which leads up to and includes the decision to adopt
- Phase II – the phase in which initial use occurs along with initial attempts to practice the innovation
- Phase III – the phase in which an innovation is built into the ongoing system or discarded.

(3) Staff Development. As indicated in the research by Proctor and Allen (1994), teachers must fully understand the philosophy as well as the use of the Internet as an innovation before they will become its champion. Research indicates that staff development must be one of the primary initiatives in any plan for improvement in schools (Bonsting, 1992). Not only must teachers be shown ways in which the Internet will enhance their curricula, they must also be given time, information and training necessary to use the available resources effectively. One of the primary methods used to encourage change is to provide information that will answer the concerns of the participants (Hall, Wallace, & Dossett, 1973). The process of

diffusing the innovation must include ongoing information sessions, as well as education and training if the adoption of the innovation is to be successful (Hall & Hord, 1987).

There is some hope that distance education via the World Wide Web can help provide staff development in the use of educational technology. Perkins (2001) suggested that the WWW solves two problems in the process of trying to take teacher development to task. One is of economics. Given travel costs, program fees, and other costs (not to mention getting the time off), it's too expensive to show up all the time. The second bottleneck is one of expertise. Just who is going to do this? Professional technological development requires a certain art and craft. The ones with the knowledge are already teaching and are not about to quit their jobs to go on the road. The nice thing about the Internet and "Web" is that they won't have to. They can take part in web-based structures of dialogue as a sideline and stay where they are.

2.2.8 Factors That Inhibit Internet and World Wide Web Use

To many educators, the Internet is viewed as the best available tool to enhance instructional methods (Harasim, Hiltz, Teles, & Turoff, 1995). Nonetheless, many community college educators are lagging behind in adopting this popular and useful educational resource.

With the given potential and promise of the Internet for students in schools, why is it that educators and schools are hesitant in embracing this new technology? Research has revealed five major barriers to the adoption of new technologies: 1) resistance to change, 2) lack of training, 3) lack of time, 4) lack of planning, and 5) funding.

(1) Resistance to change. Paradoxically, education is a field that is often resistant to major change. Educators become comfortable with philosophies they have learned, methods they have practiced, notions of what "works." Using Internet as part of the every day curriculum in a classroom involved a major change in philosophy, method and practice. Killian (1995) maintained that fear of the Internet has three causes: technological, pedagogical, and psychological. Technology is still unpredictable, and in many cases not user-friendly. Rather than seeing the Internet as a routinely

used resource for all students, many teachers view the Internet as a separate entity, and they do not see how it fits into an already overloaded curriculum. Another pedagogical resistance factor has to do with teachers being accustomed to defining their students' education. They present material and provide activities aimed at a clear outcome. When the students have access to a world of information, they are essentially free of the teacher-defined curriculum. They are defining their own curriculum, a desired outcome for all advocates of life-long learning.

According to Killian (1995) the power and control teachers exercise over students is psychologically rewarding. With the changing role of the teacher from information provider to facilitator, a large part of that control will diminish. As the pedagogy changes from the industrial model school to the student-defined curriculum, the school culture will also change and a different type of teacher will be recruited. That teacher will be able to provide intriguing, challenging problems for students, and teach them the necessary skills to solve those problems. The psychological reward for teachers will be in seeing students move through the educational system to become lifelong learners.

In explaining resistance to change, Dickerson and Gentry (1983) discussed three types of innovations as described by Robertson: continuous, dynamically continuous, and discontinuous. A continuous innovation is implemented gradually and requires little change in behavior on the part of the instructor or the student. For example, a social studies teacher might introduce a short current event discussion at the beginning of the hour, one day a week. A dynamically continuous innovation (such as the use of video rather than still pictures in a science class) causes some behavior changes. A discontinuous innovation requires a more complex change in classroom behavior. Using computers in instruction would be considered a discontinuous innovation in that it calls for new teaching behaviors (Dickerson & Gentry, 1983). The prospect of those changes is sometimes a deterrent for teachers. In some cases the resistance to embrace innovation does not imply an unwillingness to change, but rather an uncertainty concerning the time and preparation needed to implement the change.

Attention must be given to the stages of concern experienced by teachers involved in a change process (Hord, Rutherford, Huling-Austin, & Hall, 1987). Those seven levels of concern, as identified by Hall (1979) include the following:

- awareness concerns
- informational concerns
- personal concerns
- management concerns
- consequence concerns
- collaboration concerns
- refocusing concerns.

Teachers move through these stages of concern at varying rates, and the change facilitators must be aware of the concerns as they attempt to understand and reduce resistance to change.

(2) Lack of training. One of the biggest inhibitors to the adoption of new programs and practices is the feeling of inadequacy on the part of the teacher. If teachers are not comfortable navigating the Internet, it is not likely that they will use the resource to improve their classroom learning environment. Dede (as cited in O'Neil, 1995) maintained that one of the mistakes made in early attempts at implementing educational technology was focusing first on equipment rather than on teachers. Teachers were expected to jump on the technology bandwagon, but they did not have the training or the resources to do so. Many still do not have the training or the resources.

All Internet users require training, whether they are teachers, media specialists, parents, administrators or students. The professional development of teachers has often been an afterthought in American schools. When budgets get tight, career development is often one of the first things to go. But if teachers are to become comfortable with the technologies that will reshape schools, they must receive both preservice training during their college years and inservice training during their careers. A part of training should also include an explanation of the attributes of the

innovation, including (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability (Rogers & Shoemaker, 1971). Before the teacher is apt to embrace a new technology, he/she must fully understand and champion the attributes of the innovation.

(3) Lack of time. Any new teaching method requires time. Teachers must have time to study the technology itself, the Internet as well as other forms of multimedia, and to plan for introducing them into the curriculum. Lack of teacher time, according to Proctor and Allen (1994) is considered a very strong barrier to the successful implementation of many telecommunications projects. In addition to the time required for training, the time factor is enormous in the implementation stage. In a study of Internet users (Killian, 1995), teachers and students were time-tested in Internet drills. The time required to sign on and search for information was 41 minutes. The time used to compile, organize and screen information was nine minutes. The time of actual use of information in a lesson plan, activity or report was approximately 10 minutes. In other words, most of the time was spent searching for information rather than using it. For educators, the issue of time is a major concern on a number of levels relating to Internet use.

(4) Lack of a plan for instructional technology. Change is a process, not an event (Hord, et al., 1987), and change requires a plan. Some schools still do not have a long-range plan for instructional technology. Instructional technology, as defined by Seels and Richey (1994), “is the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning” (p. 22). This definition has many of implications for curriculum designers and school planners.

Each step of the process in the introduction of new technologies holds its own set of issues to be addressed. For example, in the area of new technology management, what happens in a computer lab when 30 students want to download pictures of bacteria from the Internet all at the same time? How long is each student allowed to log on to the Internet at one time? Which web sites are inappropriate for students to access during school time, and who makes those decisions? In schools with limited access, who is allowed to use the lab or the traveling computer and modem? Who

develops a rotation for the use of the equipment? A flood of management questions sometimes prevents schools from using new technology. Such is the case in every area of implementation. The diffusion of innovation must begin with a well-studied plan involving the school technology expert (if applicable) and both teachers and administrators. This is not to say that individual teachers should not be encouraged to serve as pioneers, establishing benchmarks for adopting new models. But at some point, a college-wide plan needs to be in place, beginning with a vision of our students as lifelong learners. The lack of this type of planning is often symptomatic of an administration and a community (one that normally supports the local community college) that is not committed to change, and is often a deterrent to teachers and other staff members embracing change.

(5) Lack of funding. The Office of Technology Assessment calculated that it would cost \$145 billion for every child in America to access the Internet from his/her desk at school (Pondiscio, 1996). While the use of business partnerships, grant monies, and alternative sources of revenues are becoming increasingly important in the funding of technology for schools, some still lag behind.

Twenty percent of America's schools are in rural areas, whereas 80% of telecommunications nodes are based in urban areas. Other technical considerations, such as touch-tone service and bandwidth make rural areas destined to be among the last to have access to the Internet (Connell & Franklin, 1994). Even in urban areas with adequate funding, Internet access is not a priority. In some cases, schools are in fact installing new hardware, but have given little thought to the costs of staff development and maintenance. The funding issue remains a complex area and a major barrier for implementation of new technologies.

William Sterling, a business person and parent from Summit, New Jersey offered several recommendations for addressing funding issues (Sterling, 1995). He suggests public-private partnerships with businesses energized by profit motive. Those businesses want an educated workforce and they want to provide input as well as resources to ensure this outcome. He also suggests support for extended libraries so that they may become open access gateways into the information highway. While each child might not have equipment in the home, a growth in the

number of public access centers would help provide more equitable communities. Sterling also calls on the information industry millionaires to collaborate with community activists and educators to provide these extended libraries to their communities. The issue of funding and equity will continue to be a primary concern.

In addition to the previously mentioned major inhibitors to using the Internet, there are some other “minor” barriers that teachers also face. Sometimes Internet access even varies within the school system. Available search engines, long lag times, shut downs, or freeze-ups of systems disrupt lesson plans. One administrator was heard to say that the Internet was just a curiosity for many teachers in her school, “because her teachers do not have personal access, nor training, nor involvement with the Internet” (Balow, 1998, p. 3).

2.2.9 Summary

The focus of the literature reviewed in this part of Chapter 2 was based on initial research questions posed by educators themselves. Educators want to know who is using the Internet, and what implications the identification of those users might suggest. They want to know how students are using the Internet, and where students are gaining access. Most of all, educators and administrators want information about the factors contributing to the adoption of the Internet as an integral part of the curriculum, and what it will take for all schools to share in this 21st century paradigm shift. Using the Internet in the laboratory or classroom does not guarantee good curriculum or teaching practices but research suggests that teachers at the forefront of Internet-based instruction provide their students with learning experiences that do not happen (at least in the same way and to the same extent) when the Internet is not used.

Research suggests that planning is the key component to major educational technology innovations such as Internet use. In addition, the literature advocates that teacher support and training are crucial to the success of the adoption of the technology, and that any attempt to meet the challenges provided by technology use must be a widespread, collaborative effort among school, business and community, government, and corporate America.

On December 19, 2000 the *United States Web-Based Education Commission*, chaired by Senator Bob Kerry (Democrat from Nebraska), called for an immediate national focus to fulfill the Internet's promise to help transform learning and improvement. "We must immediately put to rest the notion that full development of Web-based technology for education is a choice," Kerry (p. 1).

The Commission's report revealed that there are troubling gaps in accessing the Internet, leaving still millions of Americans lagging behind with outdated and inadequate technology – or none at all. The report also indicated that, while progress was being made, the development of technology at the school levels paled in comparison to U.S. industry. On average, companies invested as much as \$5,500 in technology and support per worker, but the typical school spent no more than \$200 per student on technology. Yet, the nation's schools and colleges are still expected to be the breeding ground for the high performance, technologically-savvy workforce of the new century.

Based on the evidence presented by hundreds of people, the Commission issued a seven-point call-to-action to government, industry, and the education community:

- make powerful new Internet resources, especially broadband access, widely and equitably available and affordable for all learners;
- provide continuous and relevant training and support for educators and administrators at all levels;
- build a new research and development framework around learning in the Internet age;
- develop quality online educational content that meets the highest standards of educational excellence;
- revise outdated regulations that impede innovation and replace them with approaches that embrace anytime, anywhere, any pace learning;
- protect online learners and ensure their privacy; and
- sustain funding via traditional and new sources that is adequate to the challenge at hand (p. 1).

Representative Johnny Isakson (Republican-Georgia), Vice Chair of the commission, summed it up by saying, “Every stakeholder in American education must make it a priority to work in collaboration to realize the Internet’s potential in education” (p. 2).

2.3 Multimedia’s Role In Educational Technology

2.3.1 Introduction

Ask yourself! What is the dominant mode of experience at the end of the twentieth century? How do people see things, and how do they expect to see things? The answer is simple. In every field, from business to politics to marketing to education, the dominant mode has become entertainment (Crichton, 1999, p. 442).

Crichton, in his novel *Timeline*, continues to say,

Today, everybody expects to be entertained, and they expect to be entertained all the time. Business meetings must be snappy, with bullet lists and animated graphics, so executives aren’t bored. Malls and stores must be engaging, so they amuse as well as sell us. Politicians must have pleasing video personalities and tell us only what we want to hear. Schools must be careful not to bore young minds that expect the speed and complexity of television. Students must be amused – everyone must be amused, or they will switch: switch brands, switch channels, switch parties, switch loyalties. This is the intellectual reality of Western society at the end of the century (p. 443).

Although Crichton’s novel is fiction, what he says about schools and students is all too true. Students nowadays, expect to be entertained and when not, in the case of higher education, may go elsewhere!

2.3.2 What is Multimedia?

Good teachers have always known the importance of organizing the teaching of key concepts around questions of interest to students, and they have often found that traditional texts don’t provide them with sufficient resources. The Internet allows

teachers to download resources to use in their teaching, and students to download resources to use in their research. This information may be text and photos, or it may be multimedia such as animations, simulations, and video clips.

Multimedia, defined, is the combination of various digital media types such as text, images, sound and video, into an integrated multi-sensory interactive application or presentation to convey a message or information to an audience. In other words, multimedia means “an individual or a small group using a computer to interact with information that is represented in several media, by repeatedly selecting what to see and hear next” (Agnew, Kellerman, & Meyer, 1996, p. 1).

2.3.3 Types of Multimedia Investigated

Although there are many types of multimedia, this research focused on just four of the more prevalent ones. PowerPoint, CD-ROMs, and Laser Videodiscs can be used without the need of the Internet. However, their use does require a computer or Videodisc player and some way to project the illustration onto a screen. Many instructors, in order to supplement their classroom presentations, are now using a newer form of multimedia known as WebCT. WebCT has grown out of distance learning but the instructor needs to have access to the Internet as well as a computer and a means of projecting the imagery.

PowerPoint: PowerPoint is a complete presentation graphics package. It gives the instructor everything needed to produce a professional looking presentation - text handling, outlining, drawing, graphing, clip art, and so on. It also offers rich speaker support and aids to help instructors create truly effective multimedia presentations.

CD-ROM: Most computers now come with CD-ROM drives. CDs remain an important medium for the distribution of many types of digital content (Lubka & Holden, 2000). Physical storage formats for multimedia, such as CDs, enjoy some strong advantages over Internet distribution. Developers can use large graphics and rich media without worrying about modems or network traffic. There are a few drawbacks, however, to CDs. They cost money to produce and distribute and until recently couldn't be updated.

Laser Videodisc: The videodisc is a combination of photos, videos, experiments, animations, still graphics and movie segments presented in a non-linear manner. It can be played through a television or a video monitor. Images on videodiscs can be randomly accessed and instructors can control the complexity of instruction by skipping over material that may not fit their particular situation. The directories and lessons are coded with laser barcodes, which are read with a barcode wand. The instructor passes the wand across the code and the image appears almost simultaneously. Barcodes can be photocopied from the directory and used to create customized lessons or projects.

