THE UNIVERSITY OF CALGARY

Web-Based Technology to Support Medical Education

by

Dalton James Cote

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ABSTRACT

Education, including medical education is changing dramatically. The Internet has captured the interest and imagination of educators around the globe. Online learning activities are becoming a common component of higher education. Many universities and colleges have already started or intend to explore ways of using the Internet in their curricula. However, the integration of a new innovation like the Internet is often a slow process that does not always succeed for various reasons. This research study used Rogers' (1995) attributes of innovations to develop a model to examine the use of Web-Based computer tools to support undergraduate medical education. The results indicated that medical students readily used and appreciated the usefulness of computer support tools, including the Internet, provided that the tool gave them a relative advantage over their traditional methods of communicating and learning. The study also determined that the beliefs, attitudes and abilities of students affect the way that they approach and use computer support tools. In this study the constructs of computer expertise, anxiety towards computers, attitude about computers, computer awareness, computer confidence, perceived control over computers and liking to use computers all significantly affected the way that medical students approached and used computer support tools, including the Internet. The implication for educational institutions is that student perceptions and concerns should be considered before introducing new technological innovations. This will assist in the proper integration of a new learning technology, such as the Internet, so that its prime user, the student, accepts it.

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DEDICATION

This thesis is dedicated with love and respect to my parents, Jacques and Lillian Cote. I am grateful for the opportunities that they have provided me to further myself throughout my life. In particular, I am indebted to them for the support and encouragement that they have provided towards my education. They worked hard to ensure that their children had all the opportunities that were not available to them during their own youth. I only hope that I can provide my children with the same opportunities.

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CHAPTER 1 - INTRODUCTION

Background

The Faculty of Medicine at the University of Calgary offers a medical degree program that stresses case based learning and self directed study. The emphasis is on providing the students with patient profiles that are the typical observable symptoms of an ill patient. These profiles are then used as vehicles to demonstrate the knowledge and skills that are required to properly diagnose and treat a patient. This approach lends itself to relevant and powerful learning on the part of the student but it poses some logistical problems. Rather than presenting all of the information about a topic such as anatomy at one time, the information is spread out over the entire program. Material is presented when relevant depending on the patient profile and body system being studied at that time. A problem with this approach is that it requires an instructor, versed in the topic, to be available for teaching and consultation throughout the program rather than for just a scheduled course over one semester. This fact compounded with the reduction in the number of instructors available has led the faculty to explore alternative strategies to provide information to the students.

The anatomy department has initiated an instructional strategy that uses web-based technology to assist the students in learning histology. Traditionally, a session on histology for every body system would be a one to two hour lecture on a particular subject followed by a two to three hour lab with instructor supervision. The difficulty with this approach is the lack of funds to support dedicated laboratory technicians and equipment maintenance. Therefore, it became necessary to find an alternative strategy to deliver this instruction to the students. The anatomy department has developed prototype courseware, delivered via web-based technology, to support the learning of histology for University of Calgary medical students. The proposed plan is that the histology courseware will remove the need for a dedicated microscope lab and staff to supervise its use. The department is moving forward with this initiative and felt it necessary to evaluate the acceptance and use of this new instructional delivery system to ensure that the courseware is as beneficial as possible for the students.

Rationale for this Study

Education, including medical education is changing dramatically. The Internet has captured the imagination and interest of educators around the globe. It is causing learning institutions from K-12 to graduate school to re-examine the way they deliver teaching, learning and schooling (Owsten, 1997). Online learning activities are becoming a common component of higher education with activities that include the use of electronic mail (e-mail), bulletin boards, computer mediated conferencing, audiographics, video teleconferencing, remote databases and the World Wide Web (WWW) (Kearsley, Lynch, & Wizer, 1995).

The Internet, with its increasing capacity to transmit synchronous and asynchronous audio, video, text, and graphics, presents educators with tremendous opportunities for distance education and independent learning (Hiumi & Bermudez, 1996). Due to the development of the WWW and the subsequent introduction of graphical browsers such as Netscape, the Internet has moved from being a text-only communications system to a "powerful multimedia platform" whose potential applications are still being investigated (Starr & Milheim, 1996). The WWW provides the versatility to provide unlimited access to class materials that would normally be restricted to classroom-only viewing or limited viewing as part of library reserve materials (Schotsberger, 1996).

Many universities and colleges are moving towards distance education, in particular the use of the Internet to deliver courses and in a sense to become "virtual universities". They are doing this not only as a way to reach working adults, but also as a method of reining in the costs associated with expanding and maintaining an increasingly expensive campus infrastructure (Barnard, 1997). "The creation of online or virtual universities is being driven by market forces as well as by technological innovation and tightening government budgets" (Barnard, 1997). The "virtual university" is emerging to challenge the dominant paradigm of higher education by providing universal access to on-line courses and degrees (Owsten, 1997).

Kearsley, Lynch & Wizer (1995), in an examination of studies conducted to determine the effectiveness of online learning, determined that it is clear that it is as effective, if not better in some regards, than traditional instruction. However, they identified a number of major problems with online learning and indicated a number of issues and questions that still required research. These include: which teaching/learning strategies to use for a given subject matter; how individual learning styles interact with different types of online systems; the most effective way to organize and conduct online courses; how online courses should be financed and administered by the university; and how they should be successfully integrated into the curriculum. It is this last issue that was the focus of this research project, specifically the study of how successful was the integration of web-based technology into the undergraduate medical curriculum at the University of Calgary.

A difficulty with integrating technology, such as Internet delivered learning support, as a potential education solution is that not all innovations are readily adopted by the population for which they were designed. Rogers (1995) defines an innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption. He identifies attributes of innovations, as perceived by individuals, to help explain their different rates of adoption. These attributes are relative advantage, compatibility, complexity, trialability, and observability.

A study by Anderson & Joerg (1996) using Roger's attributes of innovations to measure the use of the WWW to support classroom teaching found that the WWW is perceived by students and instructors as a valued education enhancement. There were, however, significant barriers to adoption including access restrictions, questions related to relative advantage of the technology, and problems in the creation and organization of large quantities of WWW pages. Barriers to the use of the Internet fall into three general categories: hardware and software, time and knowledge, and concerns about student access to unsuitable materials (Starr & Milheim, 1996).

King, Henderson and Putt (1997) wrote that "… there has been a proliferation of papers at conferences and in journals addressing various aspects of the utilization of the WWW and e-mail. Major recurring themes focus on programming tools, copyright, censorship, cognitive aspects of teaching and learning, and descriptions of the design and implementation of WWW subjects. There appear to be few studies measuring the affective aspects of student learning using the WWW and e-mail". Evaluations of the effect of introducing computer-based programs into the educational curriculum should include both cognitive and attitudinal data since the success or failure of educational innovations is significantly affected by student's attitudes (Askar, Yavus & Koskal, 1992).

Aim of this Research Study

This research study was designed to measure the rate of adoption of computer support tools, particularly Internet delivered histology courseware, by medical students at the University of Calgary. Roger's attributes of innovations were used as a framework to develop an evaluation model to help identify the benefits and barriers to using Internet based technology from a student's perspective.

Evaluation Model and Questions

An evaluation model based on Rogers' attributes of innovations and their rate of adoption was developed to examine the adoption of computer based support tools by the undergraduate medical students at the University of Calgary (Figure 1).

Questions Addressed by the Model

A detailed survey was developed to use the evaluation model to obtain information about the adoption of computer based support tools by the undergraduate medical students at the University of Calgary. This research study analyzed the following questions in relation to how medical students at the University of Calgary used computer support tools to support their learning activities:

1. How did the students use the Internet delivered histology courseware to support the learning of histology, in particular:
   a) How often did the students use it?
   b) How did they use it? Did they use it exclusively or in combination with other instructional media? Did they use it in groups? From where did they access the material?
   c) What were their opinions and feelings on its usability and perceived effectiveness?
   d) What were the barriers to its use?
2. How did the students use other computer support tools, in particular Internet based technologies such as e-mail and the WWW, to support their medical education? Questions of interest include:
   a) How often did the students use it?
   b) How did they use it?
   c) What were their opinions and feelings on its usability and perceived effectiveness?
   d) What were the barriers to its use?
   e) What were their opinions about the future use and value of computer based technology in the practice of medicine?

3. How did the student's individual characteristics and attitudes affect their opinions and feelings on the usability and perceived effectiveness of computer support tools in medical education? Items of interest included:

   a) Gender.

   b) Computer expertise.

   c) Access to a home computer.

   d) Attitude towards the use of computers. This included measures of computer liking, computer anxiety, computer confidence, computer awareness, and perceived control.

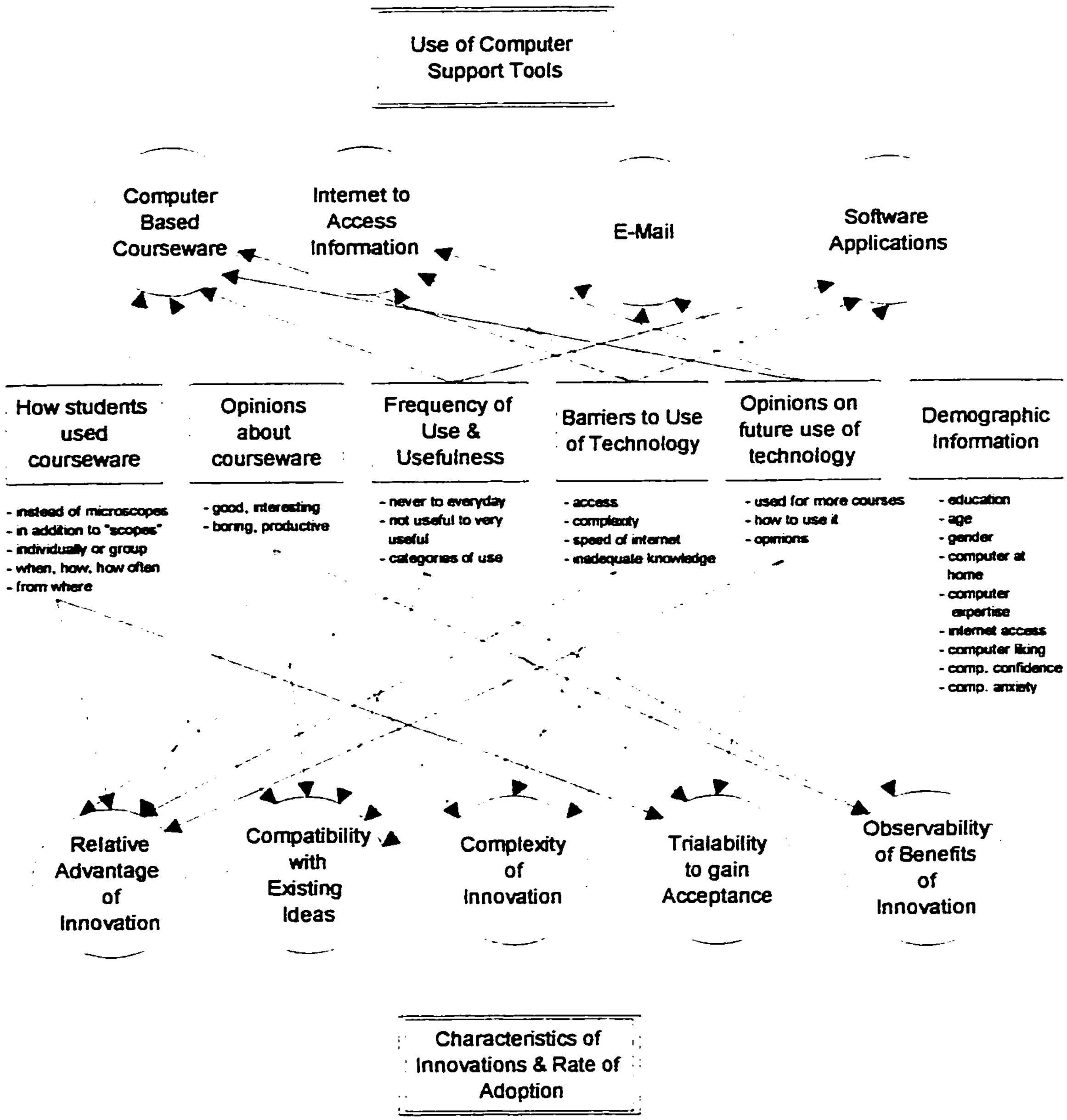

Figure 1. Evaluation model for the rate of adoption of computer support tools.

CHAPTER 2 - LITERATURE REVIEW

Introduction

This chapter will review literature relevant to using computer support tools, particularly web-based technology to support medical education. It will examine the literature relating to the following main questions:

- Why are people excited about using the Internet to assist learning and instruction?
- How can, and how is, the Internet being used to assist learning?
- Why is the use of technology, and inherently the use of the Internet, a critical competence for professionals, particularly medical practitioners?
- How is technology being used in Medicine and medical education?
- What are some of the challenges of new learning technologies?
- How does one successfully integrate a technological innovation?
- What can we learn about successful integration from studies on computer use?
- What are the barriers to using the Internet for education purposes?