The full power of the interactive videodisc emerges when it is coupled with a computer. The videodisc's multimedia shell combines the resources of the written index with the powerful remote control, barcode generator, slideshow utility and indexes. The software presents a computerized index; the instructor clicks the mouse on the name of the desired image and the computer tells the disk which frame to display. The instructor can then navigate by linkages throughout the entire database. While videodiscs will never replace hands-on experience, video augmented labs are finding a place in today's multi-sensory classroom.

WebCT: WebCT is a tool that facilitates the creation of sophisticated World Wide Web-based educational environments. It can be used to create entire online distance learning courses, or to simply publish materials that supplement existing courses. WebCT was developed in the Department of Computer Science at the University of British Columbia (What Is WebCT?, 2001).

WebCT provides the tools to present online learning in a variety of ways, ranging from structured learning pathways to dynamic, interactive virtual classrooms. How a course is presented online depends on the content and complexity of the learning material, and the delivery methodology used by the instructor. Running as a program installed on a web server, WebCT manages all aspects of student access to web course pages while providing faculty with a web interface for creating their materials. For students, WebCT provides a single and consistent interface for course pages and related areas, plus students themselves have access to their own records (What Is WebCT?, 2001).

Who uses WebCT?

There are four classes of user in WebCT:

- The administrator
- The designer
- Graders
- Students

Each of the user classes operates as follows:

- There is only one administrator account. The administrator can initialize and delete courses, and change the passwords of course designers. This person does not actually configure or add any content to a course, but simply initializes a course and hands over the new empty course to a designer.
- Each course has at least one designer. Normally, this designer is the instructor of the course. The designer or designers can manipulate the course in any way: create quizzes, alter grades, check student progress, define student presentation groups, manipulate student accounts, etc.
- Each course can have any number of graders. A grader has the same privileges as a student, but can also mark quizzes and manipulate student grades. The course designer creates the grader accounts.
- Each course can have any number of students. Students cannot manipulate the course content (other than in the student presentation area as defined by the designer). Students can change their own password at the discretion of the designer. The course designer creates the students accounts (Introduction to WebCT, 2001, p. 1).

What can be done with WebCT?

Built-in to WebCT are tools and features that can be used to assist both the student in the act of communicating and learning, and the instructor in the act of providing and maintaining an educational environment:

- Electronic Mail – Email allows one-to-one message transfer among course participants. Messages can be searched for based on the sender, content or the date of sending.
- Chat Tool – Chat rooms provide synchronous communication between students and faculty and between students. The students' view of the chat room shows their names and a list of course participants in each room. If the instructor wishes, he/she can observe the exchanges taking place there.
- Timed On-line Quizzes – Quizzes can be written by the designer and delivered on-line on a predetermined day. A clock on the quiz page counts down the number of minutes assigned to the quiz once the student has begun. Once completed and marked, the grade assigned is, along with comments, made available to the student.
- Course Conferencing System (aka Bulletin Board) – This allows communication among all course participants (instructor, graders and students).
- Grade Tool – Each student can view his or her own marks as entered by the instructor.
The student also has access to minimum, maximum and average grades for each course component. Students also have online access to comments and grades from each online quiz written and marked.
- Progress Tracking – Progress tracking pages allow the instructor to monitor student progress in the course. Indicators such as date of first and last access, time spent on the system, percentage of pages visited, and more is available. The students can be sorted on any tracking field in order to easily identify students who, for example, have stopped accessing the course, or who are productive posters to the conferences.
- Course Calendar – important dates for assignments can be listed; syllabus of the course can be viewed; description of a particular class is given.
- External References – This tool allows the placement of a button that is linked to an external reference. External references can include textbook references, paper references, and URLs.

- Searchable and Linkable Glossary – A searchable glossary can be created by the course-author, and links from the notes to glossary entries can be added automatically by WebCT under the control of the instructor. The student can reach the glossary in one of two ways: clicking on a highlighted word or by clicking on the glossary button in the button bar.
- Student Presentation Areas – The designer can designate icons that serve as the document homepage link for student generated web pages. The designer can give authoring privileges to a single student, a group of students, or the entire class. This tool is useful for displaying course projects, student work, student newsletters and more.

2.3.4 Factors That Encourage the Use of Multimedia

Perhaps the most common misconception about multimedia is that it has the unintended effort of “dumbing down” content. Many teachers assume that if a lecture contains video clips, cartoons, or lots of digital images, it must be at the expense of content. Perhaps this is because of the belief that what is learned in the classroom is a direct function of the total volume of words used. The more teachers say, the more students must be learning.

Traditionally, the audio-visual departments of schools, universities, and libraries gathered educational materials in the form of filmstrips, films, slide shows, audiotapes, and later, cassettes, and videos for use by teachers. According to Lubka and Holden (2000), most of these media are still widely being used in classrooms, as most school systems have a considerable investment in equipment for showing movies and playing audiotapes and videotapes.

However, school budgets have increasingly reflected a reallocation of funds towards computers and Internet access, as teachers and administrators learn to harness the value and benefits of these new media. Billions of public and private dollars have been contributed to this redirection of technology in schools and libraries (Lubka & Holden, 2000).

Local and state National Educational Association affiliates are offering diverse professional development opportunities, including conferences, workshops, trade shows, and mentoring programs. NEA also sponsors national events on technology. At the NEA's Focus on Technology web page (www.nea.org/cet/index_educator.html), teachers can find announcements of virtual conferences, technology briefs, a message board, a roundup of favorite software and web sites (Valenti, 2001).

Another web site (Valenti, 2001) (www.21ct.org) is a nationwide, nonprofit volunteer movement that encourages teachers to share their skills in using educational technology. There are now over 11,000 registered users for the service with 300-500 new users signing up each month. The teachers are using the service to share ideas on curriculum, and plans are in place to establish mentoring programs through local chapters.

Students have indicated to King (1998) that they value multimedia presentations because such an approach:

- Makes classes more interesting, exciting and even entertaining.
- Helps organize the class material.
- Helps them understand the material better and enhance learning.
- Makes the presentation clearer, neater and more colorful.
- Aids in note taking.
- Helps them stay focused on the subject.
- Assists visual learners, which is almost everyone.
- Provides a more flexible, versatile and efficient way of learning.
- Reinforces and supports textbook material, as opposed to simple repeating it.
- Demonstrates that professors are keeping up with technology (p. 15).

2.3.5 Factors That Inhibit the Use of Multimedia

Many computers in schools, even up-to-date multimedia computers with high-speed Internet access, are not being used in ways that significantly enhance teaching and learning. Kleiman (2001) suggested several reasons for this:

- Teachers have not received adequate training and support for integrating technology into the core of day-to-day classroom instruction. So, the computers sit around the edges of the classroom and the students ‘get’ to use the computers as a reward for completing their work.
- Teachers often do not know of software that supports major curriculum goals, is consistent with their approaches to teaching, and is well designed for classroom use.
- Technical support is often insufficient, so that if a computer problem occurs that the teacher and students cannot solve, there may be long delays before a technician is available to address it. Thus many teachers then feel that they cannot depend on technology, so they do not plan to use it for important purposes in the classroom.
- The ways computers are made available are often inconsistent with teachers’ approaches to curriculum planning and classroom management. For instance, some schools may have only a few computers in the classroom while others may have a dozen or more. This requires teachers to organize daily activities so that some students can be working on the computers while others are engaged in other tasks. In schools without computers in the classroom, teachers have to schedule time in the school’s computer lab, often well in advance.
- In developing curriculum materials, publishers have not been able to assume that all schools have sufficient computers or teacher expertise to make use of technology central to the curriculum (p. 8-9).

Many instructors are still unsure how, or why, to use this technology in their teaching. One of the biggest difficulties with in-house development of classroom multimedia presentations is that the average faculty member needs large blocks of

time to develop them. Not only does the faculty member need to re-design a given lecture but also learn how to use a new tool. Many consider the time and effort to integrate technology into existing practices as too great a commitment. King (1998) suggested that it takes about 15 hours of development time to produce a multimedia presentation used in one hour. Faculty object to being pressured to use multimedia in teaching for various reasons, but the time needed to develop presentations is certainly an important factor.

Another problem facing many instructors in attempts to incorporate multimedia into science classes is that most students remain focused not on the technology but on the lecture presentation (Laurillard, 1993). Thus, if the instructor expects the students to have anything more than a passive role in the process, they are quickly faced with the problems of a dual learning curve. The terminology and concepts of an introductory biology class typically present a challenge to most students and when coupled with the requirements to learn to manipulate multimedia presentations and programs, the results may be devastating. The instructor often assumes the simultaneous tasks of lecturer, computer science instructor, help desk technician and graphics designer. The demand on instructor time and resources often reduces teaching effectiveness (Palloff & Pratt, 1999).

Some faculty members are put off by the artificial urgency of the whole campaign to adopt technology. “Adopt now, or die!” seems to be a common attitude. It’s interesting to note that many of those who are urging the immediate adoption of technology are not teachers, but people with a professional stake in the outcome. Such populace includes software developers or administrators who believe that technology will allow more students to be educated for the same amount of money—or less—than is now being spent (Neal, 1998).

Then there is the argument of computer simulations vs real-life experiences. An example of computer simulation used in many biology labs today is that of viewing Mendelian genetics in action. Students are able to access the *Electronic Desktop Project* (1997) on the Internet, then design and mate flies. They are able to set up mono-hybrid crosses, di-hybrid crosses, or sex-linked crosses and view very realistic results. For example: they can run a mono-hybrid cross involving wing structure,

crossing true breeding winged with true breeding apterous flies. According to Mendelian genetics the results should show a three to one ratio of winged to apterous flies. The data may, in fact, show 30 winged flies to 10 apterous. But it may also show 32 winged to eight apterous or even 35 to five — the numbers are realistic and not “cookbook.”

Traditional fruit fly labs are completed with the research organism *Drosophila melanogaster*. When these are used in a biology course, students are typically responsible for setting up simple crosses such as red eyes vs white eyes or winged vs apterous. When students set up the crosses, they are expected to learn and implement many “hands-on” activities. They learn some standard techniques such as anesthetizing flies, preparing media, maintaining live cultures and counting flies [using the dissecting scope]. More often than not, problems arise with the experiments: flies over-anesthetized, flies die due to mold contamination, working with non-virgin flies, flies escaping, or someone brings up animal-rights issues. These events can be classified under “realistic learning experiences” or “real world science” or even just plain “reality.” Some science educators see these “accidents” as “things” that just contaminate the real lessons of classical Mendelian genetics. Still others see these “accidents” as “teachable moments,” that is, real world lessons in science (Jensen, 1998).

In many ways the computer simulation is wonderful. Flies can’t escape the screen. Flies do not unexpectedly die. No animal rights activist complaints. The computer provides electronic tools that allow automatic counting, sorting, control over number of offspring, and buttons to peek at the genotypes. There is even a tool to move genes to different positions on the chromosome. The program is clean, quick, efficient, flexible, and powerful, and it can be used any time of the day and night. But, is it too good? After students have completed the activities, have they been involved in a laboratory experience? Have they done “real science?” Isn’t “real science” facing the risk of over anesthetizing flies or having two weeks of work fly off to the lunchroom? What has happened to the feel, smell, and even taste of “real science?”

Neal (1998) suggested that since faculty members are the ones who have to implement new technology, they should be the ones who decide whether or to experiment with it or adopt it. Yet often they are not consulted about practical problems and barriers they confront when they do want to experiment with using technology in their particular courses. Faculty need effective assistance—of the type they desire, not what software developers choose to provide.

The ease of information accessibility via the “WWW” has also produced other challenges for educators. The natural progression of science has resulted in a demand to compress more information into freshman biology curriculum. This has occurred simultaneously with an increase in faculty workloads and class sizes (National Science Foundation, 1996). Thus, while many instructors may have a desire to reform their curriculum, often the time for development of the electronic resources is not available.

2.3.6 Summary

Multimedia is changing the way we communicate with each other. The way we send and receive messages is more effectively done and better comprehended. The inclusion of media elements reinforces the message and the delivery, which leads to a better learning. The power of multimedia lies in the fact that it is multi-sensory, stimulating the senses of the audience. It is also interactive, enabling the end-users of the application to control the content and flow of information. This has introduced important changes on our educational system and impacts the way we communicate information to the learners (Neo & Neo, 2000).

Multimedia presentations have an advantage over hastily scribbled notes on a blackboard or overhead projector. But multimedia classroom presentations are not, and should not be, an end in themselves. We must keep in mind that computer-aided multimedia presentations are just one of several methods that are useful on helping students learn and master the material. Students can easily differentiate between “need-to-know” material versus “nice-to-know” material. Without a firm foundation in normal anatomy and normal physiology, for example, it is impossible to understand abnormalities and disease processes. Students are intuitively aware of

this, and it provides intrinsic motivation. When the move is away from text slides with bullet points to illustrate ideas and more towards presentations that incorporate images, sounds and animation, the content is enriched in ways that are suggested by contemporary theories of learning.

In an increasingly technological world, alternative media will continue to gain prominence in the biology classroom. Instructors presently find themselves in a transitory moment, when long-held methods of teaching and learning are being challenged by newly developed technologies. It is possible that within the next ten years, the printed textbook will go the way of the slide rule, mimeograph and film strip – each a longtime classroom staple replaced by better, more complex technology. Therefore, now is the time to ask whether electronic media are appropriate for the classroom and how they can best be adapted to student learning.

2.4 The Constructivist's Role in Educational Technology

2.4.1 Introduction

The perception is that current educational practices have failed to meet many intellectual and occupational needs of many students (Airasian & Walsch, 1997). Specifically, there is a view that thinking skills are not receiving enough focus because of an emphasis on rote memorization.

The educational philosophy known as constructivism has an appeal as an alternative to traditional practices because it seems to address the criticism of current practices and promises to deliver higher levels of literacy, self-reliance, cooperation, problem-solving skills, and satisfaction with school (Brooks & Brooks, 1999; Iran-Nejad, 1995; Larochelle, Bednarz, & Garrison, 1998; Sprague & Dede, 1999; Windschitl, 1999). Constructivism presents possibilities for classroom strategies that vary dramatically from those used in the traditional information-transfer model of instruction and presents possibilities for producing students who possess the skills necessary for work and life-long learning.

Theories of instruction have shifted from a behavioristic orientation that emphasizes observable changes in performance to a cognitive orientation that emphasizes internal cognitive processing. The stimulus-response approach of behaviorism made teaching simply a question of how to get the desired behavior from the learner. In contrast, a cognitive approach emphasizes the mental elaborations that the learner performs more than the specific features of instruction (Bruning, 1983). From this framework, teachers can create learning environments that encourage achievement (Brezin, 1980). This point of view has been termed constructivism, or active learning, by a growing number of authors.

2.4.2 Constructivist Approach to Learning

During the latter part of the 1970's science educators began to (re) examine some of the theories of knowledge. One of the theories to (re) emerge was that of constructivism (Taylor, 2000). Constructivism, however, is not a new concept. It has its roots in philosophy and psychology and has been applied to sociology in addition to anthropology (Yager, 1991).

Throughout the 1930s and 1940s, it was the leading perspective among public school educators in the United States. Within the past decade, educators have used constructivism as a basis for thinking about research and practice. Tobin (1993) observed that when constructivism was used as a referent for action, dramatic changes in the practice of education occurred.

Constructivism's central idea is that human learning is constructed, that learners build new knowledge upon the foundation of previous learning (Taylor, 2000). This view of learning sharply contrasts with one in which learning is the passive receiving of information from one individual to another or from teacher to student.

Constructivists believe that learning is a process of sense making, of adding and synthesizing new information within existing knowledge and adjusting prior understandings to new experiences. Therefore, the meaning that each learner receives from a particular experience is unique and each individual's experience is filtered through his or her personal understandings, beliefs, and values (Jones, 1997).

In order to learn from new experiences, the learner must first become dissatisfied with his or her existing knowledge and beliefs.

Fosnot (1996) referred to constructivism as “a theory about knowledge and learning.” Knowledge is “temporary, developmental, nonobjective, internally constructed, and socially and culturally mediated” (p. ix). Such a theory has significant implications for teaching. It changes the emphasis of the traditional classroom by focusing around the learner or student and redefining the role of the instructor to that of a facilitator or guide rather than being the only source of knowledge. In other words, the focus is placed on the student rather than the teacher.

Constructivists view the student as one who acts on objects and events within his or her environment and thereby gains some understanding of the features held by the objects and events. The foundation premise is that learners actively construct their knowledge by anchoring new information to preexisting knowledge (Strommen & Lincoln, 1992). The student actively constructs his/her own ideas and solutions to problems. Student independence and initiative is encouraged.

Present day education involves a view of constructivism that includes a focus on effort instead of ability. Constructivism places the learner in an active position of learning that involves formulating various concepts in order to resolve the problem. This enables the teacher to lead, to facilitate, or to coach while the student experiments in order to learn. While it is important for educators to understand constructivism, it is equally important to understand the implications that this view of learning has for teaching and teacher professional development.

2.4.3 What Constructivism Does and Does Not Entail for Teaching

While it is important for educators to understand constructivism, it is equally important for educators to understand the implications this view of learning has for teaching. The central idea is that learners create more knowledge by making connections to what they already know.

Lecturing is a presentation of connections made by other people, generally a passive process for students. A very strong message of constructivism is that educators can realize the most significant improvement by shifting from the traditional transmission model to active teaching and learning strategies.

Airasian and Walsh (1997) have suggested that both teachers and students will have to redefine their roles in how they believe learning takes place. Teachers will have to learn to guide, not tell; not stick to rigid standards and criteria; not search for the “right” answer, being open to modifying “right” and wrong”; and being a facilitator rather than being the “expert.” Students will have to learn to think for themselves, not wait for the teacher to tell them what to think; to express their own ideas, not the teacher’s; and to revise constructions, not to move immediately on to memorize the next concept.

Constructivism does not always produce predictable outcomes. Active learning environments place a high cognitive load on learners and the unfamiliar style of instruction poses some difficulties for many students. If they interpret this as an opportunity to “do as they wish”, the first reaction of many students is to not take the subject seriously, or to remain passive and assume that other students will do the work. Many teacher – centered instructors see creative student – centered activities as play. Rarely do traditional teachers see such activities as effective means of distributing new and difficult science material to students. But creating thought provoking lessons and providing them to small collaborative groups of science students to work through are more effective than the same lessons recited by the teacher. Rather than being nonactive recipients of the content, students in constructivist – based classes are involved in lively and challenging activities created by the teacher to teach the material (Lord, 1994).

2.4.4 The Role Technology Plays in Constructivism

Bagley and Hunter (1992), and Jonassen (1996) have proposed that technology, particularly computer-based technology, can become an essential piece of learning environment based on constructivist learning theory.

For example, Sandholtz, Ringstaff, and Dwyer (1997) stated:

Technology is a catalyst for change in classroom processes because it provides a distinct departure, a change in context that suggests alternative ways of operating. It can drive a shift from a traditional instructional approach toward a more eclectic set of learning activities that include knowledge-building situations for students. (p. 48)

According to Bagley and Hunter (1992) students became empowered and spent more time in active construction of knowledge when using technology. Technology provides more resources for student use in problem solving, thinking and reflection. Students spend more time collaborating with other students and communicating with teachers when developing technology projects. Often, however, what holds students back is not the technology but the structure of schools. Traditional or fearful teachers may not tolerate the kinds of exploratory constructivist approaches that students bring to the web surfing and computer use. A student who is an expert in the technology can be a threat to a science teacher. Also, the school day may be organized so that access to computers is limited or time is not set aside to work on small-group or individual projects (McAdoo, 2001).

One problem with many school reform efforts is that teachers are told what they should do to improve classroom environments without provision of the tools they need to accomplish those changes. Technology, particularly in the form of interactive computer assisted instruction and the information available on the Internet, may provide tools that can help teachers implement constructivist practices.

2.4.5 Summary

Mehlinger (1996) suggested that the use of new technologies would greatly influence schools. The relationship between teacher and students is changing because technology gives learners control over their own learning – one of the primary tenets of constructivism.

One of the few long-term studies on the use of technology in the classroom seems to support Mehlinger's views. Dwyer (1994) reported that a four-year study of seven Apple Classroom Of Tomorrow classrooms demonstrated that the dramatic impact of

technology in these types of learning environments should not be underestimated. Researchers watched as technology “profoundly disturbed the inertia of traditional classrooms” (p. 7). There were noticeable differences in the behavior of students and teachers. The researchers reported that the use of technology in instruction:

- encourages fundamentally different forms of interactions among students and between students and teachers;
- engages students systematically in high-order cognitive tasks; and
- prompts teachers to question old assumptions about instruction and learning.

Constructivism in education relies heavily on collaborative methods and active involvement of the learner. But constructivism itself is not a method – it is an approach, a point of view of how to teach based on how people learn. Constructivism teaching offers a bold departure from traditional objectivist classroom strategies. The goal is for the learner to play an active role in assimilating knowledge onto his/her existing mental framework. The ability of students to apply their school – learned knowledge to the real world is valued over memorizing bits and pieces of knowledge that may seem unrelated to them. The constructivist approach opens new avenues for learning as well as challenges for the teacher to implement.

Mehlinger (1995) further suggested that even though change rarely results from one event, sometimes one event is more powerful than others in the process of change.

The use of technology will have a profound effect on schools. It challenges the very relationship between students and teachers, because technology enables learners to gain control their own learning... The technology provides access to information that was once under the control of teachers (p. 94).

2.5 Conclusion

We have come a long way from the film loop. Current technology allows students the same technology to learn biology that they use to pay bills or listen to music. Today's students are more comfortable with technology than their parents probably ever will be. They surf the Internet, program VCRs, operate cellphones and beepers, and scan dozens of cable TV channels in mere seconds, all with dexterity. Furthermore, they can interact in a way not possible with earlier electronic technologies. For many years, students have wanted to review, self-test, and acquire information independently. Now they can. They have control, and the burden is on them to be active learners and on schools to make this possible. "With both skepticism and awe we dub them the "Net Generation" – and then try to figure out what to teach them and how best to do it" (Gordon, 2001, p. vii)

The evolution of multimedia has made it possible for learners to become more involved in their work. With multimedia technologies, students can create multimedia applications as part of their course requirements. This makes them active participants in their own learning process, instead of just being passive learners of the educational content. Cognitive research suggests that the addition of multimedia can actually improve the learning process. By using auditory and visual methods of presenting information, students can process that information more quickly, often fostering an enhanced learning process (Campbell, Lumm, & Singh, 2000).

There is no longer a question about whether the new technology will be used in schools. Many believe these technologies are necessary because competency in their use is an important feature of career preparations; others see equally important outcomes for civic participation. Most importantly, a growing research base confirms technology's potential for enhancing student achievement. What is less certain is how and when these technologies will change the nature of schooling itself (Wise, 1997). Kleiman (2001) believes that to use technology effectively we must fully integrate it into school improvement plans, curriculum plans, professional development plans, and all the other plans created by schools. "Significant

educational returns require that technology be viewed as providing tools to meet central educational goals, not as defining a new, separate set of goals” (p. 13).

Multimedia presentations seem to have many advantages over hastily scribbled notes on the blackboard or the overhead projector. Knowing that students feel this way about multimedia presentations may be reason enough for teachers to seriously consider the use of technology in the classroom. But, multimedia classroom presentations should not be an end in themselves. We must keep in mind that computer-aided multimedia presentations are just *one* of several methods that can be useful in helping students learn and master the material. However, if we begin to move away from the text slides and diagrams which point out important ideas and move toward well prepared presentations that use images, sounds and animation, we can provide an environment where the students are the ultimate beneficiaries.

This review of literature suggests that technology can be a promising alternative/addition to traditional textbooks in the biology classroom. The multiple benefits of electronic media, such as the ability to dynamically customize the curriculum, animations, interactive bulletin boards, distance learning formats, and hyperlinking to further resources, have the potential to aid both students and instructor by improving the teaching and learning process. Teachers, parents, school administrators, and students themselves all have the challenging assignment of making sure that these marvelous new resources don't go to waste (Gordon, 2001).

In addition to the investigations that have centered on the use of technology in education, there is a need for the research described in this thesis that examined the role and usage of educational technology in Florida's Community College biology departments. The results of the research will help to expand our knowledge and provide some rationale that can be used to encourage community colleges to provide support to their instructors who want to implement technology into their classrooms and laboratories.

CHAPTER 3

METHODOLOGY

3.1 Overview

This chapter of the thesis is focused on the methodology used in this study. The research perspective is first discussed and a basis for the design established. The development of the instrument used in the Educational Technology Survey is explained followed by a brief description of the pilot study. The remaining portion of the chapter outlines the data collecting procedures and how the data were treated.

3.2 Instrumentation

A review of the literature in Chapter 2 pinpointed general concerns of educators nationwide concerning the use of educational technology. An instrument was designed to direct those concerns specifically to Florida Community College biologists. Unfortunately, since this survey has only been used once, in this study, there is no validity and reliability data as would be true with any new instrument. Nevertheless, this survey was appropriate for this study because it specifically addresses the issues of factors affecting the implementation and use of technology in teaching biology courses in Florida's Community Colleges.

The Educational Technology Survey was intended to address the focus questions suggested by the literature and to provide information about how biologists were using the Internet and multimedia in their classroom and laboratory presentations. In addition, the survey was designed to provide a profile of the people who are in positions to effect change in the areas of technology. The primary purpose of the written survey, however, was to identify factors that encourage and those that inhibit the use of the Internet and multimedia in the teaching of biology courses in Florida's Community Colleges.

3.3 Development of the Written Survey Instrument

A study of the series *Qualitative Applications in the Social Sciences* (Converse & Presser, 1986 and Kalton, 1983), along with suggestions by Borg and Gall in *Educational Research* (1989), supported the technique of using a written survey for data collection in this type of study. This researcher designed the written survey for ease of use. That goal included the concept of not asking for information that might be difficult for the respondent to answer quickly. Estimated time for completion of the survey, based on the pilot test, was between 15 and 20 minutes.

The primary research question that generated the survey was, “What factors encourage and inhibit the use of educational technology in the teaching of biology in Florida’s Community Colleges?” The survey was designed around this question and a variety of factors were determined by the research to have a possible impact on answers to that question.

3.4 Pilot Test

A written survey was field tested by 23 community college biology instructors from the State of North Carolina in the spring of 2000. This researcher was employed at one of the community colleges in that state during the initial development of the instrument. The field test provided an opportunity for this test designer to consider possible questions concerning their content, grammar and readability. Appropriate changes were made based on the field test.

The format of the final product consisted of a four-part survey that was placed on the World Wide Web and that the instructors could access and respond to electronically.

3.5 Population Description

The target audience in this study consisted of biology instructors from Florida’s Community Colleges. An announcement of the survey and a request for participation by current instructors was sent via a distribution list to all community college biologists.

Faculty was instructed to access a URL designating the location of the survey on the World Wide Web. Upon completion of the technology survey form, the results were automatically emailed back to the investigator.

There are 28 community colleges in the State of Florida. Ninety-two biology instructors from 25 (89%) of the community colleges returned complete, usable Educational Technology Surveys.

3.6 Demographics

The first six questions asked the instructors for their name, email addresses, size of their campus, and size of the town. In addition to the information provided by the respondents, some data were also obtained from the *Florida Community College System's Web Site* (2001).

1. The name of the college, address, city, zip code, instructor's name, and email addresses (Survey Questions 1, 2, 3, and 4) were withheld from the final analysis to ensure anonymity for all those who participated.
2. College Size (Survey Question 5). This question asked the participants to provide the approximate number of students who were attending their community college (Figure 4.1, page 62).
3. College Location (Survey Question 6). The instructors were encouraged to provide information as to whether their college was located in a rural area, small town, suburb or in an urban area (Figure 4.2, page 62).

The remaining questions on the Educational Technology Survey were primarily itemized choices, with some opportunities to write in variations in responses, elaborate on responses or add to the choices. The items endorsed by the participants were objective. According to Murphy and Davidshofer (1988), scales such as these are less susceptible to error and produce relatively stable and accurate ratings.

3.7 Data Collection Procedures

After being granted permission from Curtin University of Technology to conduct this survey, an email was sent to every known community college biology instructor in the State of Florida by way of distribution lists that this researcher was able to put together. The email introduced this investigator and outlined the research that he was interested in conducting.

Participants were asked to respond within two weeks or by February 14, 2002. At that time, non-respondents were sent a follow-up email and given an additional two weeks to respond if they were interested in participating in the survey. A final email was sent via distribution lists, thanking all that responded and seeking any others that were still interested, indicating that they still had time to reply by March 27, 2002. Once the completed surveys had been collected, the data were entered into an Excel file for analysis.

While the demographic information collected in the written survey and online was helpful in compiling a qualitative picture of Florida's Community Colleges in relation to their Internet use, the main focus of this research and the bulk of the data analysis were related to the specific research questions presented below:

- 1) To what extent are Florida's Community College biology instructors using the Internet?
- 2) What factors encourage Florida's Community College biology instructors to use the Internet?
- 3) What factors inhibit Florida's Community College biology instructors from using the Internet?
- 4) To what extent are Florida's Community College biology instructors using multimedia?
- 5) What factors encourage Florida's Community College biology instructors to use multimedia?
- 6) What factors inhibit Florida's Community College biology instructors from using multimedia?