The Use of the Internet to Assist Learning - Why all the excitement?

Starr (1997) states that the "development of the Internet has started a revolution in communication that is providing new opportunities for delivering instruction". Owston (1997) states that "the web is now causing educators, from preschool to graduate school, to rethink the very nature of teaching, learning, and schooling". These are strong accolades but what is it about the Internet that makes it any different from previous instructional technologies that were also accompanied by fanfare, such as television and computer-based learning?

> The most significant aspect of the Web for education at all levels is that it dissolves the artificial wall between the classroom and the "real world." ...With the Web... students can find the original materials and collect first-hand information themselves... The second powerful aspect is that it provides an easy mechanism for students (and teachers) to make their work public ... Furthermore, students can examine the work of others..., allowing for global comparisons, collaborations and competition ... A third aspect is that it provides an easy way to create and distribute multimedia materials.... Finally, ... students... can include source material in their work (Kearsley, 1996, p. 28-29).

Hackbarth (1997) identifies five attributes that make using the WWW for education distinctive from other media:

- It provides economic access to people and multi-format information in ways unmatched by any other combination of media.
- Much content on the Web cannot be found in any other format, except the author's originals.
- The Web permits the work of individuals to be shared with the world.
- It is a powerful, flexible resource, in some ways, unlike any others, that the students are likely to encounter and rely on in the workplace.
- Students approach the Web with eager anticipation and awe, knowing that it is the cutting edge of technology used by their most progressive peers and by successful adults.

Starr (1997) identifies three keys to the educational value of the WWW: hypertext, the delivery of multimedia, and true interactivity. Hypertext on the web allows for the simplest form of interaction whereby a user can access information around the world by a simple click of the mouse. Graphical browsers enable the delivery of multimedia via the Web. Audio, video, and animation can be delivered to many users with a one-time cost and with no decline in quality with repeated uses. The WWW can deliver interactivity through information exchange between the user and the server via applications such as Active-x, CGI and shockwave from Macromedia. Other advantages cited by Starr (1997) include the platform independent nature of the WWW so that different models of computers can view the same material, the ability to create lessons containing content from many sites, and the ease with which material can be updated, expanded and distributed to users.

Quinlan (1997) characterizes three primary functions of the Web that make it an attractive curricular resource: *communication* (the ability to communicate with other schools and communities), *information access* (the ability to access and use information), and *resource sharing* (the ability to share and publish information resources for others to access and use). Dyrli & Kinnaman (1996) note that telecommunication systems like the WWW can assist students in achieving the following educational goals:

- developing strong basic skills;
- mastering core content;
- thinking critically and creatively;
- working collaboratively and creatively;
- using appropriate problem-solving strategies;
- functioning as part of a global community; and
- making commitments to lifelong learning.

Lessons from Distance Education Literature

The use of the Internet has brought both excitement and fear to educators who are used to the traditional model of education where the teacher transmits knowledge in a one-way direction to the learner. Their fear stems from a concern that using the Internet could change or alter the modes of communication and interaction in the learning process. It is valuable to examine some of the literature on distance education before an examination of how the Internet is currently being used is undertaken.

The rationale for delivering distance learning is well established as it removes the limitations of the time and space of the traditional classroom. Learners can access information at different times and from different locations. Therefore, for institutions there is the potential for a larger target audience, a necessity for the survival of many current academic programs in the current fiscal environment. Additionally, the feasibility of accessing education is increased for students who otherwise could not afford to move or travel to obtain the required courses.

A legitimate and important concern about the delivery of distance learning is the amount of communication and interaction that is provided so the learner can actively participate in the learning process. Some criticism of distance learning is that it is nothing more than independent learning and therefore does not provide the learner with the opportunity to reflect, challenge and synthesize information and ideas with an instructor and/or other learners.

It is beneficial to examine what the literature on distance learning says about communication and interaction. Farr and Schaeffer (1993) describe the types of communication in distance learning as:

> *One-way communication.* Often typified by the lecture it is effective for transmitting information.
>
> *Two- way communication.* Typified by discussion or small group tasks, is effective for enhancing thinking skills, promoting understanding of concepts and principles, increasing problem-solving skills, promoting positive attitudes and developing values.

Moore (1989) identifies three types of interaction in distance education: learner-content, learner-instructor and learner-learner. He also states " educators need to organize programs to ensure maximum effectiveness of each type of interaction, and ensure that they provide the type of interaction that is most suitable for the various teaching tasks of different subject areas, and for learners at different stages of development"

Bates (1990) outlines a number of contexts of interaction on the part of the learner: interaction with the learning material, interaction with originator of the learning material, interaction with the deliverer of the learning material, and interaction with other learners.

El-Tigi & Branch (1997) write that learning sessions, whether on-site, at a distance, under a tree, delivered electronically, or otherwise, should provide opportunities for the learner to interact with the teacher, control the information he or she processes, and give and receive feedback about the knowledge being constructed.

Schieman, Teare and McLaren (1992) state that there is considerable support in the literature for the view that distance education should involve some type of interaction in which the learners are active participants in the learning process. Garrison and Shale (1990) go so far as to state that a "student must validate this emerging knowledge through collaborative and sustained interaction with a teacher and other students".

The Internet, with its increasing capacity to transmit synchronous and asynchronous audio, video, text and graphics, presents educators with tremendous opportunities for distance education. However, many Internet courses rely heavily on self-instructional text, lacking interactivity among teachers and students. This is consistent with past theories and research in distance education where a new technology simply transmits the traditional correspondence course without necessarily taking advantage of the new delivery medium (Hirumi & Bermudez, 1996). Hirumi & Bermudez (1996) conducted an analysis of a selection of on-line courses and found that "while some programs used e-mail to facilitate management and communication between the instructor and students, relatively few included explicit strategies for fostering communication among learners and experts to form virtual learning communities".

Lessons from Resource Based Learning

Resource-Based learning is strongly related to the Inquiry Training model of instruction, originally developed by Richard Suchman in 1962 (Rakes, 1996). "Suchman believed that students learn best when presented with a problem or question of genuine interest. This type of training also better prepares students to deal with the kind of problems that occur in everyday life and in the work environment". Figure 2 shows the paradigm shifts required when transforming from a traditional to a resource-based learning model.

Resource-based learning, which occurs in the medical program at the University of Calgary, is well served by the effective use of technological innovations that support the examining of a topic and the locating of information necessary to solve problems related to that topic. In resource-based learning, a wide range of resources should be made available for structuring teaching and learning (Rakes, 1996). Learning resources that could be used include print and non-print media, ranging from books and articles to sound and video recordings to electronic databases and other computer-based resources (Rakes, 1996).

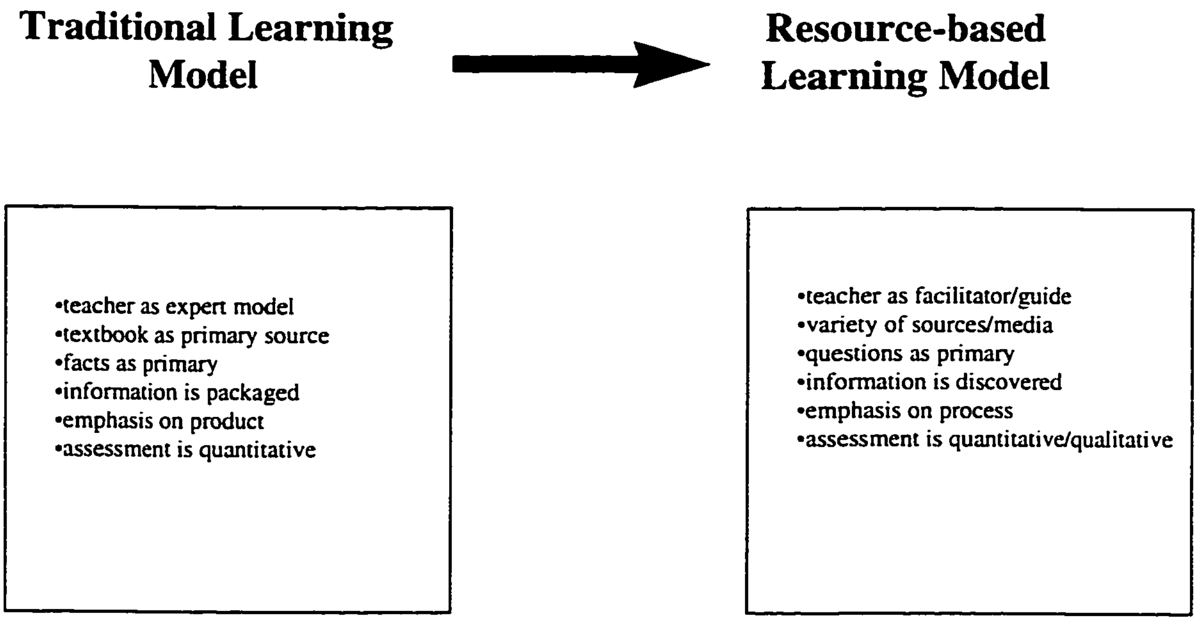

Figure 2. Paradigm shift from traditional learning models to a resource based learning model. From: Using the Internet as a tool in a resource-based learning environment, by G.C. Rakes, 1996 in *Educational Technology, 36(2),* 52-56. Copyright Educational Technology Publications.

Problem-Based Learning

Resource-Based Learning is similar to the problem-based learning (PBL) approach that promotes active learning by presenting relevant, realistic problems to students working in cooperative teams with the facilitation of a tutor. Barrows (1995) as cited in Savery (1996) identifies four key characteristics of the PBL approach as:

1. student centered and the teacher facilitates the student's ability to take control of self-learning through guidance when it is needed;
2. problems should represent those the student is most likely to encounter in the real world after graduation;
3. problem presentation should be in a manner and format that allows the student to use the same cognitive processes as required in the real world;
4. students should be able to access information from a wide range of disciplines in solving the problem so that information will be integrated and organized in ways useful to work in the real world.

The recent trend in medical education has been toward problem-based learning (PBL) and performance based learning (Schwartz, Burgett, Blue, Donnelly & Sloan, 1997). PBL is an attractive alternative to traditional lecture-based instruction because it emphasizes knowledge acquisition and its application in the clinical setting. A University of Kentucky study found that: medical students that used PBL performed as well or better than students who received lecture based instruction on tests of factual knowledge, PBL students performed significantly better on examinations designed to measure clinical application of knowledge, and PBL students developed better clinical reasoning and time-management skills during the course of their PBL instruction (Schwartz, Burgett, Blue, Donnelly & Sloan, 1997).

Lessons Learned and the Internet

Two major events are currently taking place in education at the post-graduate level. Universities are under pressure to start operating as businesses which can cost-effectively deliver learning opportunities to all of their clients and to move their curriculums from lecture centered to more resource based learning strategies (Barnard, 1997). Distance education strategies can allow a college or university to not only reach a larger client base, namely working adults, but help rein in some of the costs of maintaining an increasingly expensive campus infrastructure (Barnard, 1997). The asynchronous nature of Internet based communications opens the avenues for learning institutions to provide courses to students at any time and in any location. The Internet also supports the move to problem-based learning where learners not only gain information in a particular content area but also continue to develop and use skills that allow them to become more information literate. Brevik & Senn (1994) write that information literacy is a key educational issue:

> ... to respond effectively to an ever-changing environment, people need more than just a knowledge base, they also need techniques for exploring it, connecting it to other knowledge bases, and making practical use of it. In other words, the landscape upon which we used to stand has been transformed, and we are being forced to establish a new foundation called information literacy (p. ix).

Internet Based Learning - How is it Being Used

Starr & Milheim (1996) conducted an exploratory study whereby they posted a survey on "Educational Uses of the Internet" in thirty newsgroups on the Internet that were related to education and/or instruction. A total of 147 people responded to the survey. Respondents indicated the following educational usage of the Internet: 80 percent indicated that they used the Internet for personal research and for working with a colleague; 70 percent used for it for library access; 40 percent utilized the Internet for class materials, student research and class demonstrations; Additionally, many respondents indicated that they would probably use the Internet in the future for credit classes (38.4%), non-credit classes (23.8%) and a full-degree program (14.7%).

Most existing educational sites on the Internet are intended as an adjunct to the classroom and simply contain course information, class notes and handouts (Schotsberger, 1996). An example of this type of use is a Graduate level course on survey research delivered at the University of Calgary which can be found at [http://www.ucalgary.ca/~tgougeon/].

Various instructional sites demonstrate the versatility of the Internet for providing unlimited access to class materials that would normally be restricted to classroom-only viewing as part of library reserve services (Schotsberger, 1996). An example of this type of course is a University of Texas A&M course Taxonomy of Flowering Plants [http://www.isc.tamu.edu/FLORA/tfphome1.html] that makes use of an extensive collection of graphics that allow for up-close inspections with detailed descriptions.