- 7) To what extent are Florida's Community College biology instructors using WebCT?
- 8) What factors encourage Florida's Community College biology instructors to use WebCT?
- 9) What factors inhibit Florida's Community College biology instructors from using WebCT?
- 10) How do Florida's Community College biology instructors communicate with students outside the classroom?
- 11) Who manages the use, policies and long-range planning of technology for your community college?

3.8 Treatment of Data

Information for all the research questions was gathered from the responses to the questions asked in the Educational Technology Survey and is presented in the following chapter.

Every effort was made to tailor the written survey to the research questions. To summarize, Table 3.1 shows how the research questions relate to the items on the written survey. A complete copy of the survey is provided in Appendix F.

Table 3.1 *Relationship of Research Questions and Written Survey Items*

Research Question	Written Survey Item
1	A1, A2
2	A3
3	A4
4	B1, B2
5	B3
6	B4
7	C1, C2
8	C3
9	C4
10	D1
11	D2, D3, D4

3.9 Summary

Chapter 3 has provided a description of the specific processes that were used to conduct the research in this study. The population description, research design and the eleven research questions of the study were presented. The procedure by which the data were collected was also included. The chapter has set out the plan by which the research conducted in this study was carried out.

Chapter 4 begins the discussion of the technical details of the research actually undertaken and describes the implementation, analysis of, and findings of the Educational Technology Survey.

CHAPTER 4

RESULTS

4.1 Overview

The focus of this study was to present a profile of the biology instructors in Florida's Community Colleges in relation to whether they are currently using the Internet and/or multimedia as part of their teaching tools. In addition, the intent was to answer research questions relating to the level of Internet and multimedia use. Information was compiled regarding factors that encourage and factors that inhibit the use of the Internet and multimedia in education. Finally, data also were collected concerning those who are responsible for managing the use of technology in these colleges. This chapter presents the results from the Educational Technology Survey that was emailed to Florida's Community College biologists, organized first by demographic information and then by information relating to the eleven research questions.

4.2 Data analysis

4.2.1 Demographics

The data analysis process began with a study of the demographics of the community colleges. In order to maintain anonymity in the data analysis, questions one, two, three, and four were not analyzed, as they specifically identified the schools and instructors responding. These identifications were used only as a check for instructors not responding so that follow-up emails could be sent.

Responses to questions five (school size) and six (school location) were compiled in order to create a profile of the community colleges responding to the survey.

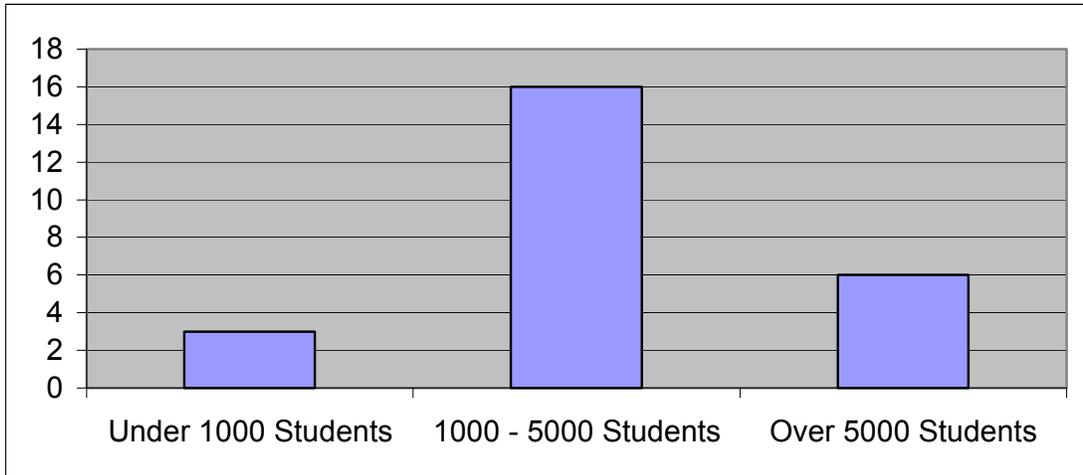


Figure 4.1 College Size

Figure 4.1 indicates that of the 25 community colleges responding, three had fewer than 1000 students in total enrollment while six had over 5000 enrolled. The majority (16) of the colleges, however, had between 1000 and 5000 students in their total population.

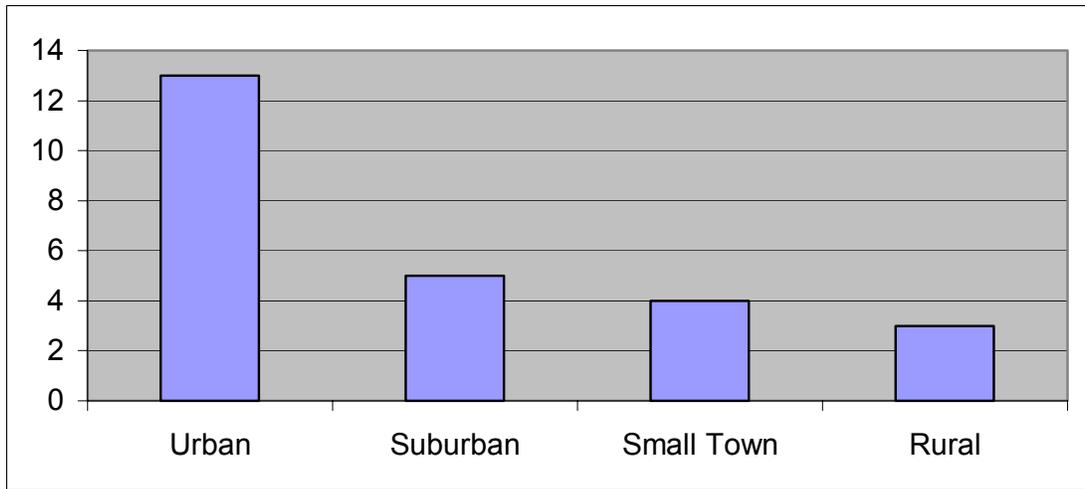


Figure 4.2 College location

Figure 4.2 shows that three of the community colleges are located in a rural area. Four colleges are situated in a small town while five are to be found in suburban communities.

Most of the community colleges (13) are located in urban areas. Thus, the majority of the colleges are in an urban area and have between 1,000 and 5,000 students.

While the demographic information collected in this research was helpful in compiling a picture of the size and location of Florida's Community Colleges, the main focus of the research and the bulk of the analysis is related to the research questions initially discussed in Chapter 1. In order to achieve this, the following discussion is organized in sections that correspond to the research questions.

4.2.2 The Internet

Research Question 1: To what extent are Florida's Community College biology instructors using the Internet? Survey Questions A1 and A2 in Table 4.1 (page 63) were designed to answer this question.

Table 4.1

Use of Internet Resources in The Biology Classroom and in The Laboratory					
A1. To what extent do you use the Internet?		Lecture	%	Lab	%
Total Responses		92		92	
Never		29	32%	43	47%
Seldom		10	11%	15	16%
Sometimes		27	29%	23	25%
Often		10	11%	5	5%
Very Often		16	17%	6	7%
A2. How do you use the Internet? (Check all that apply)		Lecture	%	Lab	%
Total Responses		124		74	
In Place of Lecture/Laboratory		4	3%	4	5%
To Enhance Lecture/Laboratory		49	40%	26	35%
As a Review		29	23%	13	18%
Assignments for Students		42	34%	31	42%
Other: Research, 4; Projects/Reports; Online Quizzes; Additional Labs					
A3. Factors that encourage your use of the Internet. (Check all that apply)		Lecture	%	Lab	%
Total Responses		119		80	
Technology Plan		19	16%	9	11%
Training Provided		22	18%	19	24%
Instructor Interest		59	50%	37	46%
Pressure from Students		8	7%	7	9%
Pressure from Administration		6	5%	4	5%
Pressure from Colleagues/Department		5	4%	4	5%
Other: Easy to Access, 2; Tech Support Available, 2; Current Info, 2;					
Students Need to Know, 2; Change of Pace; Companion Site With Text					
A4. Factors that inhibit your use of the Internet. (Check all that apply)		Lecture	%	Lab	%
Total Responses		212		165	
Lack of:					
Means of Projection		43	20%	35	21%
Instructor Training		18	8%	15	9%
Instructor Interest		13	6%	9	5%
Time for Preparing		53	25%	39	24%
Administration Encouragement		4	2%	4	2%
Department Encouragement		3	1%	2	1%
Resources		25	12%	17	10%
Computer Access		32	15%	26	16%
College/Department Plan		5	2%	6	4%
Prefer "Traditional Methods"		16	8%	12	7%
Other: Takes time away from "traditional Methods", 2; Equipment malfunctions, 2;					
Have to develop two courses, one "traditional"/one technology;					
Prefer more student active participation					

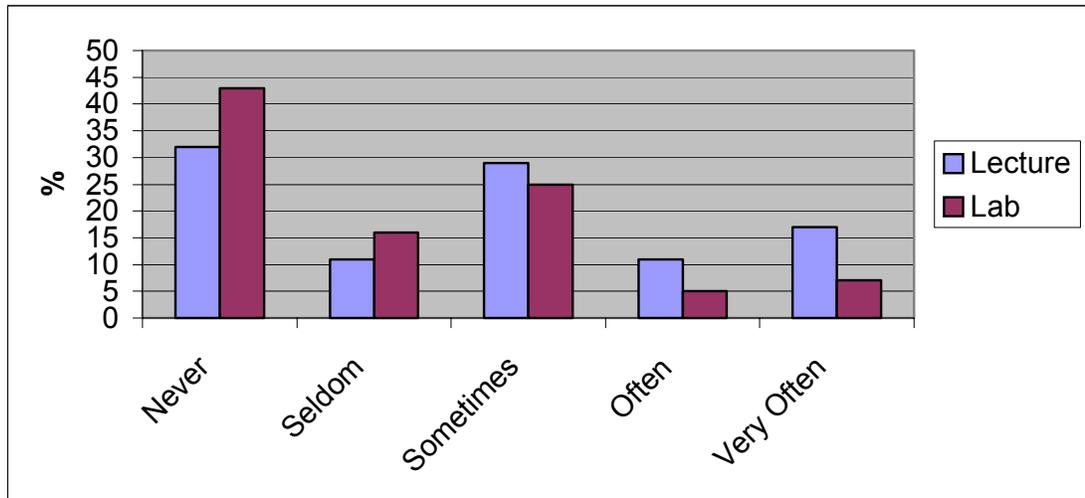


Figure 4.3 Use of the Internet

Figure 4.3 shows about one third (32%) of the instructors indicated that they had never used the Internet in the classroom during lecture. Of the remaining, only 17% reported that they had used it very often. In the laboratory, the number that had never used the Internet was much more with almost half (47%) indicating this. A small group (only 7%) very often used the Internet in the laboratory.

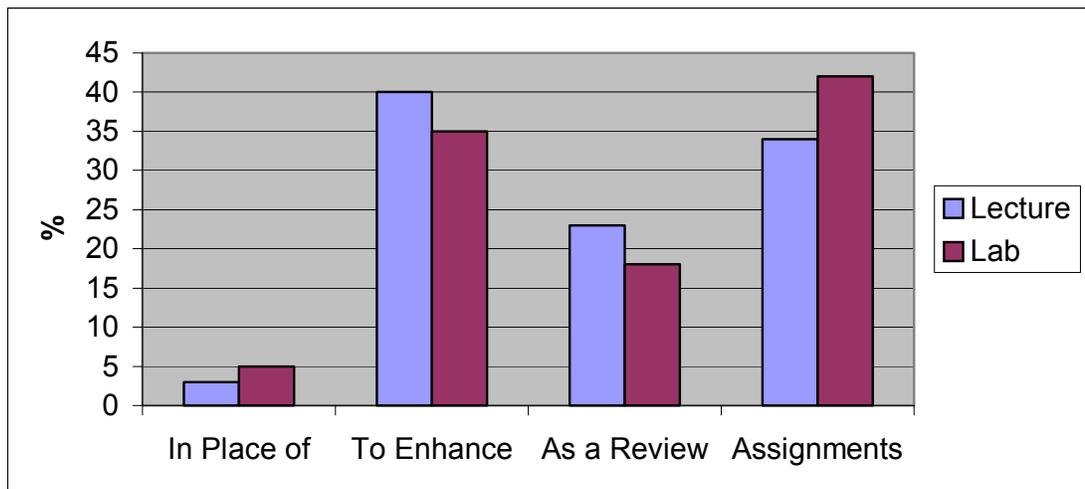


Figure 4.4 How the Internet is used

The results of how instructors use the Internet were similar in both lectures and laboratory sessions. Over one third (lecture, 40%, and laboratory, 35%) specified that they used the Internet to enhance their presentations. A large percentage of

instructors (35%-40%) used the Internet to assign students research projects and reports and to have them take online quizzes. About 20% used it as a review of information prior to exams while only five percent used the Internet to replace traditional presentations.

Research Question 2: What factors encourage Florida’s Community College biology instructors to use the Internet? Survey Question A3 in Table 4.1 (page 63) was designed to answer this question.

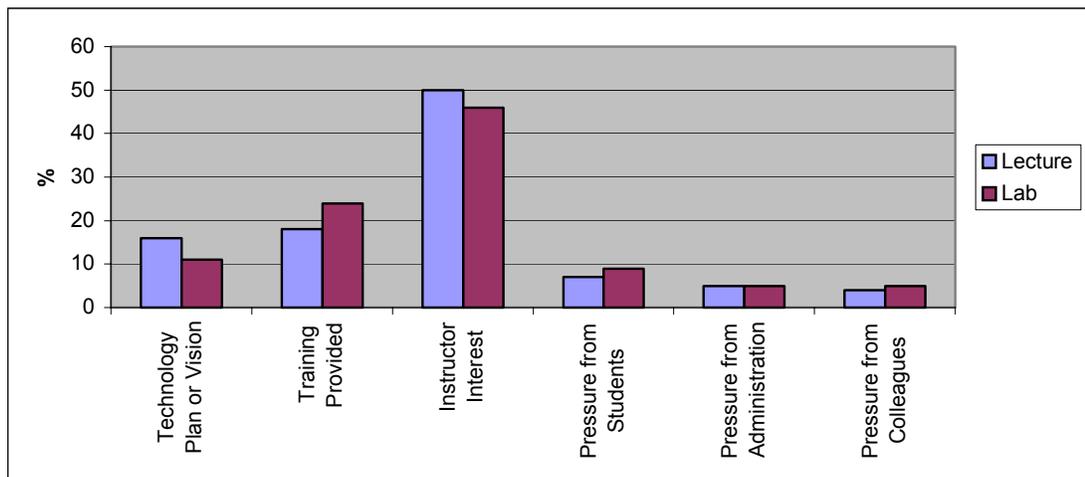


Figure 4.5 Factors that encourage use of the Internet

Fifty percent of the instructors responding indicated that instructor interest was the major factor in using the Internet both in the classroom and in the laboratory. About 20% were encouraged to use the Internet because there was a technology plan in place as well as training that was provided. Very few (less than 10%) felt pressured by students, administrators, or colleagues to use the Internet.