Some sites go beyond the archival nature of sites discussed above and provide new or additional learning experiences for students (Shotsberger, 1996). An example is the Virtual Hospital at the University Of Iowa College of Medicine [http://indy.radiology.uiowa.edu/VirtualHospital.html]. The virtual hospital is a collection of multimedia textbooks that includes both teaching files and virtual patients. Students are presented with patient scenarios from which they are asked to answer questions about the symptoms, causes, and treatments of illnesses.

A University of Calgary course titled "Telecommunications in Education" [http://www.acs.ucalgary.ca/~edtech/677/frameset.htm] uses the Internet to facilitate both asynchronous and synchronous communication (through the use of First Class conferencing groupware) in addition to providing students a place to post their assignments for comment and review.

A detailed list of Universities and Colleges that deliver on-line courses can be found at the World Hall at the University of Texas [http://www.utexas.edu/world/lecture].

Effectiveness of Online Learning

Kearsley, Lynch & Wizer (1995) examined a large number of studies on the many different ways that computer networks could be used in instruction and learning.

> The overwhelming conclusion from these studies is that online learning activities are well suited for graduate level education. When compared to traditional classes: student satisfaction with online courses is higher; GPA and other measures of student achievement are the same or better; a higher level of critical thinking and problem-solving is reported; and there is often more discussion among students and instructors in a course. Instructors are able to track the progress of their students in a detailed way and have a better understanding of what students are/are not learning.

> Finally, computer networking provides a more "authentic" learning environment in the sense that students can easily communicate with other educational professionals outside of the class group if they desire (p.37).

Use of Technology - A Professional Competence

> Millions of people in today's world make their livelihood from processing and manipulating information. Such diverse professions as computer scientists, engineers, physicians, lawyers, bankers and many more have become "knowledge workers". Often what they produce is data or ways to categorize and search data. They share the common professional need to access the rapidly changing streams of information related to their fields. The world's increasing reliance on growing mountains of data has put pressure on universities to meet the educational needs of adults who expect to access the classes they need as easily as they can access online databases (Barnard, 1997, p. 30)

The competencies required of today's graduates include the ability to acquire and evaluate information, organize and maintain information, interpret and communicate information and use computers to process information (Rakes, 1996). In order to provide students with the best chance of being lifelong learners and future employees, students need to become information literate and skilled in using computer-based tools to access information (Rakes, 1996).

Use of Technology - A Professional Competence for Medical Doctors

> The Web is no longer a curiosity for academicians seeking grant support from various National Information Infrastructure funding programs; it is a strategic tool capable of facilitating effective scholarly collaboration, economical internal communication, and a new form of relationship between health care provider and patient (Frisse, 1996, p. 753).

Physicians will need to be life-long learners to maintain the currency of their knowledge and skills in a rapidly changing environment where the amount of information is continually increasing (Swanson & Anderson, 1993; Mendelson, Levinson, & Gaylin, 1996). Computer assisted learning can provide a means of accomplishing this, provided physicians are comfortable with using the technology (Kaufman & Paterson, 1995). The Director of Medical Informatics at the University of Calgary states that computer literacy should be an essential course at medical school and that all doctors should be able to access hospital and home office online databases to access medical records when required. However, he estimates that with only about 20 per cent of Alberta doctors having electronic mail that reality is still along way off (Walker, 1997).

Medical schools are under increased pressure to address the continuing medical education needs of practicing physicians and specialists. These needs will require more flexible and innovative approaches to delivering learning opportunities including the use of distance education strategies such as video-conferencing, compressed video, audio-conferencing, and computer-assisted learning (Kaufman & Paterson, 1995; Klemm & Snell, 1995).

The benefits of a globally connected computer network will change medical practice by improving the access to information and the ability to share high quality multi-media images with colleagues for advice on diagnosis and treatment (Klemm & Snell, 1995; Landini & Rippin, 1995; De Jager & Tangelder, 1995; Farman & Scarfe, 1995). The Canadian Medical Association (CMA) currently lists 11 journals and newsletters that are available online to allow medical practitioners to keep up with research in their respective fields (CMA, 1997a). The CMA also offers a series of courses designed to develop the skills that physicians need to access clinical research and educational information from the Internet (CMA, 1997b).

Mendelson, Levinson & Gaylin (1996) highlight the large amount of quality Internet sites that are available to medical practitioners to keep up with the research literature in their respective specialties. They provide links with descriptions to physician information management services, clinical information, and non-clinical information (i.e. medical schools, continuing education, etc.). The National Institutes of Health (NIH) in the United States disseminates new research information to practicing physicians on-line (National Institutes of Health, 1997). The NIH offers free continuing educational credit for physicians who demonstrate that they have learned the findings and recommendations of each new on-line module.

A 1997 study on Internet usage by the Emerging Technologies Research Group (1997) found that 38% of users were accessing information on medical and health information. The consequence of this fact for physicians is that patients now have relatively easy access to the latest medical information. Physicians, to maintain their credibility, will need to be able to keep up with the research and be able to discuss the legitimacy, reliability and credibility of information brought forward by their patients. This will require that physicians be able to access the same information in the same fashion and not solely rely on printed journals, which take longer to deliver the latest information.

Use of Technology in Medicine

Technology has increasingly played an important role in the practice of medicine in the twentieth century with the X-ray being the preferred imaging tool to allow doctors to examine the human body and disease process (Pickover, 1995). New technologies began to enter clinical use quickly in the 1970s and '80s including such technologies as: computed tomography (CT), magnetic resonance-imaging (MRI), positron emission tomography (PET), ultrasound, video thermography, superconducting quantum interference devices (SQUIDS), and digital subtraction angiography (DSA) (Pickover, 1995).

The developing alliance of computers with medicine has been going on for over thirty years but the forces of powerful, affordable technology and current and impending changes in the medical system (due to cost and resources) promises to change medical practice, research and education (Galassi, 1995)

Use of Technology in Medical Education

> To practice medicine in the twenty-first century medical students educated in the twentieth century must be given a strong grounding in the use of computer technology to manage information, support patient care decisions, select treatments, and develop their abilities as lifelong learners. (Association of American Medical Colleges, 1992, see Kaufman & Paterson, 1995, p.4).

Medical informatics is a field that concerns itself with the organization and management of information in support of patient care, education, research and administration (Kaufman & Paterson, 1995). A 1992 survey of the learning needs of

Nova Scotian physicians showed a need for education in the area of medical informatics (Mann & Chaytor, 1992). Forty-two percent of family practitioners and 62 percent of specialists said that they had a computer in their office. However, 78 percent of family practitioners and 68 percent of specialists assessed their computer skills as "nil" or "less than adequate". In 1992 the Royal College of Physicians of England recognized the need for education in the use of information technology by medical practitioners (Chan, Fox, Clamp & de Dombal, 1996).

Kaufman & Paterson (1995) outlined seven goals for medical informatics for future physicians. Table 3 highlights these seven goals.

Table 1. **Seven goals for medical informatics use by future physicians.**

AREA	GOAL STATEMENT
1. Computer literacy	Able to use general-purpose computer software packages.
2. Communications	Able to use electronic networks for communications with other professionals and for access to information sources.
3. Information retrieval and management	Able to search, retrieve, and organize information from a variety of computerized information sources.
4. Computer-aided learning	Able to select and use computer -aided learning (CAL) materials as a resource in self-directed learning.
5. Patient management	a. Biomedical computing. Able to use database systems and statistical software for patient management.
	b. Decision support. Able to use expert systems and knowledge databases in patient care.

(Table continues on next page)

Table 1 (Continued). **Seven goals for medical informatics use by future physicians.**

6. Office practice management	Understand office practice management concepts and use the computer in support of office-based practice.
7. Hospital information systems	Understand the hospital as an institution and make use of information systems for practicing in the hospital.

Note: From Preparing future physicians: How will medical schools meet the challenge, by D.M. Kaufman & G.I. Paterson, 1995. In C.A. Pickover (Ed.) *Future Health.* Copyright C.A. Pickover.

In 1992, the American Association of Medical Colleges (AAMC) in their ACME-TRI Report on Educating Medical Students (see Kaufman & Paterson, 1995) identified a number of recommendations regarding the use of technology in medical education:

- Support should be increased for faculty members who are willing to develop medical education software programs and are capable of doing so.
- Consortia of medical schools that share computer programs should be encouraged and funded.
- There must be facilities to train faculty members in the use of computers for medical education. Such training is essential as training in new research techniques.
- Medical schools should require faculty members who have responsibility for medical student's education to become skilled in the educational application of computers.

- Medical schools should establish some organizational structure to promote the use of computers in medical education.

A 1991 survey (Protti & Bannister) found general agreement with the idea of integrating medical informatics into the general curriculum. However, most schools reported barriers to this integration including lack of funding for hardware/software, lack of space in the program, and lack of staff and faculty members who were available, skilled, or willing to teach in this area.

Examples of Technology Use in Medical Education

Dalhousie University and other medical schools are considering that each new student entering the medical program be computer literate and have a computer (Kaufman & Paterson, 1995). A 1996 Association of American Medical Colleges (AAMC, 1996) report found that access to a personal computer for aspects of the undergraduate medical curriculum was required at 29 of 49 responding medical schools.

The University of Calgary is well on it way to having a post diploma program for hospital school-trained registered nurses seeking an academic bachelor of nursing degree available to be delivered entirely at a distance using the Internet and CD-ROMs (Trigueiro, 1996).

The AAMC has developed a database management system, that will be able to be accessed via the Internet, that will allow participating institutions to do detailed comparisons of curricula and will be able to be used to analyze trends in medical education in both the United States and Canada (Salas & Anderson, 1997).

The University of Washington School of Medicine developed an interactive personal computer program to teach gram-stain interpretation to first-year medical students in an introductory human biology course (Mandel, Schadd, Cookson, Curtis, Orkand, Wener, Lecrone, Dewitt and Astion, 1996). Students demonstrated statistically significant pretest-posttest improvement in gram stain interpretation after using the computer program. This improvement was attributed to the enhancement of learning through repetition and immediate feedback. It was also noted that student acceptance of the program was high and that the program was designed to supplement rather than replace supervised instruction.

Leeds University developed an information technology (IT) course to get first year medical students comfortable with using technology (Chan, Fox, et. al, 1996). The course was a combination of five hours lecture and five hours practical assignments. The topics covered the following IT skills: basic network skills, basic file handling skills, spreadsheet usage, file handling, use of network for clinical decision support, word processing, and database usage. Independent studies comparing two randomly selected groups suggested that those that had taken the IT course used IT more frequently and viewed IT more favorably than their counterparts. However the study also showed that there was a mixed ability of students entering medical school in regards to IT skills and knowledge. It was identified that lectures on IT must be kept to a minimum and that the practical exercises be based around clinical medical problems.

The Department of Anatomy at the University of Otago (New Zealand) introduced case-based learning (CBL) as part of their gross anatomy course in 1988 to encourage second year medical students to develop independent learning skills and a deeper understanding of the topics being studied (Peplow, 1996). However due to a lack of staff available to support this style of teaching this initiative was not run in 1990-92. In 1993, a local one -way video-conferencing system was set up to allow one staff member to run the initial discussions and facilitate small group discussions based on clinical cases used in the program. An evaluation of the program found that the program delivered via video-conferencing promoted the favorable aspects of PBL but was not as demanding on staff time as previous incarnations which required one staff member for each small group. Most students were reasonably satisfied with the presentations of the cases via video-conference, the discussions that took place in their own groups, and the opportunity to be able to talk to other groups or the facilitator via the means of microphones in their rooms. Nearly all the students identified that the CBL projects had helped their learning and studying in this part of the course and 94 percent indicated that the CBL projects via video-conferencing had been a good use of time. It was identified that this reduction in staff teaching commitment allowed the CBL program to be once again introduced in the curriculum. "This is especially important at a time when staff teaching commitments in many universities are increasing (Pedlow, p. 317).

The Universiti Sains of Malaysia conducted a research study where they compared traditional lecture methods versus computer assisted instruction (CAI) to teach congenital heart diseases, in particular Tetralogy of Fallot (Ram, Phua, & Ang, 1997). This topic requires numerous diagrams to illustrate the normal and abnormal anatomical structures of the heart during fetal development. It was considered that this topic was ideally taught using computer graphics, animation and video. The results of the comparison indicated no statistical difference on a pre-test but post-tests indicated that the group who received their instruction via CAI did significantly better than students taught using the conventional method. However it should be noted that this study did not identify what type of instructional resources and interaction were utilized in the traditional method. Additionally, the authors are careful to note that this finding could be attributed to the fact that the majority of students are English Second Language Students (ESL) and that this topic requires extensive use of animation, graphics and extensive feedback which can be more easily provided through CAI than by an individual instructor.