Research Question 3: What factors inhibit Florida’s Community College biology instructors from using the Internet? Survey Question A4 in Table 4.1 (page 63) was designed to answer this question.

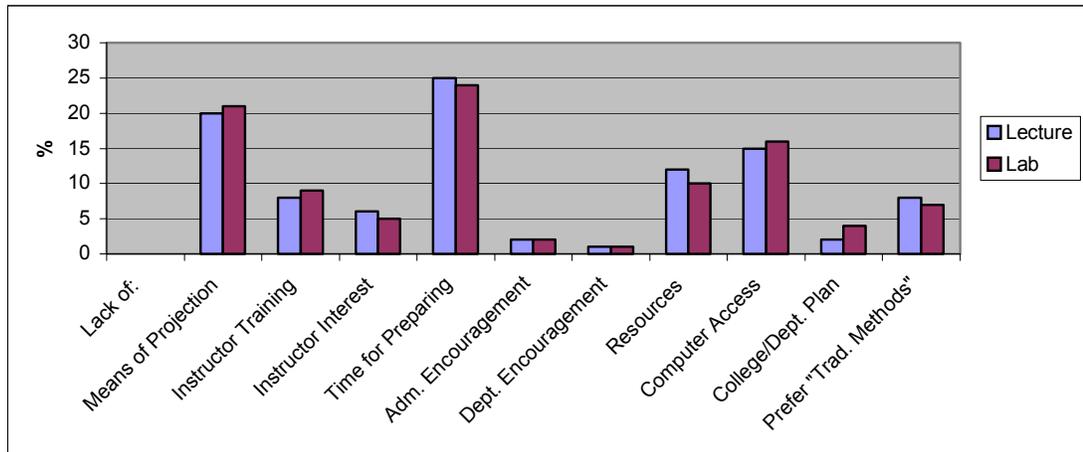


Figure 4.6 Factors that inhibit use of the Internet

As illustrated in Figure 4.6 (25%) of the instructors suggested that the time it takes to prepare lessons for use in the classroom, as well as in the laboratory, was the number one reason for not using the Internet. Not having a means of projecting the image was the second most inhibiting factor (20%) in both the laboratory and classroom. Fifteen percent of those responding did not have computer access, while 12% said that they lacked the resources both in the classroom and laboratory to add multimedia to their lessons. About eight percent cited the lack of instructor training as inhibiting their using multimedia. Eight percent also said that they preferred to use traditional methods, while six percent didn't have any interest at all in using the Internet either in the classroom or laboratory. Only a small percent (2%) said that they lacked administrative or departmental encouragement.

The lecture classroom and laboratory continue to be used as the primary method of teaching biology rather than the Internet. One third of the instructors responded that they did use the Internet, however, they did so to enhance their presentations, for reviewing the work, and for outside assignments. The most important reason that encouraged biologists to use the Internet was that of their own interest. The four major factors that contributed to inhibiting its use was the amount of time it takes to prepare the lessons, the lack of the means to project the images, computer access, and the provision of resources needed to develop Internet activities.

Thus, as seen in Chapter 2, time and access are the underlining issues which computer integration is dependent upon. Integrating computers into their teaching takes so much time, that teachers often feel like a first-year teacher rethinking, redesigning, and creating curriculum activities that utilize computer technology effectively within the classroom setting. Time and support need to be provided to instructors at the planning stage of the lesson.

4.2.3 Multimedia

Research Question 4: To what extent are Florida's Community College biology instructors using multimedia? Survey Questions B1 and B2 in Table 4.2 (page 67) were designed to answer this question.

Table 4.2

Use of Multimedia in The Biology Classroom and in The Laboratory																						
B 1. To what extent do you use multimedia?											CD Lec	%	CD Lab	%	PP Lec	%	PP Lab	%	LD Lec	%	LD Lab	%
Total Responses											92		92		92		92		92		92	
Never											28	30%	40	43%	34	37%	58	63%	62	67%	64	70%
Seldom											15	16%	15	16%	9	10%	13	14%	15	16%	15	16%
Sometimes											26	28%	18	20%	11	12%	8	9%	7	8%	8	9%
Often											13	14%	15	16%	10	11%	7	8%	6	7%	4	4%
Very Often											10	11%	4	4%	28	30%	6	7%	2	2%	1	1%
B 2. How do you use the multimedia? (Check all that apply)											CD Lec	%	CD Lab	%	PP Lec	%	PP Lab	%	LD Lec	%	LD Lab	%
Total Responses											93		59		64		31		39		20	
In Place of Lecture/Laboratory											3	3%	1	2%	4	6%	1	3%	1	3%	0	0%
To Enhance Lecture/Laboratory											57	61%	28	47%	45	70%	20	65%	22	56%	13	65%
As a Review											18	19%	18	31%	10	16%	8	26%	8	21%	7	35%
Assignments for Students											15	16%	12	20%	5	8%	2	6%	0	0%	0	0%
Other: Study groups; Use videos; Option for students to use CD that comes with book																						
B 3. Factors that encourage your use of multimedia. (Check all that apply)											CD Lec	%	CD Lab	%	PP Lec	%	PP Lab	%	LD Lec	%	LD Lab	%
Total Responses											85		67		102		59		28		24	
Technology Plan or Vision											19	22%	9	13%	25	25%	16	27%	4	14%	5	21%
Training Provided											22	26%	19	28%	22	22%	12	20%	5	18%	3	13%
Instructor Interest											59	69%	37	55%	42	41%	25	42%	16	57%	14	58%
Pressure from Students											8	9%	7	10%	5	5%	3	5%	2	7%	1	4%
Pressure from Administration											6	7%	4	6%	5	5%	2	3%	0	0%	0	0%
Pressure from Colleagues/Department											5	6%	4	6%	3	3%	1	2%	1	4%	1	4%
Other: Availability; Ease of use; Good for visual learners; Posting lectures on web site; Available as part of text																						
B 4. Factors that inhibit your use of multimedia. (Check all that apply)											CD Lec	%	CD Lab	%	PP Lec	%	PP Lab	%	LD Lec	%	LD Lab	%
Total Responses											127		119		133		128		76		72	
Lack of:																						
Means of Projection											43	34%	35	29%	31	23%	33	26%	15	20%	14	19%
Instructor Training											18	14%	15	13%	11	8%	10	8%	4	5%	3	4%
Instructor Interest											13	10%	9	8%	11	8%	11	9%	12	16%	11	15%
Time for Preparing											53	42%	39	33%	39	29%	30	23%	18	24%	16	22%
Administration Encouragement											4	3%	4	3%	0	0%	0	0%	0	0%	0	0%
College/Department Encouragement											3	2%	2	2%	0	0%	0	0%	0	0%	0	0%
Resources											25	20%	17	14%	15	11%	14	11%	14	18%	15	21%
Computer Access											32	25%	26	22%	16	12%	17	13%	6	8%	6	8%
College/Department Plan											5	4%	6	5%	3	2%	4	3%	1	1%	1	1%
Prefer "Traditional Methods"											16	13%	12	10%	7	5%	9	7%	6	8%	6	8%
Other: Software; Rooms not wired; Limited finances; No compensation for time; Accessing involves 'dead time' during presentation; Not a good substitute for active learning																						

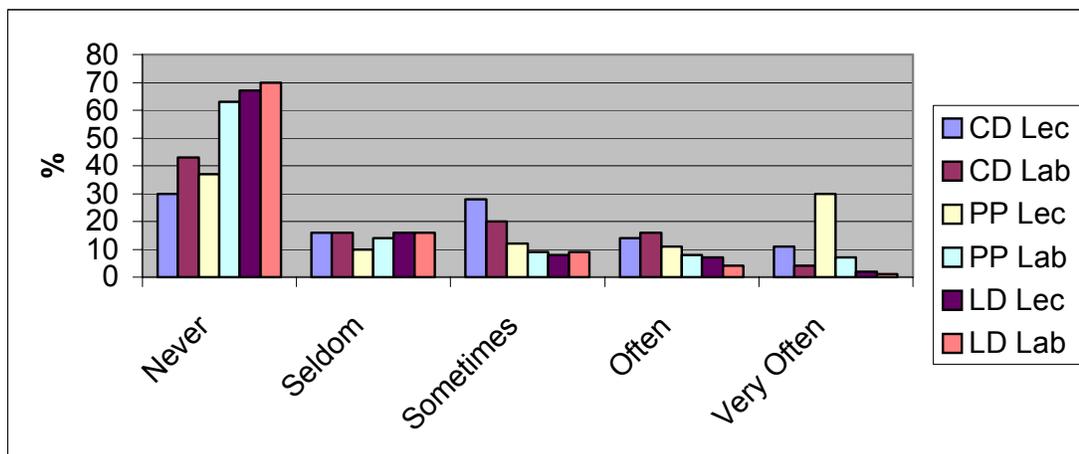


Figure 4.7 Use of multimedia

CD-ROM: Of those that responded to the Technology Survey, almost one third (30%) reported that they never used CDs during lecture, and nearly one half (43%) never used them in the laboratory. Twenty-eight percent of the instructors said that they sometimes used them in the classroom while about 20% used the CD in the laboratory. Eleven percent used CDs very often during lecture but only four percent used them in the laboratory.

PowerPoint: One third (37%) of the respondents said that they never used PowerPoint during lecture. By contrast, almost one third (30%) said that they very often used PowerPoint in the classroom. A large percentage (63%) never used PowerPoint in the laboratory while only a small percentage (7%) said that they used it very often. Approximately ten percent of the instructors reported using PowerPoint both in the laboratory and in the classroom. A few, seven or eight percent, seldom used PowerPoint, while another seven or eight percent said that they often used it.

Laser Videodisc: Over two thirds of the instructors responding to the Survey said that they never used Videodiscs either in the laboratory or in the classroom. By comparison, two percent used them in the classroom while only one percent used them in the laboratory. Sixteen percent said that they seldom used Videodiscs; eight percent sometimes used them and approximately six percent used them very often in the classroom and in the laboratory.

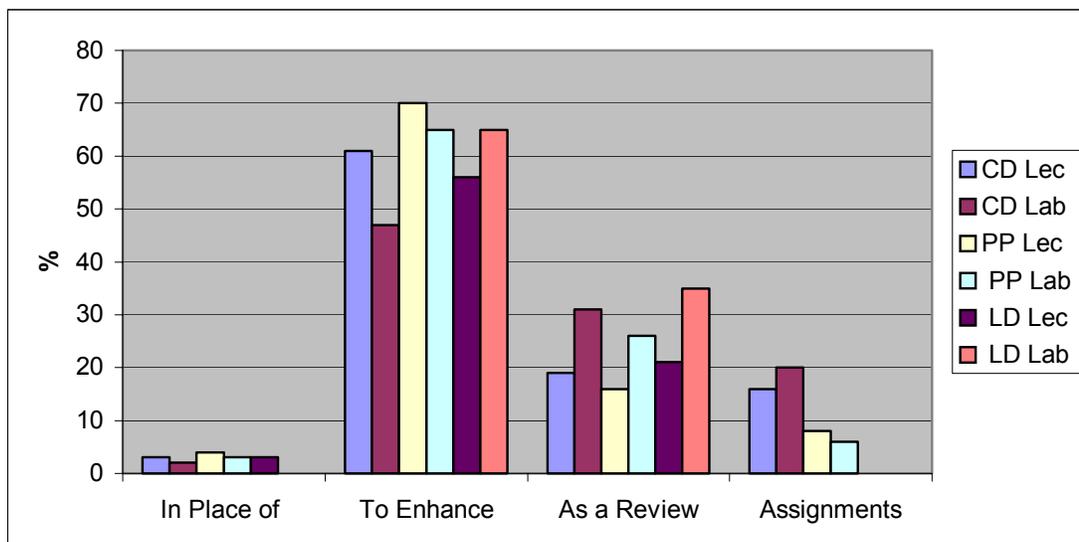


Figure 4.8 How multimedia is used

Of all those that responded to the Survey, over one half reported using all three forms of multimedia to enhance both their lecture and laboratory presentations. Approximately 30% of the instructors used CD-ROMS, PowerPoint, and Laser Videodiscs as a review in both the classroom and in the laboratory. Twenty percent of the respondents said that they used the CD as an assignment for students to do on their own. Less than ten percent assigned PowerPoint activities, while no instructors gave Videodisc assignments to students. Very few, less than three percent, used any form of multimedia to actually replace lecture presentations or laboratory activities.

Research Question 5: What factors encourage Florida's Community College biology instructors to use multimedia? Survey Question B3 in Table 4.2 (page 67) was designed to answer this question.

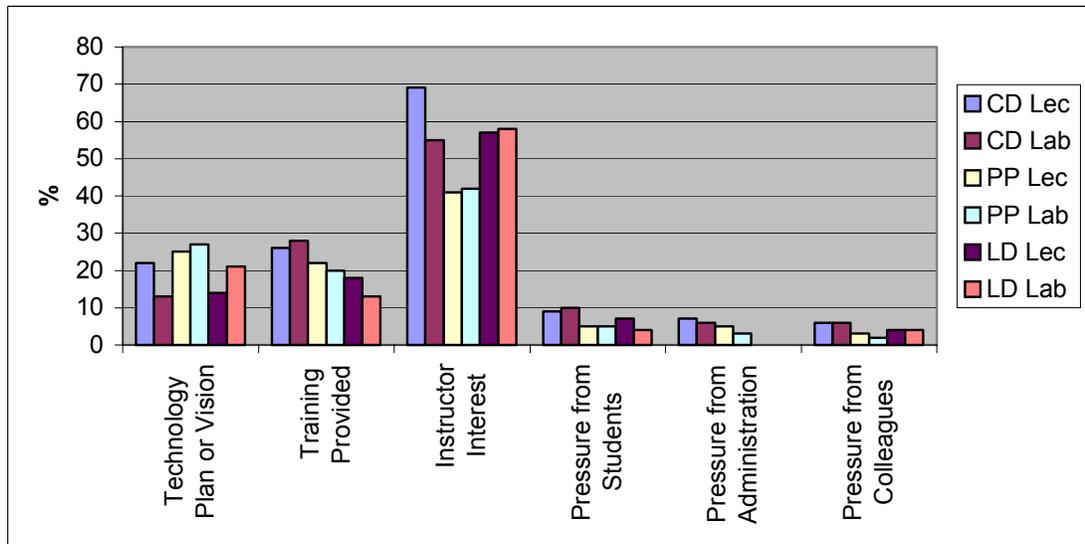


Figure 4.9 Factors that encourage use of multimedia

CD-ROM: Over two thirds (69%) of those who responded to the Technology Survey cited instructor interest as the major factor in their use of CDs in the classroom. In the laboratory, instructor interest was also the number one factor with over one half signifying this. Approximately one fourth of the instructors indicated that they were encouraged to use CDs in both the laboratory and the classroom because their college had a technology plan in place and that training was provided.

PowerPoint: Instructor interest (about 40%) was again the primary factor for using PowerPoint in the classroom and in the laboratory. Having a college technology plan in place and having the college provide training in the use of PowerPoint was also an important factor with 25% reporting this.

Laser Videodisc: Yet again, instructor interest (57%) was the key factor for using Videodiscs. About 20% of the instructors said that they were encouraged to use Videodiscs because there was a technology plan in place and training was provided. Pressure from students, administrators or colleagues was not a significant factor (only about 9%) in determining whether or not instructors used the multimedia surveyed in the classroom or in the laboratory.

Research Question 6: What factors inhibit Florida's Community College biology instructors from using multimedia? Survey Question B4 in Table 4.2 (page 67) was designed to answer this question.

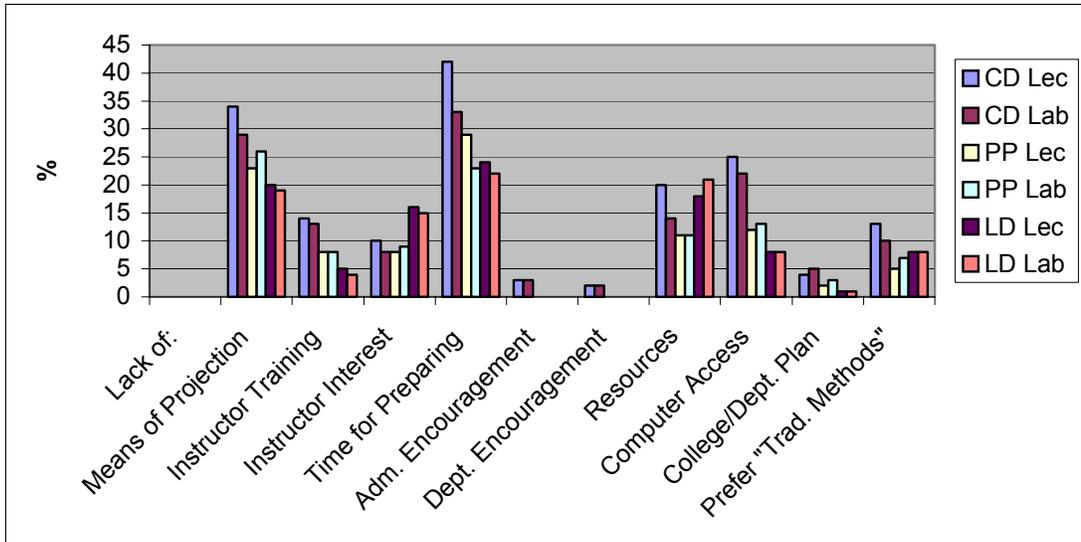


Figure 4.10 Factors that inhibit use of multimedia

CD-ROM: The leading factor that inhibits instructors from using CDs either in the classroom (42%) or in the laboratory (33%) is the time that it takes instructors to integrate them into their presentations. Ranking high on factors that inhibit CD use either in the laboratory or in the classroom is the means to project them, with about one third indicating this. Close behind was the lack of resources (about 20%); lack of computer access (about 25%); and the lack of instructor training (14%).

PowerPoint: Over one fourth (29%) cited the lack of time for preparing presentations as the number one reason for not using PowerPoint in the classroom or in the laboratory (26%). The means to project PowerPoint presentations ranked high as an obstacle both in the laboratory (26%) and in the classroom (23%). Again, the lack of resources (11%), lack of computer access (about 12%), and the lack of instructor training (8%) also provided stumbling blocks for instructors that wanted to add PowerPoint to their delivery.

Laser Videodisc: The primary factors that hindered the use of Videodiscs in the classroom and in the laboratory were the same as those of other multimedia. The lack

of time for preparation (24%), the lack of a means to project the images (20%), and the lack of resources such as a Videodisc player (18%) topped the list of inhibiting factors. Very few instructors (less than 5%) believed that they lacked encouragement from either their administration or from their department to add multimedia to their presentations.

Many instructors said that they did not use any form of multimedia during their classroom or laboratory presentations. The Survey points out several factors that may have contributed to this. The time that it takes to prepare the material using multimedia was the number one inhibitor. Lack of instructor training and the lack of a means, such as a Proxima projector, to project the material were also detrimental to instructors using multimedia.

Instructor interest was the driving force behind those choosing to use multimedia and most of them did so to enhance their lectures and laboratory activities. The fact that instructor training was provided and that there was a technology plan in place were also contributing factors that encouraged teachers to use multimedia.

The administration or the biology department did not discourage instructors from using technology but at the same time they did not provide the resources needed to implement multimedia. In order to use these resources, there has to be a means of projecting the imagery. A computer, screen, Videodisc player and/or a proxima need to be readily available in order to effectively use multimedia.

4.2.4 WebCT

Research Question 7: To what extent are Florida's Community College biology instructors using WebCT? Survey Questions C1 and C2 in Table 4.3 (page 73) were designed to answer this question.

Table 4.3

Use of WebCT				
C1. To what extent do you use WebCT?				
Total Responses			92	%
Never			64	70%
Seldom			6	7%
Sometimes			5	5%
Often			4	4%
Very Often			13	14%
C2. How do you use WebCT? (Check all that apply)				
Total Responses			59	%
Online Courses			16	27%
To Enhance Regular Courses via Online Testing			12	20%
To Enhance Regular Courses via Chat Room			4	7%
To Enhance Regular Courses via Message Board			7	12%
To Enhance Regular Courses via Grade Tool			6	10%
Assignments for Students			14	24%
Other: Post photos, calender, lecture notes, class email list; Information for students; Not available				
C3. Factors that encourage your use of WebCT. (Check all that apply)				
Total Responses			66	%
Teach Online Course			15	23%
Technology Plan or Vision			12	18%
Training Provided			11	17%
Instructor Interest			21	32%
Pressure from Students			0	0%
Pressure from Administration			7	11%
Pressure from Colleagues/Department			0	0%
Other:				
C4. Factors that inhibit your use of WebCT. (Check all that apply)				
Total Responses			138	%
Lack of:				
Instructor Training			32	23%
Instructor Interest			16	12%
Time for Preparing			49	36%
Administrative Encouragement			4	3%
Department Encouragement			0	0%
Resources			13	9%
Computer Access			9	7%
College/Department Plan			4	3%
Believe Only Useful for Online Courses			11	8%
Other: Means of projection, 12; Time consuming, 2; Use blackboard, 2;				
Lack of knowledge; No security for tests/quizzes; No time to train				

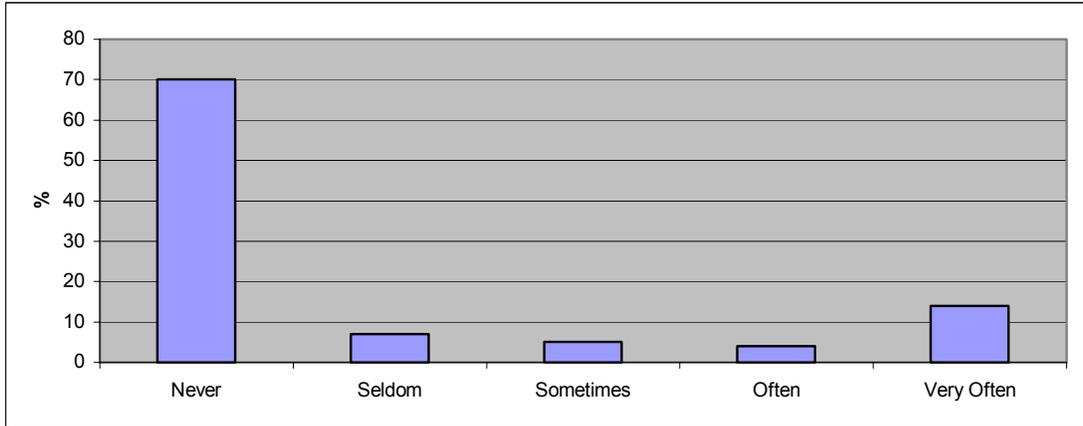


Figure 4.11 Use of WebCT

Almost three fourths (70%) of the respondents reported that they had never used WebCT while only 14% reported using it very often. A small percentage, seven, five, and four, respectively indicated that they had either seldom, sometimes or often, used WebCT.

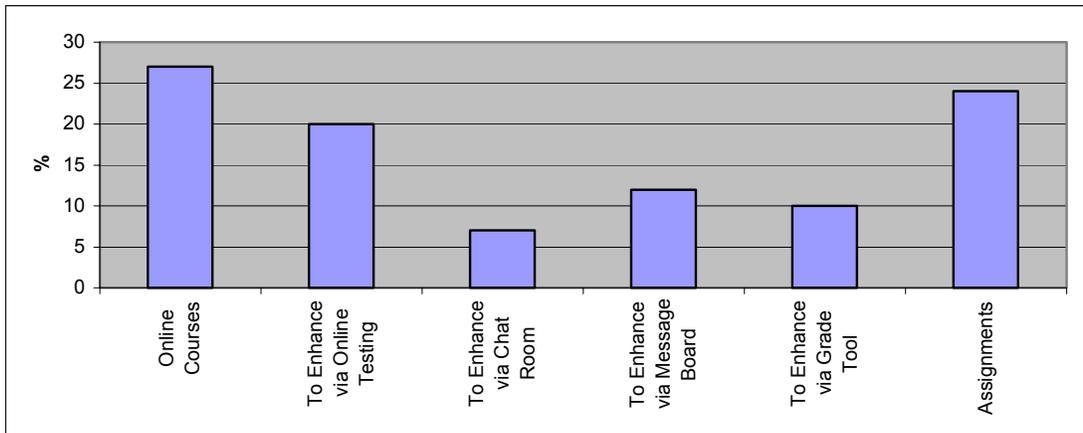


Figure 4.12 How WebCT is used

Of the instructors that utilize WebCT, 27% said that they used it for online courses. Twenty-four percent said that they used it as assignments for students. Many instructors that responded to the Survey made the most of WebCT as a supplement to enhance their regular courses. Twenty percent used WebCT for online testing; 12% use it for a message board; ten percent as a grade tool, while seven percent use it as a chat room.

Research Question 8: What factors encourage Florida's Community College biology instructors to use WebCT? Survey Question C3 in Table 4.3 (page 73) was designed to answer this question.

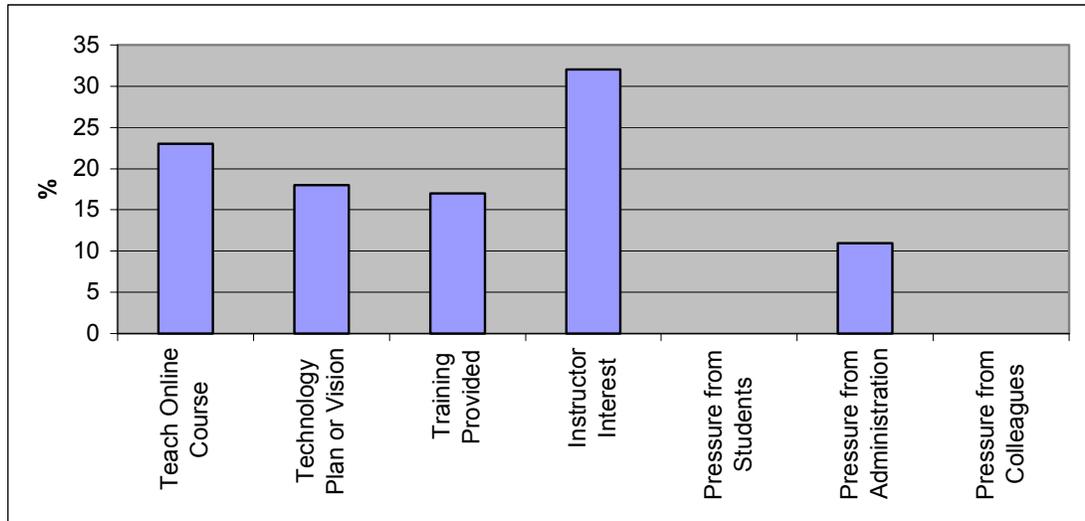


Figure 4.13 Factors that encourage use of WebCT

Not surprisingly, as shown in Figure 4.13, the primary factor cited by the respondents for using WebCT was that of instructor interest (32%). Teaching online courses ranked second with 23%, while 18% stated that what encouraged them to use WebCT was that the college had a technology plan in place. Seventeen percent said they were encouraged to use WebCT because training was provided. Eleven percent felt pressured from the administration, but no one that responded to the Survey felt pressured from the students or their department.

Research Question 9: What factors inhibit Florida's Community College biology instructors from using WebCT? Survey Question C4 in Table 4.3 (page 73) was designed to answer this question.

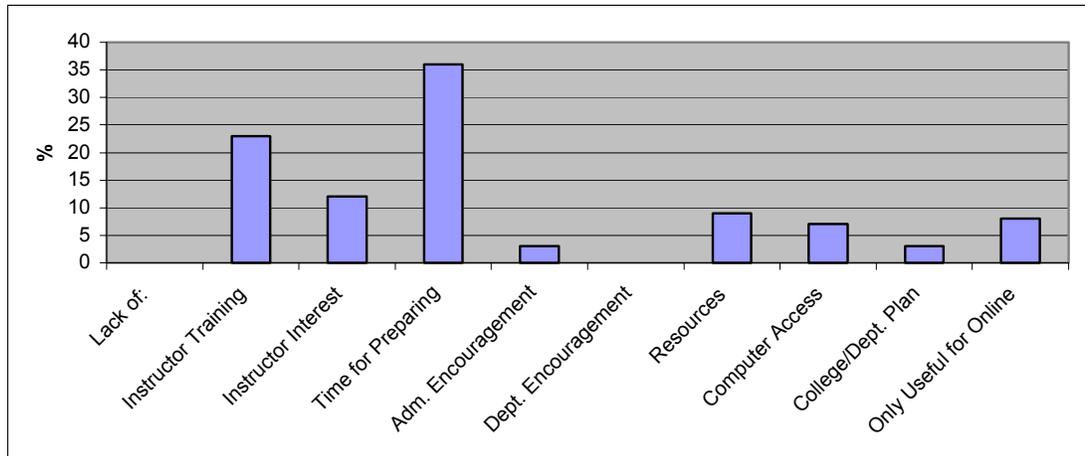


Figure 4.14 Factors that inhibit use of WebCT

Figure 4.14 depicts the percentages of factors inhibiting the use of WebCT. The time that it takes to prepare a WebCT supplement is the foremost factor that inhibits instructors (36%) from using it. Twenty-three percent said that the lack of instructor training was also a strong inhibitor in making use of WebCT. The lack of instructor interest (12%) was further down the list as an inhibiting factor. Nine percent cited the lack of resources, seven percent cited the lack of computer access, while three percent cited the lack of administration encouragement as factors that inhibit their use of WebCT. Eight percent believed that WebCT was only useful for online courses while three percent believed the college lacked a plan for developing its use. However, no one felt that their department discouraged them from using it.