The University of New South Wales, Sydney, Australia has developed a large interactive database of images of diseased tissues to assist in undergraduate education in the discipline of pathology (Hawkins, Ward, & Smith, 1997). Images of macroscopic, microscopic, radiographic and clinical aspects of disease were acquired and stored in the database. Image identifiers, together with relevant textual information, were indexed in a relational database format. A graphical user interface, developed in Visual basic 3.0, was built to simplify data access. The database was available on both a local network and via CD-ROM so both students on and off campus could study the material. The authors of this study identified a number of benefits for developing a computerized database to support learning in pathology:

- Electronic image database greatly improves the current use of visual teaching resources in the teaching of pathology.
- It provides a means for delivering these resources to students, both within the school and at remote sites.
- The quality of the images, particularly with magnification and appropriate lighting, is often superior to the actual specimen.

- It permits cross-referencing of the different points of interest in individual specimens.
- The images can be displayed with information regarding clinical history and detailed descriptions of the pathological changes present, thus enriching the student's appreciation of the disease process.
- It provides students with the opportunity to browse unsupervised through the image collection, something that would not have been possible viewing the actual specimens in the specimen museum located at the University.

The University of Limburg, Maastritch, The Netherlands, has developed a number of computer problem based modules to assess their undergraduate medical students (Schuwirth, L.W.T., Van Der Vleuten, C.P., de Kock, C.A., Peperkamp, A.G,. & Donkers, H.H., 1996). They identified a number of perceived advantages and disadvantages to using a computer to assess clinical practice. The advantages were:

- Using a computerized system for the administration and scoring of tests may save many of the resources used in examinations.
- The fidelity of the cases can be improved through the use of multimedia tools, which can show motion, sound and reproduce images without generating further costs.
- Since cases typically provide information in steps the computer is better able to prevent students from changing their previous answers based on new information (by preventing access to previous screens) instead of having to realistically deal with the consequences of their previous decision.

- Outcome variables such as response time or number of corrections can be analyzed rather than just correct number of responses.
- Sequential testing can be employed whereby cut-off times and scores can be assigned.

Some of the disadvantages are:

- Computer illiteracy of some of the students.
- Initial costs for software and hardware.
- Difficulty of scoring open-ended questions.
- Taking an examination from a computer screen is more fatiguing as opposes to a written examination.

The Challenge of New Learning Technologies

> The educator continually devises and applies new instructional treatments, hoping for improved results. He seeks the best method of instruction for a given purpose. Since learners differ, the search for generally superior methods should be supplemented by a search for ways to fit the instruction to each kind of learner. One can expect interactions between learner characteristics and instructional method. Where these exist, the instructional approach that is best on the average is not best for all persons (Cronbach & Snow, 1977, p.1).

Once again a new technology has appeared on the educational horizon claiming to offer educators, from preschool to graduate school, a tool that will improve teaching and learning. Owsten (1997) stated that "Nothing before has captured the imagination and interest of educators simultaneously around the globe more than the World Wide Web" (p.27). One has to be careful of such statements, as these claims have been made many times before in the past:

> At least since Thorndike suggested the use of pictures as labor-saving devices at the turn of the century, each new medium has created a wave of interest and positive enthusiasm on the part of educators (Clark & Salomon, 1986, p.464).

New mediums that raise our hopes for improved learning have characterized the history of instructional media in teaching and learning. It is not surprising that the Internet and the WWW are receiving the same treatment in the current literature. However this new technology must be examined with a critical eye to ensure that its promise meets its hype. Clark & Salomon (1986, p. 474) offer four statements based on their research that all educators should keep in mind when examining new instructional media:

1. Past research on media has shown quite clearly that no medium enhances learning more than any other medium regardless of learning task, learner traits, symbolic elements, curriculum content or setting.
2. Any new technology is likely to teach better than its predecessors are because it generally provides better instructional materials and its novelty engages learners.
3. Future research on media should be conducted in the context of and with reference to similar questions in the general cognitive sciences (i.e. ATI research, information processing theory, dual coding, etc).

4. In the future, researchers might ask not only how and why a medium operates in instruction and learning, but also why it should be used at all.

Successful Integration of a Technological Innovation

"A technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (Eveland, 1986 as cited in Rogers, 1995). Eveland considered that technology was information and that the transfer of information is a communication process, therefore technology transfer was the communication of information. This perspective is important because too often we consider technology to be composed of just physical hardware. Rogers (1995) characterized technology as having two components: (1) a hardware aspect consisting of the tool that embodies technology as a physical object, and (2) a software aspect, consisting of the information base for the tool. It is important to consider both the hardware and software aspects of technology when evaluating the success of any technological innovation. Rogers (1995) defined an innovation as an idea, practice, or object that is perceived as new by an individual. Therefore, it leads to considering the success of a technological innovation as the motivation that impels an individual to exert effort to learn about the hardware and software aspects of the new technology.

> A technological innovation usually has some degree of benefit for its potential adopters. This advantage is not always very clear-cut, at least not to the intended adopters. They are seldom certain that an innovation represents a superior alternative to the previous practice that it might replace (Rogers, 1995, p 13).

The rate of adoption of an innovation is the speed with which an innovation is adopted by members of a social system (Rogers, 1995). There have been many technological innovations that, while apparently superior in hardware technology, failed to be adopted readily by the public. A prime example that comes to mind is Beta videotapes which, while delivering a better quality picture, failed to be adopted by the public as the technological standard for the home video market.

Havelock (1973) focused on innovations in education and his model was based on the relationship between a "change agent" and the client. A change agent is a person who facilitates planned change or planned innovation while the client is a person, group, organization, or communities which the change agent chooses to serve (Havelock, p. 5). Havelock divided the innovation process into both change agent and client activities.

Change agent activities include:

1. promoting the innovation
2. informing and telling about the innovation
3. demonstrating and showing the benefits of the innovation
4. training people to adopt the innovation
5. helping to maintain and service the innovation
6. nurturing the innovation process

Client activities include:

1. becoming aware of the innovation
2. developing an interest in the innovation and seeking more information about it
3. evaluating the feasibility of using the innovation
4. trialling and testing the innovation under "work" conditions

5. adopting the innovation

6. integrating the innovation into the work routine

Rogers (1995) identified a number of variables that determine the rate of adoption of innovations. They are:

1. Perceived Attributes of Innovations:
    a) relative advantage
    b) compatibility
    c) complexity
    d) trialability
    e) observability
2. Type of Innovation-Decision
    a) optional
    b) collective
    c) authority
3. Communication Channels (e.g., mass media or interpersonal)
4. Nature of the Social System (e.g., norms, degree of networking)
5. Extent of Change Agents' promotion Efforts

It is clear from both Havelock's and Rogers' models that the adoption of an innovation is a systematic process that can be influenced, both positively and negatively, by many variables. However, for the purposes of this research study the focus was on Rogers' perceived attributes of innovation.

Rogers (1995) identified characteristics of innovations, as perceived by individuals, to help explain their different rates of adoption. These characteristics are relative advantage, compatibility, complexity, trialability, and observability.

1. **Relative advantage** is the degree to which an innovation is perceived to be better than the idea it supersedes. The greater the perceived relative advantage of an innovation, the more rapid will be its rate of adoption.
2. **Compatibility** is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.
3. **Complexity** is the degree to which an innovation is perceived as difficult to understand and use. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and strategies.
4. **Trialability** is the degree to which an innovation may be experimented with on a limited basis. An innovation that is trialable (prototyped) before it is implemented, particularly before the removal of the "old way" of performing a function, represents less uncertainty to the individual who is considering it for adoption.
5. **Observability** is the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to develop it.

These five attributes are similar to Havelock's (1972) model where he groups the factors that are involved in evaluating any innovation into the three main categories of potential benefit (how and who will it help?), workability (how difficult is it to implement?, will people be able to understand it and use it?), and diffusiblity (are the benefits observable?, can it be tried out first?, is it compatible with people's current ideas?). Rogers selected his five attributes listed above based on past writing and research and his desire for maximum generality and succinctness. Holloway (1977, as cited in Rogers 1995) conducted research on Roger's five attributes with 100 high school principals to examine if the attributes aided in predicting the rate of adoption for educational innovations. General support for the framework was found with the only problem being an apparent lack of distinction between relative advantage and compatibility. Tornatzky and Klein (1982) carried out a meta- analysis of seventy-five studies on perceived attributes and rate of adoption. Relative advantage and compatibility were almost always related to the rate of adoption in a positive direction, while complexity was related negatively to the rate of adoption. Anderson and Joerg (1996) used Roger's five attributes to examine the usage and perceived usefulness of the WWW to support classroom delivery of university courses. Their study found that there were problems related to complexity and relative advantage. Complexity issues were related to WWW access restrictions caused either by lack of equipment, lack of knowledge, or difficulty in getting an Internet connection. Relative advantage appeared to be largest inhibiting factor for on-campus students. Anderson and Joerg speculated that the WWW would be more readily adopted, due to a perceived relative advantage, by students off-campus or those that prefer WWW instruction rather than face-to-face instruction.

Student's Beliefs, Values and Experience

Student's beliefs, attitudes, values and experiences have the potential to influence the rate of adoption of the Internet as a learning medium. However, there are few studies, besides Anderson & Joerg (1996), that deal with student's rates of adoption in regards to using the Internet in education. Therefore, it is beneficial to examine computer use studies that explore the issue of student ability, aptitude and attitude in relation to the successful introduction of computers into educational settings.

Attitudes toward Computer Use

Clement (1981) wrote that if positive attitudes towards computers increase, students could master the skills required to benefit from the application of computers into the educational process. Loyd and Gressard (1984), in a study on attitudes towards computers, found that computer experience was significantly related to more positive attitudes about anxiety, confidence, and liking of computers. Koohang (1987), in a study on pre-service teachers, found that prior computer experience and prior exposure to programming and/or instructional application had a positive effect on attitudes towards computers. Koohang (1989) defined four types of attitudes toward computers:

1. Computer anxiety, defined as anxiety toward or fear of computers or learning to use computers;
2. Computer confidence, defined as confidence in the ability to learn about or use computers;
3. Computer liking, defined as enjoyment or liking of computers;

4. Perception of computer usefulness, defined as the ability to perceive computers as a useful tool after exposure to computers.

Koohang (1989), in the study on attitudes towards computers, found that:

- subjects who had more computer experience expressed more positive attitudes towards computers in general;
- building a strong experiential background with computers enhances positive attitudes towards computers; and
- subjects who had more knowledge of computer applications and programming scored significantly lower on computer anxiety and higher on computer confidence sub-scales.

Koohang (1989) concluded that word processing, spreadsheets and database computer use should be introduced into the curriculum to develop positive attitudes in students about the use of computers.

Mitra (1997) examined the entire student population of Wake Forest University to study the relationship between computer use and attitudes toward computers. A return of 1,444 surveys allowed Mitra to demonstrate through factor analysis that there were four distinct areas of computer use for different tasks: Internet use for non-task activity (access of information, e-mail with friends, e-mail with family, e-mail with classmates); Internet use for task activity (e-mail with teachers, e-mail with student organizations); mathematical computing (statistical computing, mathematical computing); and data management (spreadsheets, databases). Mitra also reported that low users of computers tend to have a more negative attitude towards computers. The results suggest that students are often forced to use computers for task purposes even when they might have a negative attitude towards computer use. Conversely, those students who have a positive attitude tend to use the computers more for both non-task and task purposes. Mitra concludes his exploratory study by writing:

> Based on the results of the 1,444 surveys it is clear that there are several categories of computer use among students and their attitudes towards computers is related to the categories of use. These differences and relations have possible far-reaching implications for institutions that are planning widespread computer implementation in teaching. If the students have a negative attitude towards computer use, it could impact their level of use of computers. That, in turn, can have an impact on learning and the way that the learning process changes with the adaptation of computers. While it has been known that there is a relationship between computer use and attitudes towards computers, the results reported here demonstrate that computer use is not a monolithic and singular construct. Indeed, it is a multi-dimensional element and there are relationships between categories of use and attitude towards computers. These different relations need to be considered when computers are used in teaching (p. 6).

Studies of Computer Use by Medical Students

A 1994 Portuguese study on the attitudes and opinions of first-year medical students towards computer use reported the following findings: 140 students responded to the survey (77%); 14 percent of students classified their computer knowledge as negligible and 49 percent as deficient; 93 percent indicated that computer literacy is important for doctors; and computer education in the undergraduate curriculum was demanded by 92 percent (Gouveia-Oliveira, Rodrigues & de Melo, 1994).

A 1994 report by the McMaster Health Science Faculty (Haynes, McKibbon, Bayley, Walker, & Johnston, 1994) on the competency and use of computers by medical students reported the following findings for their 1991 class: 70 percent had access to computers; those that had access used the following computer applications - word-processing (98%), online searching (40%), electronic mail (13%), filing (24%), statistics (18%).

Huntley & Conrad (1994) in an Irish study of the introduction of Internet tools (E-mail, newsgroups, and gopher) into the medical school curriculum classroom reported the following findings: 93 percent used their e-mail account; 81 percent accessed the newsgroups; 65 percent used gopher access. A student survey produced the following findings: 36 of 58 responses indicated an appreciation of access to information and seven gave an indication of enhanced computer literacy. On the negative side: 15 indicated that time was a limitation, nine indicated that the system was intimidating or confusing; six indicated problems with getting started; and six reported miscellaneous complaints.