As was mentioned in Chapter 2, WebCT grew out of distance learning. But as more instructors are introduced to it through professional development workshops many are beginning to see possibilities for its use if integrated into their on-campus courses.

Almost 15% of those instructors responding to the Survey said that they very often used WebCT. However, since the number one response for how did you used WebCT was for online courses it seems that the majority of those that do use it are teaching distance learning classes at least as part of their teaching load. About one fourth of the teachers use WebCT to enhance their classes by testing online and as assignments for students.

Of the 92 instructors that replied to the Survey, 64 (70%) have never used WebCT. The principle deterrent for using WebCT, as for other forms of multimedia, is the amount of time that it takes to prepare lessons. And since less than 12% listed the lack of instructor interest as a major factor for not using WebCT, it would appear that if instructors were given the time for preparation, many would add WebCT to their teaching tools.

4.2.5 Communication

Research Question 10: How do Florida's Community College biology instructors communicate with students outside the classroom? Survey Question D1 in Table 4.4 was designed to answer this question.

Table 4.4

General Data			
D1. How Do You Communicate With Your Students Outside The Classroom?			
Total Responses		112	%
Email		88	79%
Chat Room		8	7%
Message Board		16	14%
Web - Cam		0	0%
Other: Telephone, 9; Office hours, 2; Voice mail; Threaded discussion			
D2. What Method Does Your College Use to Connect to The Internet? (Check all that apply)			
Total Responses		92	%
Commercial Service (AOL, Prodigy, etc.)		7	8%
Independent Service Provider		10	11%
School Network		75	82%
Other: FIRM, 2; Don't know			
D3. Who Develops Current Policies? (Check all that apply)			
Total Responses		183	%
Administration		64	35%
Technology Expert		33	18%
Technology Committee		53	29%
Faculty		33	18%
Other: Don't know, 6; Joint effort from all interested; Special committee picked by administration			
D4. Who is Involved in The Long Range Planning of The Use of Technology. (Check all that apply)			
Total Responses		239	%
Administration		84	35%
Technology Expert		49	21%
Technology Committee		60	25%
Faculty		46	19%
Other: Don't know, 4; Computer staff; Special committee picked by administration			

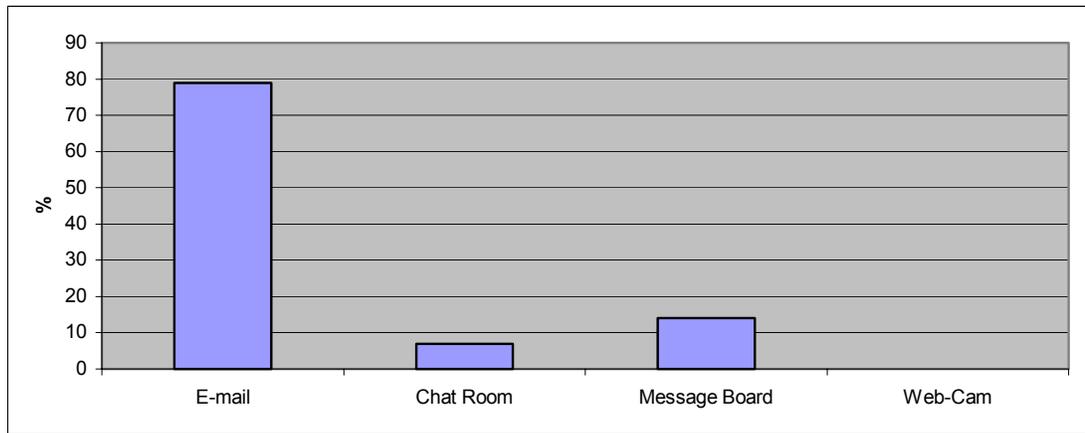


Figure 4.15 Methods of communicating with students outside the classroom

Figure 4.15 shows that by far the leading method that instructors used to communicate with their students was by electronic mail with almost 80% using this technology. Fourteen percent used the message board while seven percent used the chat room as means of corresponding with students. None of the respondents used web-cam as a way of communicating with their students.

4.2.6 Management

Research Question 11: Who manages the use, policies and long-range planning of technology for your community college? Survey Questions D2, D3, and D4 in Table 4.4 (page 77) were designed to answer this question.

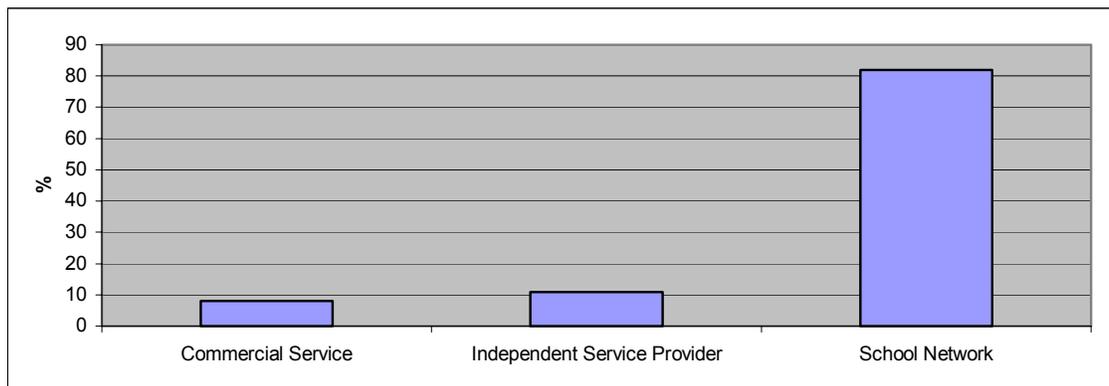


Figure 4.16 How colleges connect to the Internet

Over three fourths (82%) of the respondents stated that their community college had their own network or server to connect to the Internet as indicated in Figure 4.16. Eleven percent believed that their college connects to the Internet by way of an independent service provider while eight percent assumed that their college uses a commercial service such as America Online.

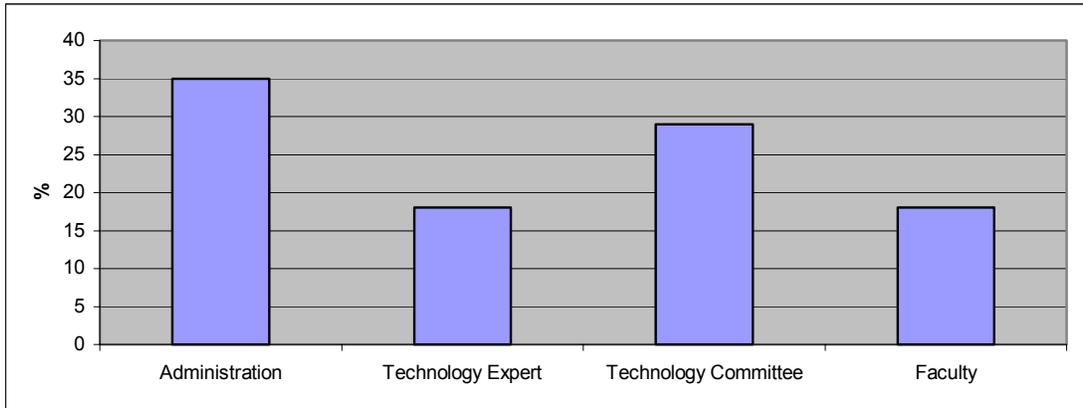


Figure 4.17 Development of policies

According to 35% of the respondents, Figure 4.17 shows that the administration develops the current technology policies at their college. Twenty- nine percent said that a technology committee develops their policies, while 18% believed a technology expert either within the college or hired outside of the college develops the policies. Only 18% said that faculty had some input in technology policy making.

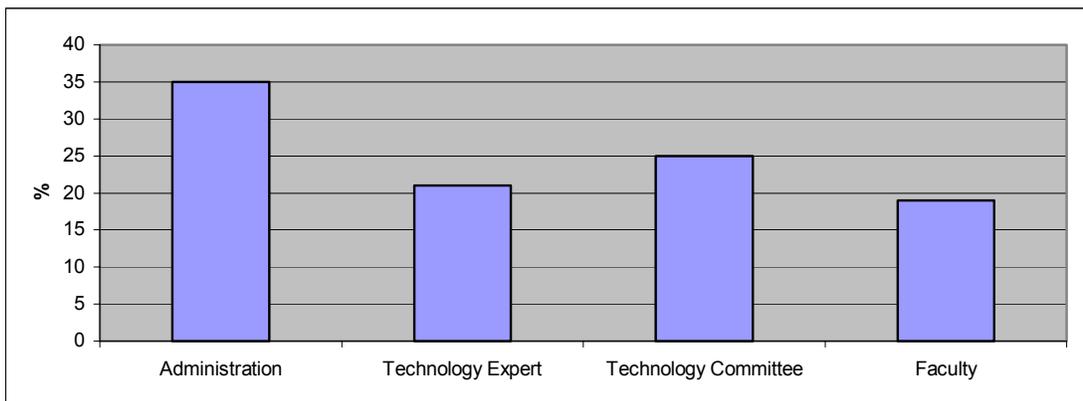


Figure 4.18 Involved in long-range planning for use of technology

Again, according to 35% of the respondents, the administration is the key group responsible for the long-range planning for the use of technology. Also shown in

Figure 4.18 is that 25% said that a technology committee is also involved in the planning. Twenty-one percent believed that a technology expert is consulted in the long-range planning while only 19% said that faculty had some input.

According to the Survey the administration was the primary group responsible for developing the current policies as well as developing the long-range plans for technology at their institutions. About one fourth of the instructors reported that their school had a technology committee and /or a technology expert that was also involved in developing technology policies. However, less than 20% of the instructors said that faculty were part of the decision planning.

4.3 Chapter Summary

When looking at the overall picture of the results of the Educational Technology Survey, it was fairly easy to pick out major factors that both encouraged and inhibited the use of the Internet and multimedia in the teaching of biology in Florida's Community Colleges. It was apparent from this research that instructors have to be interested in the technology that they want to implement. It was also apparent that teachers have to be given enough time in order to put this technology to use. Maybe if teachers were given the necessary time, good reliable resources, and enough computers and a means of projecting the imagery, others might be more encouraged to add technology to their presentations.

Technology committees are powerful tools and as proposed by literature sources discussed in Chapter 2 should be composed of administrators, faculty, technology experts, and business leaders with expertise in the areas of technology. This Survey points out that in Florida's Community Colleges, most technology decisions are made by administrators without the input of others, particular those that are expected to use the technology.

Chapter 5 discusses the key factors that encourage and inhibit the use of the Internet and multimedia in teaching biology in Florida's Community Colleges and suggests some recommendations for administrators as well as faculty members regarding ways of implementing technology that can be beneficial to everyone, especially to students.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

5.1 Overview

This chapter draws together the many threads that have emerged in previous chapters and provides answers to the research questions that have been at the heart of this enquiry. The primary purpose of this study was to identify factors that inhibit and factors that encourage the use of the Internet, multimedia and WebCT by biology instructors in community colleges in the State of Florida. In addition, the study attempted to provide a profile of instructors' reasons for using multimedia and the Internet, and those not using either, as well as a profile of the personnel most likely to make technology decisions for their schools.

This research involved a written survey that was designed to collect information from a large number of instructors, thus providing an adequate sample from which to draw conclusions. As is often the case, however, information collected in a survey suggests that additional information might have been helpful. For example, it might have been helpful to ask what percent of the college's budget was allocated to technology, or what resources the colleges using the Internet and multimedia would recommend to other institutions when designing their educational technology plans. Nevertheless, this research provides a great deal of information that will prove helpful to those interested in the subject. The responses also give those community college instructors interested in implementing multimedia and the Internet into the biology classroom and laboratory sound reasoning with which to approach their administrators.

The literature cited in Chapter 2 suggests that planning, time, training, resources, computer access, and instructor interest are important elements in the implementation of technology, and the results of this study supports these suggestions.

5.2 Discussion

5.2.1 Factors That Encourage the Use of the Internet, Multimedia, and WebCT

As revealed in Chapter 4 Table 4.1, page 63, and Table 4.2, page 67, several factors were identified as those that encourage the use of the Internet, multimedia, and WebCT for biology instructors in Florida's Community Colleges. For simplicity, WebCT is included in the general topic of multimedia. These factors are discussed in the following sections.

(1) Instructor interest. This research revealed that the most significant factor that encouraged use of the Internet and multimedia was that of instructor interest. There is no question that excitement over any new learning opportunity is vital to its success. Many instructors believed that the multimedia format adds value to standard work, giving it new applications for the classroom and laboratory. Green and Gilbert (1995), referred to the A.D.A.M. anatomy software that offers advantages unique to the multimedia format. Increasingly, too, the catalogues of academic publishers and distributors, such as Harper Collins and Films for the Humanities, are advertising CD-ROM products that include multimedia specific for a particular concept. Along with that enthusiasm, however, must come a vision and a plan for utilization of the innovation.

(2) Planning. Planning is a common first step in school-based technology implementation. As no two schools are exactly alike, no two planning processes are identical. This study supports the idea that planning for Internet, multimedia, and WebCT use is necessary for success. Educators are ultimately concerned with what is best for their students, but they are interested in careful, studied, planned change. They want change that will enhance learning.

(3) Training. An interesting analysis from this research is in the area of training or lack thereof. Training ranks high among factors that both encourage and inhibit technology integration. Instructors that use the Internet and multimedia said that they are provided with training and technical support while those that do not use

much of either reported that they are not provided with the necessary training or support.

5.2.2 Factors That Inhibit the Use of the Internet, Multimedia, and WebCT

This study shows that numerous factors have been instrumental in inhibiting the adoption of Internet, multimedia, and WebCT use by biology instructors in Florida's Community Colleges. Each of these factors is disclosed in Chapter 4 Table 4.1 on page 63, and Table 4.2 on page 67, and discussed in the following sections.

(1) Time. The time factor surrounding the implementation process was said to be the primary barrier by almost 40% of the instructors responding to the survey. Stallard (1998) stated that teachers are reluctant to embrace technology because of its potential to shorten learning time for students. Stallard contends that teachers face a number of potential interruptions during the typical hour-long class and that, consequently, the actual time spent teaching and learning is shortened significantly. Hence, if the implementation of computer technology involves a "potential interruption" to teaching and learning, teachers may avoid using the technology. "Since time is short to begin with, many teachers are reluctant to "fiddle" with any type of instructional technology if it is going to reduce learning time" (p. 2).