A 1996 AAMC survey on computer ownership and computer literacy found that between 50 and 80 percent of medical students in their first year own computers. One of the responding schools to the survey indicated that their 1996 entering class reported: 68 percent own computers; 94 percent have word-processing experience; 78 percent have database experience; 85 percent have spreadsheet experience; 63 percent had limited experience writing simple programs (AAMC, 1996).

Barriers to Use

> The potential advantages of placing medical education programs on the WWW are significant, but so were the promised advantages of previous technological advances (television, time-shared computers, etc.). In almost every case, the promises proved greater than the reality. The reason for this is so many of the impediments to technology-enhanced medical education programs come from outside the technology itself and therefore cannot be solved by the latest advances in engineering. The following are the top ten reasons placing CAI programs on the WWW may also fail to

> achieve its true potential...computer-assisted instructional material is not fully integrated into the school curriculum; there are no uniform standards for judging CAI programs; the faculty does not test the students on material taught using CAI; computer-based educational material on the WWW does not fully exploit the problem-solving and visual aspects of the medium; there are insufficient computers to access the WWW-based material; the WWW does not require standardized computer equipment; the response time on the Internet appears to be deteriorating; WWW-based CAI programs tend to be poorly designed; CAI programs often are not updated or refined; computer laboratories have poor ergonomics (Friedman, 1996, p. 979)

Quintana (1996) identifies some potential problems, difficulties and limitations of Internet based courses for the student:

- lack of motivation can lead to student drop out;
- Internet methods of communication (e-mail, newsgroups, listservs) may be intimidating or awkward to use for some students;
- cost of computer equipment and communications infrastructure may limit the number of students that can afford an Internet-based course; and
- difficulty in using software and hardware may lead to incorrect usage or limit usage of tools needed to complete the course.

Kearsley, Lynch, & Wizer (1995) in their review of the literature on the effectiveness and impact of online learning identified the following major problems and barriers:

- frustrations associated with hardware and software problems;
- the additional time required by faculty to prepare and conduct courses;
- the additional time required by students to learn the computer system;
- the limited writing and communication skills of some students;

- lack of timely response from instructors; and
- student attrition in courses.

A study by the Faculty of Medicine, National University of Singapore, Singapore found that students who used a hypertext virtual textbook to learn microbiology reported the following barriers: no home computer, inadequate computer skills, problems with software, unattractive format, not useful, and no time (Inglis, Fu, & Kwok-Chan, 1995).

Starr & Milheim (1996) conducted an exploratory study whereby they posted a survey on "Educational Uses of the Internet" in thirty newsgroups on the Internet that were related to education and/or instruction. A total of 147 people responded to the survey. Major disadvantages were identified by only a third of the respondents with the most frequent being slow response and too much information. "No standardization" and "numerous users" were listed by less than 25% of respondents, and less than 10% indicated "high cost" or "difficult to use" as major disadvantages.

Starr (1997) highlights that Internet and local network transmission times are critical considerations when designing web-based learning. The University of Calgary's first attempt at delivering a nursing on-line course, in 1996, was put on hold due to the lack of available university phone lines to support student access, especially during evening hours (Cummings, 1996).

Conclusion

The literature supports that the Internet is an exciting delivery system that offers great potential to support the learning activities of students. The Internet through its varied communication channels and support for multi-media makes it an ideal delivery vehicle for distance learning. Many universities and colleges have already started or intend to explore ways of using the Internet in their curricula. It is evident that the ability to use the Internet for information access and transfer is a required competence for medical practitioners. Medical schools have recognized this need and are attempting to integrate this new technology into their curriculums. However, one has to be careful that integration of this new learning technology is done properly and accepted by its prime user, the students. Educational research into the effectiveness of various instructional delivery mediums has often focused on a comparison of "which is better". The more appropriate question may be, "which mediums best support the learning of required competencies, both academic and professional". The application of the Internet as a technological innovation to support education is still in the infancy stage. Research into the benefits and disadvantages of integrating the Internet into education is required to ensure that this integration is successful (Starr & Milheim, 1996).

CHAPTER 3 - METHODOLOGY

Overview

In order to gather information on the opinions, preferences, attitudes and beliefs of medical students at the University of Calgary regarding the usability and usefulness of computer support tools, survey research methods (Babbie, 1990; Fowler, 1993) were utilized to develop a standardized questionnaire.

Approval for research on human subjects was obtained from both the Dean of Undergraduate Studies, Faculty of Medicine and the Joint Research Ethics Committee, Faculty of Education (Appendix A). All respondents to the questionnaire gave informed consent. The consent form can be found at Appendix B.

Participants

The survey was distributed to all first and second year students in the medical program at the University of Calgary. The number of students enrolled in each year was 73 and 76 respectively. The University of Calgary's medical program is unique in that it is a three-year program that is designed for more mature students who already possess at least one undergraduate degree. The consequence is that the participants in this study have varied academic and life experiences relating to the use of computers and laboratory equipment. It is one of only two medical faculties in North America offering a three-year degree program (University of Calgary, 1998). Additionally, it is also problem-based, student-centered and mostly self-directed. Therefore, the usage patterns of computer support tools by this group was expected to be varied depending upon whether there was a requirement and/or whether there was valuable information available relating to a specific problem under study.

Survey Instrument Design

The survey instrument was designed to gain information from University of Calgary medical students on their attitudes towards the adoption of computer support tools, in particular the use of histology courseware delivered via the Internet as an instructional and learning aid. The survey was designed to gather information that would correspond to Roger's (1995) characteristics of innovations, as perceived by individuals to help explain their different rates of adoption. These characteristics are relative advantage, compatibility, complexity, trialability, and observability. The six-section survey (Appendix C) sought to collect information on:

- how the students used the Internet delivered anatomy courseware;
- students' opinions about the courseware and use of computer support tools;
- frequency and usefulness of computer support tools;
- barriers to the use of computer support tools;
- opinions about the future use of technology in medical education; and
- demographic information.

Frequency & Usefulness of Computer Support Tools (Section A)

Section A contained 13 items that used Likert scales (Babbie, 1990) to measure the frequency of use and perceived usefulness of each of the items. The subjects were asked to specify their frequency of use (A1a to A13a) of computer support tools to perform various activities based on a five point scale (1=Never Used, 2=< Once per Week, 3=Once per Week, 4=>Once per Week, 5=Used Everyday). Usefulness (Questions A1b to A13b) was measured using a five point scale (1=Not Applicable, 2=Not Useful, 3=Useful, 4=Quite Useful, 5=Very Useful). The calculation of central tendency for a measure of usefulness did not include the "not applicable" score to ensure that it was an accurate reflection of usefulness. Not applicable entries were coded as not entered for purposes of statistical analyses.

Questions 1-8 were designed to identify student categories of computer use. These categories were based on research conducted by Mitra (1997). Mitra examined the entire student population of Wake Forest University to study the relationship between computer use and attitudes toward computers. A return of 1,444 surveys allowed Mitra to demonstrate through factor analysis that there were five distinct areas of computer use for different tasks:

- Internet use for non-task activity (access of information, e-mail with friends, e-mail with family, e-mail with classmates);
- Internet use for task activity (e-mail with teachers, e-mail with student organizations);
- Mathematical computing (statistical computing, mathematical computing);
- Data management (spreadsheets, databases); and
- Word processing.

Mitra identified alpha coefficients, measuring index reliability, for four of the categories of computer use. The alpha coefficients were 0.73 (Non-Task), 0.57 (Task), 0.71 (Mathematical Computing) and 0.67 (Data Management). No statistic was provided for word processing as there was only one measure included in the index.

Questions 9-13 were designed to gather information about the student's use of the Internet to related to their medical education at the University of Calgary, such as accessing information about the University of Calgary, the Faculty of Medicine, medical course schedules and objectives, medical resources external to the University of Calgary, and viewing the on-line histology courseware.

Opinions about Computerized Histology Courseware (Section B)

Section B was designed to gather data on the student's opinions about the computerized histology courseware. A seven point rating scale was used to increase the distance between the positive and negative poles of each statement (Babbie, 1990). The measurement items were based on a study by Anderson & Joerg (1996), that dealt with student's rates of adoption in regards to using the Internet in education.

How the Students Used the Computerized Histology Courseware (Section C)

Section C was designed to capture data on how the students used the computerized histology courseware. Question one used a scale to determine the combination of instructional media that the students used to learn histology (Table 2). A scale was used to measure the response pattern on more than one possible combination of instructional media. A scale was used because it is based on more than a single question and thus give a more comprehensive and accurate assessment of a given variable (Babbie, 1990).

Table 2.
Scale indicating combination of instructional media used to study histology.

Media Utilized
Did not study
Textbook only
Microscope only
Computerized Slides only
Textbook & Microscope
Textbook & Computerized Slides
Microscope & Computerized Slides
Textbook, Microscope & Computerized Slides

Question 2 was designed to gather data on why students did not use the computerized histology courseware or used both the courseware and prepared slides with a microscope. It was hypothesized that the computerized histology courseware would be a suitable replacement for the prepared histology slides viewed using a microscope. Therefore, if students did not use the computerized histology courseware or used both forms of instructional media it was important to identify the applicable reasons. Questions 3-5 were designed to gather data on whether the students accessed the computerized histology courseware individually or in groups and from where they accessed the material.

Barriers to Using Internet Based Courseware (Section D)

Section D used a three point scoring system (No Barrier-Somewhat a Barrier-Major Barrier) scale to measure how eight different items were rated as barriers to using the computerized histology courseware by the students. These barriers were adapted from items found in a survey developed by Anderson & Joerg (1996).

Opinions on the Use of Technology (Section E)

Section E was designed to gather data on student opinions, values, beliefs and ability related to using computerized technology. Section E uses a standard five point Likert scale (strongly disagree, disagree, neutral, agree, strongly disagree) to measure student responses on 26 items. Included in the twenty-six items are the majority of items that King, Henderson & Putt (1997), based on the original CAIN index, found were a reliable measure of computer anxiety in students using the WWW and E-Mail to support university learning. Additional questions were added in an attempt to develop indexes that would support Koohang's (1989) four types of attitudes towards computers: computer anxiety, computer confidence, computer liking, and perception and computer usefulness. Additional items were created to measure computer ability. These items were developed using items from the Computer Ability Survey (CAS) designed by R. Kay (1993). Some of the items were re-written to update the terminology from a DOS environment to a Windows and WWW browser environment.

The decision to use indexes to obtain measures of student's attitudes, values, beliefs and ability related to computer use was made because indexes combine several questionnaire items, thereby avoiding the biases inherent in single items (Babbie, 1990). An index is constructed through the cumulation of scores assigned to specific responses related to the individual items comprising the index (Babbie, 1990). The assumptions for using indexes for data measurement include face validity, unidimensionality of the index, and variance of the measures (Babbie, 1990).

Demographic Information (Section F)

Section F gathers data to be used in comparing and categorizing student's responses on previous sections. Information of interest included age, gender, academic year, previous education, access to a home computer, access to the Internet from home, and a subjective rating of computer expertise. Space was also provided for open-ended comments. Individual comments can be found at Appendix D.

Pilot Survey

This evaluation survey was based on an evaluation conducted by the author for the Faculty of Medicine, University of Calgary in 1997. That evaluation focused strictly on the evaluation of one module of computerized histology courseware used by second year medical students. The evaluation gathered data exclusively about their use of the courseware. It gathered information on frequency of use, ratings of usefulness, opinions about the courseware and barriers to its use.

The results of that study were descriptive in nature and led to the more substantive questions that this research study sought to explore. However, that pilot evaluation was very helpful in the design of this evaluation questionnaire. It served as a pilot study of a representative sample that provided valuable information to improve the design of the survey instrument, particularly question clarity and questionnaire format (Babbie, 1990; Fowler, 1993).

Survey Distribution

The survey instrument was distributed, accompanied with a covering letter to all subjects, by placing it in each individual student's mailbox located in the student centre. These mailboxes were used on a daily basis by Faculty administrative staff and professors to distribute materials to students. Therefore, it was determined that this was the ideal method to distribute the survey. A drop off box was placed next to the student's mailbox centre to allow for easy return of the survey. Surveys were collected on a weekly basis. A follow up procedure was followed to obtain the highest possible return rate (Babbie, 1990; Dillman, 1978; Fowler, 1993). All subjects were sent e-mail two weeks after the original distribution of the survey. The e-mail thanked those that had completed the survey and encouraged non-respondents to submit the survey. Five weeks after the original distribution a follow up letter was distributed to students in their mailbox. The letter thanked those that had completed the survey and encouraged non-respondents to submit the survey. A deadline date for return of the survey was noted on the letter. Subjects were informed in each follow up procedure that additional surveys to replace lost or misplaced surveys could be obtained at all times from the receptionist who was available during regular business hours in the Student Centre.

Analysis of Data

Responses from the survey were coded and analyzed on the computer software program StatView (StatView 4.53 for Windows, Abacus Concepts, Inc., Berkley, CA, 1996). The computer software program, the Statistical Package for the Social Sciences

(SPSS for Windows 7.5, SPPS Inc., Chicago, IL, 1997) was used to calculate internal reliability scores and to perform a multivariate analysis of the data.

Ideally, median values are used to describe the central tendency for ordinal data (Babbie, 1990). However, to allow for more comparative statistical analyses to be performed the responses obtained on ordinal scales were treated as mean values calculated by assuming an interval scale of responses.

Index Development

Means and standard deviations were calculated for all sections of the questionnaire to describe the measures of central tendency. Indexes were analyzed by producing a Cronbach's alpha coefficient for each developed index. This measure calculates the internal reliability of the index by examining the correlations between all items in the index. A strong positive measure is an indication that the items are internally reliable. Alpha coefficients were calculated for the following indexes:

1. Use of computers for task activities (Mitra, 1997). (Items A1a, A7a, A9a, A10a, A11a, A12a, A13a).
2. Use of computers for non-task activities (Mitra, 1997). (Items A5a, A6a, A8a).
3. Use of computers for mathematical computing and data management (Mitra, 1997). These categories were separated in Mitra's (1997) study but combined for this research study. (Items A2a, A3a, A4a).
4. Usage of computer support tools. (Items A1a, A2a, A3a, A4a, A5a, A6a, A7a).

5. Attitude towards using computers (Mitra, 1997). For reliability purposes some of these items were negatively worded in the survey but were all re-coded as positive responses for statistical analyses. (Items E1, E2, E3, E4, E5).
6. Anxiety about using computers (Koohang, 1987). For reliability purposes some of these items were negatively worded in the survey but were all re-coded as positive responses for statistical analyses. (Items E2, E3, E4, E5).
7. Confidence about using computers (Koohang, 1987). For reliability purposes some of these items were negatively worded in the survey but were all re-coded as positive responses for statistical analyses. (Items E3, E7, E9, E17, E19).
8. "Liking" to use computers (Koohang, 1987). (Items E21, E22, E23, E24, E35, E26).
9. Usefulness of computers (Koohang, 1987). (Items E6, E8).
10. Awareness about computers (Kay, 1993). (Items E11, E12, E13, E14).
11. Perceived control over computers (Kay, 1993). (Items E3, E9, E10, E17, E18, E19, E20).
12. Programming Ability (Kay, 1993). (Items E15, E16).
13. Computer ability (Kay, 1993). It is an overall measure and includes all of the items in the above three indexes.

Analysis of the Effect of Beliefs, Values, Attitudes and Ability

In order to measure the effect of subject's beliefs, values, attitudes and ability with respect to computers, subjects were broken up into dichotomous categories based on their mean score (low<= mean and high =>mean) for the indexes: attitude, anxiety, confidence, liking, awareness, perceived control, and programming ability. Unpaired t-tests (.05 significance level) were calculated to determine if there was any significant difference between the dichotomous categories based on the following variables (survey questions are identified in parentheses where appropriate): frequency of use of the computerized histology courseware (Q. A13a), rating of usefulness for the computerized histology courseware (Q. A13b), usefulness of computer support tools for medical practitioners (Q.E6, E8), use of computer support tools for task purposes, use of computer support tools for non-task purposes, use of computer support tools for mathematical computing and data management purposes, usefulness of computers, and usage of computers.

Interaction Effects

Interaction effects amongst the data were analyzed using multivariate statistics. Multivariate statistics can analyze many independent variables and dependent variables to determine how they are correlated to each other in varying degrees (Wulder, 1997). Multiple analysis of variance (MANOVA) answers many of the traditional questions posed in ANOVAs. In ANOVAs a certain grouping variable is measured to see if it has an effect on a dependent variable. In a MANOVA there is more than one grouping variable, so the measurement of concern is whether certain combinations of grouping variables have an effect on a bundle of dependent variables (Malle, 1997). Wulder (1997) states that "The current scientific methodology is increasingly seeking the complex relationships between variables in an attempt to provide for more holistic, inclusive, studies and models."

A 2x2x4 MANOVA was calculated with gender *(male/female)*, home access to a computer *(yes/no)* and computer expertise *(beginner/novice/intermediate/expert)* as the grouping variables. The dependent variables were computer ability, computer anxiety, attitude towards computers, computer awareness, computer confidence, perceived control using computers, computer "liking", programming ability, use of computers for task purposes, use of computers for non-task purposes, measurement of computer usage, and a measurement of computer usefulness. Wilks' Lambda measures were calculated to determine the interaction effects between the three grouping variables. SPSS also produces F scores for the main effects (between-subjects effects) of one grouping variable against each dependent variable hence performing a univariate factorial analysis. However caution must be exercised when using MANOVAs to calculate significance for main effect interactions because the estimate of error is still based on a correlation calculation of all of the variables (Malle, 1997). Additionally a 4x2x2 MANOVA essentially produces 16 cells to compare the interaction of the grouping variables. Given the fact that the population under examination in this study was relatively small (143 subjects assuming a 100% return rate) it was questionable whether there were enough cases to generate sufficient number of subjects in each cell for statistical validity (Engles, 1998). The problem that arises was that the reported variance would likely be too low and the mathematical model would start to manufacture artificial variance to make its calculations (Engles, 1998). Therefore interaction effects between the three grouping variables in this study were calculated using a 4x2x2 MANOVA (.05 significance level) for exploration purposes only. Additionally, main effect interactions were not calculated using the 4x2x2 MANOVA model but rather individual factorial ANOVAs (.05

significance level) were calculated to determine main effects. Scheffe Post Hoc tests were performed on the independent variable of computer expertise to study the amount of variance that each of the four categories of expertise contributed to the overall variance.

CHAPTER 4 - RESULTS

Return Rate

There were 149 surveys distributed to medical students at the University of Calgary. Seventy-three surveys were distributed to first-year students and 76 surveys to second-year students. The return rate was 38 percent for first-year (28/73) and 45 percent (34/76) for second-year students. One respondent did not identify the current year. The overall return rate was 42 percent (63/149).

Demographic Information

There were 40 surveys (63%) returned by female respondents and 23 surveys (37%) returned by male respondents. The average age of the respondents was 26 with a range from 20 to 36 years of age. There was a wide range of academic backgrounds with four respondents having no previous undergraduate degree to four that had a Ph.D. Fifty-two respondents had at least a B.Sc. undergraduate degree.

Forty-two respondents (67%) indicated that they had access to a home computer while 21 respondents (33%) indicated that they had no access to a home computer. Thirty respondents (48%) indicated that they had access to Internet services from home while 33 respondents (52%) indicated that they had no such access.

Nine respondents (14%) classified themselves as beginners in a measure of computer expertise, 19 as novices (30%), 31 as intermediate (49%), and four as expert (7%) (Figure 3).

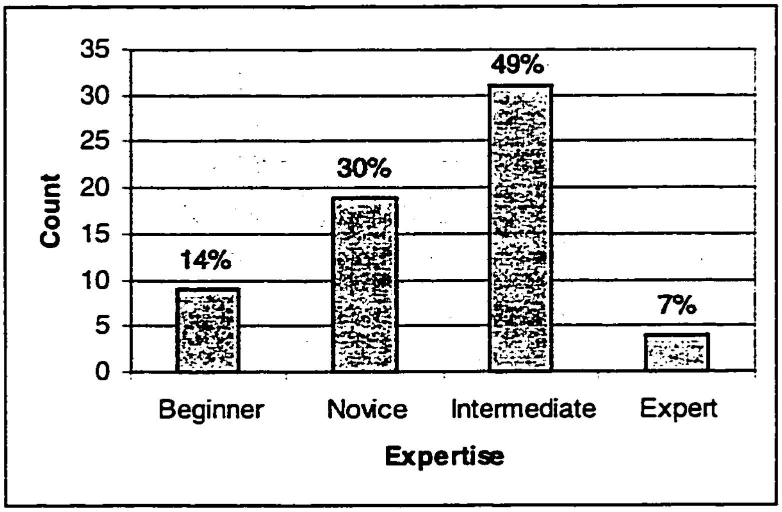

Figure 3. Frequency Distribution for Computer Expertise (Self-Reported).

Frequency of Use of Computer Support Tools

Information on the frequency of use of computer support tools was gathered using a five point Likert scale (1=Never Used, 2=<Once per Week, 3=Once per Week, 4=>Once per Week, 5=Used Everyday). Percentages, mean scores and standard deviations are reported in Table 3.

Table 3.
Frequency of use of computer support tools.

Frequency of Use	Mean	*SD*	Never Used	< Once a Week	Once a Week	> Once a Week	Used Daily
Word-processing	3.18	1.13	4(6)	16(26)	15(24)	28(44)	0(0)
Statistical Computing	1.46	0.69	39(62)	21(33)	1(2)	2(3)	0(0)
Spreadsheet Computing	1.64	0.90	36(57)	19(30)	3(5)	5(8)	0(0)
Database Management	1.27	0.65	51(81)	9(14)	1(2)	2(3)	0(0)
E-Mail with friends or family	4.75	0.67	0(0)	2(3)	2(3)	6(10)	53(85)
E-Mail with other students	3.89	1.31	3(5)	11(17)	6(10)	13(20)	30(48)
E-Mail with professors	2.97	1.12	2(3)	27(43)	12(19)	15(24)	7(11)
Internet to access general information	2.79	1.21	7(11)	25(40)	12(19)	12(19)	7(11)
Internet to access information about University	2.18	0.77	6(10)	47(74)	4(6)	5(8)	1(2)
Internet to access information about the Faculty	2.18	0.85	9(14)	42(66)	5(8)	6(10)	1(2)
Internet to access information about medical courses & objectives *	1.27	0.58	48(76)	12(19)	1(2)	1(2)	0(0)
Internet to access external medical information resources	2.14	0.86	11(17)	39(62)	7(11)	5(8)	1(2)
Internet to view computerized histology slides	2.02	0.71	5(8)	44(70)	9(14)	5(8)	0(0)

Notes. Values enclosed in parentheses represent percentages. * One non-response.

Respondents indicated the highest frequency of use (used more than once a week and/or daily) for the following computer support tools: e-mail with friends or family (95%), e-mail with other students (68%), word-processing (44%), e-mail with professors (35%) and Internet to access general information (30%).

Respondents indicated the lowest frequency of use (never used) for the following computer support tools: database management (81%), Internet to access information about medical courses and objectives (76%), statistical computing (62%) and spreadsheet computing (57%). A number of respondents indicated in the open-ended questions that they did not use a computer for these purposes but if the task required it they would use a computer to assist them.

The mean response for the use of the Internet to view the computerized histology courseware was 2.02 (*SD* = 0.71). This value indicates that the majority of students viewed the courseware less than once per week. However, a number of respondents indicated in the open-ended section of the survey that they used the Internet to view the histology courseware less than once per week but they used it very frequently during certain weeks such as the week before exams.

Usefulness of Computer Support Tools

Usefulness of computer support tools was rated using a five point Likert scale (1=Not applicable, 2=Not Useful, 3=Useful, 4=Quite Useful, 5=Very Useful). Mean scores and standard deviations are reported in Table 3. The mean scores and standard deviations were calculated by including responses of only scores of two and greater. The 'Not applicable" response was coded as a non-response for these calculations.

Table 4.
Rating of usefulness of computer support tools.

Frequency of Use *	Mean	*SD*	Not Applic-able	Not Useful	Useful	Quite Useful	Very Useful
Word-processing	4.41	0.82	3(5)	0(0)	12(19)	9(15)	38(61)
Statistical Computing	4.13	0.94	32(53)	1(2)	8(13)	7(11)	14(23)
Spreadsheet Computing	4.18	0.90	28(45)	0(0)	11(18)	6(10)	17(27)
Database Management	4.00	1.03	42(68)	1(2)	7(11)	3(5)	9(14)
E-Mail with friends or family	4.82	0.50	0(0)	0(0)	3(5)	5(8)	54(87)
E-Mail with other students	4.56	0.73	3(5)	0(0)	8(13)	10(16)	41(66)
E-Mail with professors	4.68	0.54	2(3)	0(0)	2(3)	15(25)	43(69)
Internet to access general information	4.32	0.81	6(10)	0(0)	12(19)	14(23)	30(48)
Internet to access information about University	3.92	0.91	5(8)	3(5)	17(27)	19(31)	18(29)
Internet to access information about the Faculty	3.82	0.96	6(10)	3(5)	22(35)	13(21)	18(29)
Internet to access information about medical courses & objectives	3.42	1.21	36(58)	8(13)	6(10)	5(8)	7(11)
Internet to access external medical information resources	4.17	0.83	9(15)	0(0)	14(23)	16(25)	23(37)
Internet to view computerized histology slides	4.22	0.97	3(5)	5(8)	7(11)	17(27)	30(49)

Notes. Values enclosed in parentheses represent percentages. * One non-response.