Time is an issue that underlies every theme identified in this research and occurs again in the following discussions. Time is a limited resource for teachers. To use the Internet effectively in the classroom, a teacher must learn how to use Internet software, find appropriate websites, and find or create lesson plans to integrate this information into the curriculum.

(2) Lack of training. The professional development of teachers has often been an afterthought in American schools. When budgets get tight, career development is often one of the first things to go. But if teachers are to become comfortable with the technologies that will reshape schools, they must receive both preservice training during their college years and in-service during their careers. Teachers need workshops, paid weekend and summer institutes and time off from their classes to learn how technology is being used elsewhere. They also need to be able to observe

their colleagues' classrooms and talk with them so that they can unlearn old practices and build new ones.

Professional development and training are critical to successful implementation of any complex technologies, including those being introduced into the classroom. Furthermore, few teachers receive any background in technology during their formal teacher preparation years. So these skills need to be upgraded through professional development experiences often conducted as part of the job. Unfortunately, as the data that was reported in Chapter 2 suggest, teacher technology is still all-too-frequently ignored or under-funded when schools focus solely on equipment procurement. For technology to succeed, as much time and money must be invested in teachers as is invested in the actual hardware and software.

(3) Resources. Finding the resources to finance, maintain, and upgrade equipment, and to provide teacher training and technical support is universally one of the biggest hurdles that schools face when it comes to technology implementation. For many, the funds are simply unavailable via the conventional means of local tax-based school financing. There appears to be a policy disconnect between those who fund technology and establish rules and regulations for its use, and those who actually work in the classrooms.

If schools had enough money, they could: afford all the newest computers and software; pay for extensive teacher training programs; allow lower teaching workloads to compensate for greater preparation time; and hire more computer support personnel to make sure everything works. But in reality, colleges do not have enough money and need to find cost-effective ways to overcome budgetary challenges.

During the last few decades, while business was forging ahead with development and utilization of technology, school education was constrained by limited funds. The purchase of a mainframe and terminals, or a multimedia computer, costing hundreds of thousands of dollars was simply not as cost-effective for small colleges as it was to hire several new teachers.

(4) Planning. Research (Dickerson & Gentry, 1983; Killian, 1995) supported the notion that institutional change is very slow in coming, and this study supports that research. The whole process of networking community colleges and providing access for all students and staff is a substantial commitment in terms of money and time. Many issues must be addressed when planning for this tremendous change in the way students gain access to information, share their knowledge, and communicate with other learners around the world. It is not a change that anyone at any level in education is willing to take lightly. One respondent to the survey, cautioned about underestimating the amount of time needed for change: “There is not enough time for planning. We have no real roadblocks, but every phase takes time; it all moves slower than you want and that is very frustrating. But the waiting is necessary if you want it all to work.”

(5) Computer Access. Teachers need to have reliable access and a personal comfort level with the machine before they will start planning content lessons that utilize technology resources. Understandably, many instructors feel defeated before they even begin if they know that the needed hardware and software will not be readily available. If faculty ventures into the realm of the Internet and multimedia without adequate facilities and support, the apprehension that they initially feel may harden into disillusionment.

In the case of multimedia, the teacher frequently may use the instructional tool without direct mediation. Emphasis needs to be placed on coherence and production values, which are best assured through collaborative effort and skilled use of technology. In multimedia, as in anything else, “there is nothing more useless than a product that alienates, or worse, annoys its audience” (Hunt, 1995, p. 19).

(6) Traditional Methods. Some faculty members believe that adopting multimedia can be construed as counter to their own interests in the long run. For example, the application of multimedia to distance education has been welcome by educational administrators as a means of making resources more widely available without escalating costs. According to DeSieno (1995), there is a fear that “reducing costs with the aid of digital technology translates into reducing the number of faculty and increasing student ratios.” While it may seem unlikely that faculty could be replaced

by technology, the perceptions of both faculty and administration are crucial in this matter.

Even if faculty can be assured that multimedia does not threaten them with obsolescence, there remains another line of resistance. DeSieno (1995) further suggested that multimedia technology “delivers only what the marketplace provides, and too often those provisions do not meet the local curricular need of the faculty and students.” Teachers need to be imaginative as they implement the technology into their lessons.

Another criticism of the use of the Net in schools is that it will distract from or replace the teaching of basic skills such as literacy and mathematics. Some warn that in the rush to wire up classrooms, colleges may divert money away from other, perhaps more valuable purposes, such as supplies for laboratory activities. Still others caution that with long lag times, shutdowns, or freeze-ups of systems that sometimes disrupt lesson plans, the educational value of the Internet just hasn't been proven yet.

5.2.3 How Instructors Communicate With Their Students Outside the Classroom

Since this Educational Technology Survey was conducted via the Internet, it is not surprising that 79% of the respondents said that they use email to communicate with their students outside of the classroom. Table 4.4 on page 75 shows that the use of the message board is also a popular method of corresponding with students.

5.2.4 Who Manages Technology at Florida's Community Colleges

Both previous research (Charp, 1995; Killian, 1995) and this study suggest that those who are making technology decisions in their colleges should consider the issues of scheduling and time relating to the access and use of the Internet. A plan should be in place for those wanting access to the equipment, where they use it, and when they have access. This will often be determined by how many workstations are available to the student, who is managing the use of the equipment, and the department and college policies regarding these issues.

This study (see Table 4.4, page 75) shows that 35% of the respondents reported that their administration was most responsible for technology issues in their college, which suggests that technology concerns should certainly be a part of the problem-solving discussion in an administrative course of study.

Despite college or departmental mandates and rewritten curricula, if instructors do not feel confident and enthused about a new delivery or learning strategy, they will close their doors and proceed with what is comfortable. Those in a position to try to effect change must understand the need for solid training and experience for all staff members.

5.3 Recommendations

Because the technological profile of community colleges is changing so rapidly, and because so many variables influence that change, one must constantly be able to adapt to these new changes. The following recommendations are presented for those who are interested in implementing the Internet, multimedia or WebCT into their classroom and/or laboratory activities. In addition to the formal written survey results, the recommendations presented are also derived from the literature reviewed in Chapter 2.

5.3.1 For College Administration

Recommendations for college administrators are presented for the purpose of providing information useful in long-range planning for Internet use. It is extremely important that community colleges begin with a long-range plan for implementation and use of the Internet. Previous research (Hord, et al., 1987) recommended this visioning, and this study shows that the colleges that are using the Internet, almost all have a plan in place.

(1) Planning. Not only must a plan be in place, but this research also recommends gathering input from a variety of sources. Too often, change facilitators become involved in the technology of the innovation and neglect to attend to the people who are involved. The variable most frequently chosen as one that promotes Internet use

was that of instructor interest. It would seem to follow, then, that if college administrators involve faculty in the long-range planning process, the college would have that resource of encouragement working in each department.

(2) Training. Training is as important as technology. Budget for it accordingly. One-shot training sessions may raise awareness and motivate excitement, but longer, more comprehensive training strategies, including coaching and modeling, are critical to success. The most advanced technology in the world is useless, if teachers aren't comfortable with it or cannot automatically and easily incorporate it into their lesson plans.

(3) Effectiveness. The effective use of technologies in the classroom and laboratory will occur more rapidly if those responsible for training teachers carefully convey that the purpose of technology is not an end to itself. Rather, the teacher's goal, just as it has been with older technologies—like slide-rules or books or chalk—is to use the technology as a tool. Administrators need to create environments where technology can be used for learning, as well as for teaching, and where both learners and teachers have sufficient access to computers and telecommunications to do their work.

5.3.2 For Faculty

(1) Enhancement. As a starting point, faculty ought to understand the ways in which multimedia technology may enhance, if not revolutionize, their instructional practice. "Literally, multimedia is the integration of two or more communications media. It is the use of text and sounds, plus still and moving pictures to convey ideas...it is built around the premise that anything words can do, words with sounds and pictures can do better" (Kalmbach, 1994, p. 29). For higher education, these features, in reference works or interactive courseware, can supplement course content and activities in innovative ways (for example, see Liou, 1994, p. 66).

(2) Changes. Integration of technologies into curriculum requires changes of huge magnitude. Those changes must occur in educational philosophy, classroom management, and curricular goals. For technologies to be used optimally, instructors

ought to be comfortable with a constructivist or project-based, problem-solving approach to learning. They should trust students to know more than they do about certain subjects and techniques—and to take on the role of expert teacher at times. Teachers need to be at ease about not having complete control over what resources their students access or what they learn, and they must be flexible enough to change directions when technical glitches occur. Successful Strategies for the integration of technology into the classroom must openly acknowledge that change will occur in fits and starts; that different instructors will move along different paths at different speeds; and that variations are perfectly normal.

As the literature review in Chapter 2 and this study suggest, administrators need to have a long-range plan in place, provide adequate funding, and offer ample training to their faculty, if faculty are to be encouraged to implement technology into their classroom activities. Faculty need to recognize the many forms, uses, and benefits that technology has to offer and be ready to accept and put into practice changes in their teaching methodology.

5.4 Suggestions for Future Research

The implementation of Internet and multimedia use for all community colleges in the State of Florida is a huge undertaking. Not only is the issue of hardware a costly one, but the matter of training our instructors is monumental. In addition to the issue of costs, planning and management issues are complex. The most important issue relating to technology, however, is the issue of technology's relationship to learning. How do we know if technology enhances learning? This study suggests the following areas for further research:

(1) Evaluation. Evaluation is often the weakest element of technology programs and many schools lack strategies or tools for determining whether the efforts have had any impact (Byrom & Bingham, 2001). Research suggests that teachers must see an increase in learning before they are “sold” on any new innovation in education. A study is warranted, therefore, which investigates assessment tools that have been developed for measuring the effectiveness of technology as it relates to learning in

science courses. It is important for community colleges to know which assessment tools provide the most reliable information.

During July, 1999 at the U.S. Secretary's *Conference on Educational Technology: Evaluating the Effectiveness of Technology*, the participants raised issues about the shift in schools' focus on technology. Where once the emphasis was on building and implementing a technology infrastructure, today it is on evaluating the effectiveness of its use in schools and classrooms. Parents and teachers, school boards and administrators, governors and state legislatures, and Congress all want to know if the nation's investment in technology is providing a return in student achievement. If resources are to be expended on technology, it is becoming a political, economic, and public policy necessity to demonstrate its effectiveness.

(2) Funding. This study points out that for a number of colleges, a lack of resources has been a prevailing inhibitor to both multimedia and Internet use. A study identifying available funding sources for technology, and identifying which schools do not have access to those funds is necessary in determining a direction for state spending for technology in education.

(3) Student Assessment. Based on a survey of student assessment information at Wright University, Sammons (1995) found that "students overwhelmingly supported continued use of the computer in the classroom" (p. 69). This does not at all mean, however, that students will dispense entirely with faculty in the future, for it is already evident that some students go online with little desire or incentive to study systematically. The literature review in Chapter 2 also points out that students value multimedia presentations (King, 1998). Therefore a study evaluating educational technology used in biology courses would be of merit.

(4) Additional Institutions. It is further suggested that this research be expanded to include biologists who teach in community colleges in states other than Florida and to compare results with those of this study. This would broaden the study and add validity and reliability data to the research.

(5) Outsourcing. The matter of outsourcing is a current one in business information technology [IT] management, and colleges are exploring possibilities in this area as well. It would be very useful if there were some research that could identify and quantify the benefits, costs and viability of outsourcing as a means of assisting the management of IT in schools. This could range from leasing equipment along with suitable and support agreements to even effectively contracting support services. Apart from other considerations, such an approach might serve to reduce the need for colleges to supply and service their own computer hardware.

(6) Ethical Issues. The issue of ethics may be a matter worthy of further investigation. Not only do schools now routinely store vast amounts of data on both students and staff, but with the increasingly prevalent use of high speed Internet access and telecommunications there are much greater opportunities for sensitive or unacceptable material to be accessed. There would seem to be many issues associated with matters such as levels of access to files stored on institutional resources, monitoring of Internet traffic and email messages, use of resources for antisocial or morally unacceptable purposes, and the allocation of, and access to, information technology resources.

5.5 Limitations of the Study

The author would like to note that there are a several limitations to this study. First of all, the Educational Technology Survey developed for this research does not have reliability and validity statistics. From a statistical perspective, this presents a problem in inferring the results of this study are reliable and valid. Therefore, continued replication of this study will begin to provide enough data for reliability and validity.

The second limitation relates to the fact that only Florida Community College biologists with Internet access were included in this study.

That is where the awkwardness of an electronic survey arises. Investigators generally cannot determine, nor even guess the size of population they are interested in; cannot guess the number of subscribers sitting at keyboards exploring the Internet. The

awkwardness is also compounded by lack of representativeness; e-survey investigators are restricting their studies not just to those with computer equipment but also to those of them who have connected their equipment to the outside world. (Hill, 1998).

In this particular study, the fact that the respondents were using the Internet in order to complete the Educational Technology Survey, is assumed to be indicative of the fact that they were indeed using technology in some way.

The study of the diffusion of any innovation is a complex venture. In looking at the use of the Internet and multimedia in Florida Community Colleges, it would almost be impossible to conduct an extensive descriptive of each college and instructor. The purpose of this study was to provide an overview of existing Internet and multimedia use with a glimpse at some of the implications of that use.

5.6 Conclusions

Most of today's community college faculty attended school when educational technology meant a blackboard, chalk, paper and pencil, and maybe a film projector. Today's schools employ a wide array of technology tools, including television, video cameras, graphing calculators, and computers and their peripherals—digital cameras, scanners, probeware, and more.

To achieve the most productive use of this technology, faculty needs support in learning how to integrate technology use into their pedagogical practice and their curricular materials. Without such support, educational technology is likely to be only an expensive and little-used add-on, relegated to the periphery of teaching and learning in schools. But, as more faculty and students gain access to these tools, educators' concerns shift to how to integrate technology into instruction and how to tell whether their efforts are effective in helping students learn. Experience tells us this large task won't happen overnight.

While the teaching-learning process, and the associated professional development needs of teachers, may be at the heart of every college's operation, the full impact of educational technology on colleges is unlikely to have occurred yet. It is necessary

to take on board the lessons that can be learned from past experience, but more than that, groundwork should be done now to help colleges to more effectively cope with the continuing changes that will inevitably face them in the near future.

No one can predict with certainty what the next wave of technological advancements will bring to education. We would do well, however, to consider the potential of the Internet and multimedia as they relate to the design and development of curricula, the preparation of our country's educators, and the mission of our nation's schools. It is important to continue investigating the most successful programs and practices that include multimedia and Internet use as a regular part of the community college curriculum. It is also imperative to develop both qualitative and quantitative methodologies to assess the success of those programs. Never before has it been so important for community colleges, businesses, corporations and government to work together in creating a vision for what our graduates should look like as they leave our institutions.

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