The mean scores for the usefulness of computer support tools ranged from 3.42 to 4.82. The majority of respondents indicated that the computer support tools were useful. They indicated the following computer support tools as being the most useful (quite and/or very useful): e-mail with friends or family (95%), e-mail with professors (94%), e-mail with other students (82%), Internet to view computerized histology slides (76%) and Internet to access general information (71%).

A number of respondents chose the "not applicable" usefulness rating which indicates that they did not have an opportunity or requirement to use the following computer support tools: database management (68%), Internet to access information about medical courses or objectives (58%), statistical computing (53%), and spreadsheet computing (45%).

Thirteen percent of respondents indicated that the Internet was not a useful tool to access information about medical courses and objectives. However, the standard deviation for this item was 1.21 indicating a relatively high degree of response variation. Eight percent of respondents indicated that the Internet was not a useful tool to view the computerized histology slides.

Opinions about Computerized Histology Slides

Respondents indicated positive opinions about the computerized histology slides on a seven point Likert scale (Table 5). The mean scores ranged from a low of 5.36 to a high of 6.16.

Table 5.
Opinions about the computerized histology slides.

Question #	Low Measure (=1)	High Measure (=7)	Mean	*SD*
B1	Extremely Bad	Extremely Good	5.38	1.10
B2	Difficult to use	Easy to Use	6.16	1.05
B3	Boring	Interesting	5.36	1.14
B4	Unproductive	Productive	5.52	1.30
B5	Unpleasant	Pleasant	5.56	1.13
B6	Time Wasting	Time Saving	5.54	1.36
B7	Frustrating	Satisfying	5.38	1.17
B8	Difficult to Access	Easy to Access	5.65	1.55
B9	Not Valuable	Valuable	5.70	1.41

Media Utilized to Study Anatomy

Six percent of respondents indicated that they only used the computerized histology slides to study anatomy (Table 6). Eight percent indicated that they only used the recommended textbook. Fifty-six percent used both the textbook and computerized histology slides. Thirty percent used the textbook, computerized histology slides and prepared slides and microscope.

Table 6.
Responses indicating how students studied anatomy for assigned body systems.

Media Utilized	Count	Percent (%)
Did not study	0	0
Textbook only	5	8
Microscope only	0	0
Computerized Slides only	4	6
Textbook & Microscope	0	0
Textbook & Computerized Slides	35	56
Microscope & Computerized Slides	0	0
Textbook, Microscope & Computerized Slides	19	30

Reasons given for not using the computerized slides or using both the microscope and computerized slides to study anatomy are provided in Table 7. The primary reasons given were that respondents wanted to use all available resources and that the microscope provided more viewing options. Seven respondents indicated in the open-ended portion of the survey that the computerized slides did not provide enough detail.

Table 7.

Reasons why students did not use the computerized slides or used both the microscope and the computerized slides.

Reason	True	False
Did not trust the computerized slides	1	21
Did not like using the computerized slides	4	17
Computerized slides were hard to access	4	18
Wanted to use all available resources	18	7
Microscope provided more viewing options than computerized slides	14	7
Preferred the hands-on activity associated with the microscope	8	14

How Students used the Computerized Slides

Respondents indicated on a five-point Likert scale (never, 25% of the time, 50% of the time, 75% of the time, exclusively) that they studied the computerized histology slides by themselves 75% of the time (Mean=3.74, *SD* =1.52) and 25 %of the time (Mean=2.02, *SD* =1.37) in the company of at least one other student. A number of students indicated that they tried to access the material from home but few students accessed it regularly from home (Mean=1.03, *SD*=0.18).

Barriers to Using Computerized Histology Slides

Respondents indicated on a three point Likert scale (No barrier, Somewhat a barrier, Major barrier) that they did not have any major difficulties in using the computerized histology slides (Table 8). However a number of respondents indicated that a barrier to using the material was difficulty in accessing the material from home (Table

8). Eleven students indicated in the open-ended portion of the survey that they wanted to be able to access the computerized histology courseware from home. They were unable to access the program due to either inadequate bandwidth or technical problems installing the browser plug-ins. Five students elaborated that the computerized histology program required more viewing controls so as to be able to pause and rewind. Three indicated that they had trouble reading the information off the screen or listening to the audio descriptions. They suggested that hard copy transcripts be provided of the program.

Table 8.
Identification of barriers to using the computerized histology slides.

Potential Barrier	1*	2*	3*	Mean	SD
Inconvenient access to terminals in the labs	22	16	0	1.62	0.68
Inadequate knowledge on using the technology	34	3	2	1.18	0.49
Difficulty in accessing or using the program	31	8	0	1.27	0.55
Difficulty of reading materials on a computer screen	39	0	0	1.11	0.32
Slow speed of system impaired my learning	19	15	5	1.31	0.59
Inability to connect from home	17	8	12	1.84	0.88
Slow speed to connect from home	9	4	23	1.80	0.89
Difficulty in learning the system	37	2	0	1.13	0.46

* Note: 1= No Barrier, 2=Somewhat a Barrier, 3=Major Barrier

The Effect of Values, Attitudes, Beliefs and Experience on Computer Use

Respondents provided opinions on the use of computer technology and in particular its use to support medical education in Section E of the survey using a five point Likert scale (Strongly disagree, Disagree, Neutral, Agree, Strongly Agree). These items were used to develop composite measure indexes to identify factors that affect the way that individuals approach and use computers.

Categories of Computer Use

Computer use was divided into four categories based on Mitra's (1997) research at Wake Forest University. These categories were the use of computers for word processing, task activities, non-task activities and mathematical computing and database management. An alpha coefficient of reliability was not calculated for the use of a computer for word processing activities, as there was only one item in the survey concerning this activity. Rather this item was included in the task activity category. The mean scores for the seven survey factors included in an index for the use of computers for task activities ranged from 1.28 to 3.18 (Table 9). The alpha coefficient for this index was .75. The mean scores for the three survey factors included in an index for the use of computers for non-task activities ranged from 2.79 to 4.75 (Table 9). The alpha coefficient for this index was .58. The mean scores for the three factors in an index for the use of a computer for mathematical computing and data management activities ranged from 1.27 to 1.46 (Table 9). The alpha coefficient for this index was .75.

Table 9.
Categories of Computer Use

Category	Category Items	Mean	*SD*	Reliability
Word Processing	Use of the Computer to do Word-processing tasks.	3.18	1.13	N/A
Task Activity	Word processing tasks.	3.18	1.13	.75
	Use of e-mail to communicate with professors.	2.97	1.12	
	Use of the Internet to access information about the University of Calgary.	2.18	0.77	
	Use of the Internet to access information about the Faculty of Medicine.	2.18	0.85	
	Use of the Internet to access information about medical course schedules or objectives.	1.28	0.58	
	Use of the Internet to locate medical resources external to the University of Calgary.	2.14	0.86	
	Use of the Internet to view the computerized histology slides.	2.22	0.71	
Non-Task Activity	Use of e-mail to converse with friends or family.	4.75	0.67	.58
	Use of e-mail to communicate with other students.	3.89	1.31	
	Use of the Internet to access general or personal information.	2.79	1.21	
Mathematical Computing & Data Management	Use of the computer to do statistical computing tasks.	1.46	0.69	.75
	Use of the computer to do spreadsheet computing tasks.	1.64	0.90	
	Use of the computer to do database management tasks.	1.27	0.65	

Usage of Computer Support Tools

The mean scores of the seven factors included in an index for usage of computer support tools ranged from 1.27 to 4.75 (Table 10). The alpha coefficient for this index was .76.

Table 10.
Factors included in an index for usage.

Factors	Mean	*SD*	Reliability
Word processing tasks.	3.18	1.13	.76
Use of the computer to do statistical computing tasks.	1.46	0.69	
Use of the computer to do spreadsheet computing tasks.	1.64	0.90	
Use of the computer to do database management tasks.	1.27	0.65	
Use of e-mail to communicate with professors.	2.97	1.12	
Use of e-mail to converse with friends or family.	4.75	0.67	
Use of e-mail to communicate with other students.	3.89	1.31	

Attitude towards Computer Use

The mean scores of the five survey factors included in an index for measuring attitude towards computer use ranged from 3.49 to 3.97 (Table 11). The alpha coefficient for this index was .71.

Table 11.
Factors included in an index for attitude towards computer use.

Factors	Mean	SD	Reliability
Increased use of technology makes learning easier.	3.76	0.89	.71
The introduction of computers to teaching is not too rapid. *	3.87	0.87	
I feel comfortable using computers.	3.97	0.98	
I have no apprehensions to using computers. *	3.63	1.12	
Computers in teaching do not make the learning process too impersonal. *	3.49	1.00	

* Factors were originally stated as negative factors in the survey but were re-coded as positive for this analysis.

Computer Anxiety

The mean scores for the four survey factors included in an index measuring anxiety related to computer use ranged from 2.13 to 2.65 (Table 12). The alpha coefficient for this index was .69.

Table 12.
Factors included in an index for anxiety.

Factors	Mean	*SD*	Reliability
The introduction of computers to teaching is too rapid.	2.13	0.89	.69
I have a certain apprehension to using computers.	2.32	1.12	
Computers in teaching make the learning process too impersonal.	2.51	1.00	
Computers scare me.*	2.65	1.11	

* Item was originally stated as a positive item in the survey but was re-coded as negative for this analysis.

Computer Confidence

The mean scores of the five survey factors included in an index measuring confidence about using computers ranged from 2.84 to 4.13 (Table 13). The alpha coefficient for this index was .86

Table 13.
Factors included in an index for confidence.

Factors	Mean	*SD*	Reliability
I feel comfortable using computers.	3.97	0.98	.86
I like learning new software applications.	3.40	1.01	
I could probably teach myself most things I need to know about computers.	2.84	1.36	
I will do lots of work with computers. *	4.13	1.00	
If I had a problem using a computer, I could solve it one way or another.	3.05	1.30	

* Item was originally stated as a negative item in the survey but was re-coded as positive for this analysis.

"Liking" to use Computers

The mean scores of the six survey factors included in an index measuring "liking" to use computers ranged from 2.78 to 3.94 (Table 14). The alpha coefficient for this index was .83.

Table 14.
Factors included in an index for liking.

Factors	Mean	*SD*	Reliability
I would like to see to see the computer used more to support medical education.	3.44	0.88	.83
I would like to be able to access more course information via the internet either from home or through the Medical Faculty computer lab.	3.56	0.91	
I would like to see the internet, either from home or through the Medical Faculty computer lab, used more by faculty to present instruction (i.e. information that is usually provided through a lecture).	2.78	1.16	
I would like to see the internet, either from home or through the Medical Faculty computer lab, used more by students to communicate with each other.	3.34	0.87	
I like using the internet to access information.	3.56	0.98	
I like learning independently.	3.94	0.84	

Future Usefulness of Computer Support Tools

The mean scores of the two survey factors included in an index measuring the future usefulness of computer support tools ranged from 4.40 to 4.44 (Table 15). The alpha coefficient for this index was .49.

Table 15.
Factors included in an index for usefulness.

Factors	Mean	*SD*	Reliability
I will use a computer in my future occupation.	4.44	0.62	.49
Knowing about computers will make my job easier.	4.40	0.56	

Computer Ability (Awareness, Programming Skill, Control)

The alpha coefficient for an index for computer ability based on Kay's (1993) research combining measures of computer awareness, programming skill and perceived control was .94. The mean scores of the four survey factors in an index measuring computer awareness ranged from 2.13 to 3.97 (Table 16). The alpha coefficient for this index was .83. The mean scores of the two survey factors included in an index measuring programming ability ranged from 1.86 to 2.08 (Table 16). The alpha coefficient for this index was .89. The mean scores for the six survey factors included in an index measuring perceived control of a computer ranged from 2.84 to 3.97 (Table 16). The alpha coefficient for this index was .89.

Table 16.
Factors included in an index for computer ability

Category	Category Factors	Mean	*SD*	Reliability
Awareness	I could teach someone to use a computer software package.	3.10	1.24	.83
	I can surf the web.	3.97	0.96	
	I could explain the Internet to someone.	3.43	1.20	
	I have participated in a listserv and/or newsgroup.	2.13	1.31	
Programming skill	I can write a simple computer program.	2.08	1.43	.89
	I can alter and/or debug the control file on my computer.	1.86	1.24	
Perceived Control	Increased use of technology makes learning easier.	3.76	0.89	.89
	I feel comfortable using computers.	3.97	0.98	
	I like learning new software applications.	3.40	1.01	
	Computers don't scare me at all.	3.35	1.11	
	I could probably teach myself most of the things I need to know about computers.	2.84	1.36	
	I can make the computer do what I want it to do.	3.05	1.28	
	If I had a problem using a computer, I could solve it one way or another.	3.05	1.30	
	I prefer to learn about new programs or applications on my own.	2.70	1.24	

Ability vs. Expertise

The computer ability index was correlated with the self-reported computer expertise categories to determine the validity of the respondent's self-ratings. The correlation coefficient was **r** =. 78. This indicates a strong positive relationship between the calculated measure of computer ability and the self-reported measure of computer expertise.

Interaction Effects

A Multivariate analysis was performed to determine if there was any interaction effects between the data. A 2x2x4 MANOVA was calculated using the independent variables access to a home computer (*yes or no*), gender (*male or female*), and expertise (*beginner, novice, intermediate, expert*). The dependent variables were the indexes developed to measure computer use. Wilks' Lambda measures indicated that there was no significance (alpha = .05) found for any interaction effects between all combinations of the independent variables (Table 17). An examination of main effects found that there was significant difference on the indexes for gender and expertise. There was no significance based on access to a home computer (Table 17).

Table 17.
MANOVA of the effect of gender, expertise and home access to a computer on measures related to computer use.

Effect	Hypothesis **df**	Error **df**	**F**	**p**
Gender	13.00	33.00	2.11*	.04
Expertise	39.00	98.47	1.76*	.01
Access to home computer	13.00	33.00	0.42	.95
Gender & Expertise	26.00	68.00	0.77	.77
Gender & Access to home computer	13.00	33.00	1.58	.14
Expertise & Access to home computer	26.00	66.00	0.77	.76
Gender & Expertise & Access to a home computer	26.00	66.00	1.23	.25

*p<.05

Main effect measures were further analyzed to determine the between subjects effects that were significant. Factorial ANOVAs were calculated individually for each independent variable against the dependent variables.

Gender – Between Subject Effects

Factorial ANOVA results (Table 18) indicated that there was no significant gender difference in computer ability.

Table 18.
ANOVA of Gender and Computer Ability

Source	**SS**	**df**	**MS**	**F**
Between	0.56	1	0.56	0.80
Within	42.40	61	0.70	

p>.38

Factorial ANOVA results (Table 19) indicated that there was no significant gender difference in the amount of computer anxiety reported by respondents.

Table 19.
ANOVA of Gender and Anxiety

Source	**SS**	**df**	**MS**	**F**
Between	0.20	1	0.20	0.37
Within	33.74	61	0.55	

p>.55

Factorial ANOVA results (Table 20) indicated that there was no significant gender difference in the positive attitude shown towards computers.

Table 20.
ANOVA of Gender and Attitude about Computers

Source	**SS**	**df**	**MS**	**F**
Between	0.13	1	0.13	0.29
Within	27.35	61	0.45	

p>.59

Factorial ANOVA results (Table 21) indicated that there was no significant gender difference in the amount of computer awareness reported by the respondents.

Table 21.
ANOVA of Gender and Computer Awareness

Source	**SS**	**df**	**MS**	**F**
Between	0.30	1	0.30	0.56
Within	31.98	60	0.53	

p>.46

Factorial ANOVA results (Table 22) indicated that there was no significant gender difference in the amount of computer confidence reported by the respondents.

Table 22.
ANOVA of Gender and Computer Confidence

Source	**SS**	**df**	**MS**	**F**
Between	0.21	1	0.21	0.25
Within	50.71	60	0.85	

p>.62

Factorial ANOVA results (Table 23) indicated that there was no significant gender difference in the amount of perceived control of a computer reported by the respondents.

Table 23.
ANOVA of Gender and Perceived Control of a Computer

Source	SS	df	MS	F
Between	0.87	1	0.87	0.91
Within	58.20	61	0.95	

p>.34

Factorial ANOVA results (Table 24) indicated that there was no significant gender difference in the amount of computer "liking" reported by the respondents.

Table 24.
ANOVA of Gender and Computer "Liking"

Source	SS	df	MS	F
Between	1.58	1	1.58	3.38
Within	27.51	59	0.47	

p> .07

Factorial ANOVA results (Table 25) indicated that there was no significant gender difference in computer programming ability reported by the respondents.

Table 25.
ANOVA of Gender and Computer Programming Ability

Source	SS	df	MS	F
Between	1.53	1	1.53	.95
Within	98.40	61	1.61	

p>.33

Factorial ANOVA results (Table 26) indicated that there was no significant gender difference in the use of computers for task activities reported by the respondents.

Table 26.
ANOVA of Gender and Use of Computers for Task Activities

Source	SS	df	MS	F
Between	0.20	1	0.20	0.67
Within	18.29	60	0.31	

p>.42

Factorial ANOVA results (Table 27) indicated that there was no significant gender difference in the usage of computers reported by the respondents.

Table 27.
ANOVA of Gender and Usage of Computers

Source	SS	df	MS	F
Between	0.76	1	0.76	2.04
Within	22.64	61	0.37	

p>.16

Factorial ANOVA results (Table 28) indicated that there was no significant gender difference in a rating of usefulness of computers reported by the respondents.

Table 28.
ANOVA of Gender and Usefulness of Computers

Source	SS	df	MS	F
Between	0.09	1	0.09	0.41
Within	14.01	61	0.23	

p >.52

Factorial ANOVA results (Table 29) indicated that there was no significant gender difference in the use of computers for non-task activities reported by the respondents.

Table 29.
ANOVA of Gender and Use of Computers for Non-Task Activities

Source	SS	df	MS	F
Between	0.06	1	0.06	0.09
Within	40.54	61	0.67	

$p>.76$

Factorial ANOVA results (Table 30) indicated that there was no significant gender difference in the use of computers for mathematical computing and data processing activities reported by the respondents.

Table 30.
ANOVA of Gender and Use of Computers for Mathematical Computing and Data Processing

Source	SS	df	MS	F
Between	0.22	1	0.22	0.57
Within	23.62	61	0.38	

$p>.45$

Home Access - Between subject effects

Factorial ANOVA results (Table 31) indicated that there was no significant difference on a measure of computer ability between subjects who indicated whether they had access to a home computer.

Table 31.
ANOVA of Home Access to a Computer and Computer Ability

Source	SS	df	MS	F
Between	0.58	61	0.58	0.84
Within	42.37	1	0.70	

p>.36

Factorial ANOVA results (Table 32) indicated that there was no significant difference on a measure of computer anxiety between subjects who indicated whether they had access to a home computer.

Table 32.
ANOVA of Home Access to a Computer and Anxiety

Source	SS	df	MS	F
Between	0.48	1	0.48	0.87
Within	33.47	61	0.55	

p>.35

Factorial ANOVA results (Table 33) indicated that there was no significant difference on a measure of attitude about computers between subjects who indicated whether they had access to a home computer.

Table 33.
ANOVA of Home Access to a Computer and Attitude about Computers

Source	SS	df	MS	F
Between	0.20	1	0.20	0.44
Within	27.28	61	0.45	

p>.51

Factorial ANOVA results (Table 34) indicated that there was no significant difference on a measure of computer awareness between subjects who indicated whether they had access to a home computer.

Table 34.
ANOVA of Home Access to a Computer and Computer Awareness

Source	**SS**	**df**	**MS**	**F**
Between	0.54	1	0.54	1.02
Within	31.74	60	0.53	

$p > .32$

Factorial ANOVA results (Table 35) indicated that there was no significant difference on a measure of computer confidence between subjects who indicated whether they had access to a home computer.

Table 35.
ANOVA of Home Access to a Computer and Computer Confidence

Source	**SS**	**df**	**MS**	**F**
Between	0.58	1	0.58	0.70
Within	50.33	60	0.84	

$p > .41$

Factorial ANOVA results (Table 36) indicated that there was no significant difference on a measure of perceived control of a computer between subjects who indicated whether they had access to a home computer.

Table 36.
ANOVA of Home Access to a Computer and Perceived Control of a Computer

Source	SS	df	MS	F
Between	0.26	1	0.26	0.27
Within	58.81	61	0.96	

p> .61

Factorial ANOVA results (Table 37) indicated that there was no significant difference in the amount of computer "liking" between subjects who indicated whether they had access to a home computer.

Table 37.
ANOVA of Home Access to a Computer and Computer "Liking"

Source	SS	df	MS	F
Between	0.50	1	0.50	1.03
Within	28.59	59	0.49	

p> .32

Factorial ANOVA results (Table 38) indicated that there was no significant difference in computer programming ability between subjects who indicated whether they had access to a home computer.

Table 38.
ANOVA of Home Access to a Computer and Computer Programming Ability

Source	SS	df	MS	F
Between	2.03	1	2.03	1.26
Within	97.91	61	1.61	

p> .26

Factorial ANOVA results (Table 39) indicated that there was no significant difference in the use of computers for task activities between subjects who indicated whether they had access to a home computer.

Table 39.
ANOVA of Home Access to a Computer and Use of Computers for Task Activities

Source	SS	df	MS	F
Between	0.01	1	0.01	0.04
Within	18.48	60	0.31	

$p > .84$

Factorial ANOVA results (Table 40) indicated that there was no significant difference in the usage of computers between subjects who indicated whether they had access to a home computer.

Table 40.
ANOVA of Home Access to a Computer and Usage of Computers

Source	SS	df	MS	F
Between	0.01	1	0.01	0.03
Within	23.37	61	0.38	

$p > .85$

Factorial ANOVA results (Table 41) indicated that there was no significant difference in a rating of usefulness of computers between subjects who indicated whether they had access to a home computer.

Table 41.
ANOVA of Home Access to a Computer and Usefulness of Computers

Source	SS	df	MS	F
Between	0.13	1	0.13	0.55
Within	13.98	61	0.23	

p> .46

Factorial ANOVA results (Table 42) indicated that there was no significant difference in the use of computers for non-task activities computers between subjects who indicated whether they had access to a home computer.

Table 42.
ANOVA of Home Access to a Computer and Use of Computers for Non-Task Activities

Source	SS	df	MS	F
Between	1.14	1	1.14	1.77
Within	39.46	61	0.65	

p> .19

Factorial ANOVA results (Table 43) indicated that there was no significant difference in the use of computers for mathematical computing and data processing activities between subjects who indicated whether they had access to a home computer.

Table 43.
ANOVA of Home Access to a Computer and Use of Computers for Mathematical Computing and Data Processing

Source	SS	df	MS	F
Between	0.23	1	0.23	0.58
Within	23.62	61	0.39	

p>.45

Computer Expertise - Between subject effects

Factorial ANOVA results (Table 44) indicated that there was significant difference between a measure of computer ability and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between all categories except for the beginner/novice comparison (Table 45).

Table 44.
ANOVA of Computer Expertise and Computer Ability

Source	**SS**	**df**	**MS**	**F**
Between	27.67	3	9.22	35.61*
Within	15.29	59	0.26	

*p< .01

Table 45.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Computer Ability

Comparison	Mean Difference	Critical Difference	p-Value
1,2	-.52	0.59	<.10
1,3	-1.34	0.56	<.01*
1,4	-2.64	0.88	<.01*
2,3	-0.81	0.43	<.01*
2,4	-2.12	0.81	<.01*
3,4	-1.30	0.78	<.01*

*p< .05

Factorial ANOVA results (Table 46) indicated that there was significant difference between a measure of computer anxiety and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between the comparison of the beginner/intermediate, beginner/expert and novice/expert categories (Table 47).

Table 46.
ANOVA of Computer Expertise and Computer Anxiety

Source	**SS**	**df**	**MS**	**F**
Between	12.14	3	4.05	10.95*
Within	21.80	59	0.37	

*p< .01

Table 47.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Computer Anxiety

Comparison	Mean Difference	Critical Difference	p-Value
1,2	0.56	0.71	<.17
1,3	0.97	0.66	<.01*
1,4	1.85	1.05	<.01*
2,3	0.41	0.51	<.16
2,4	1.29	0.96	<.01*
3,4	0.88	0.93	<.07

*p< .05

Factorial ANOVA results (Table 48) indicated that there was significant difference between a measure of attitude about computers and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between the comparison of the beginner/intermediate and beginner/expert (Table 49).

Table 48.
ANOVA of Computer Expertise and Attitude about Computers

Source	**SS**	**df**	**MS**	**F**
Between	6.85	3	2.28	6.53*
Within	20.63	59	0.35	

***p**< .01

Table 49.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Computer Anxiety

Comparison	Mean Difference	Critical Difference	p-Value
1,2	-0.44	0.69	<.34
1,3	-0.77	0.64	<.01*
1,4	-1.34	1.02	<.01*
2,3	-0.33	0.50	<.31
2,4	-0.90	0.94	<.06
3,4	-0.57	0.90	<.36

***p**< .05

Factorial ANOVA results (Table 50) indicated that there was significant difference between a measure of computer awareness and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between the comparison of all categories except beginner/intermediate (Table 51).

Table 50.
ANOVA of Computer Expertise and Computer Awareness

Source	**SS**	**df**	**MS**	**F**
Between	14.79	3	4.93	16.44*
Within	17.49	58	0.30	

*p< .01

Table 51.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Computer Awareness

Comparison	Mean Difference	Critical Difference	p-Value
1,2	-0.42	0.65	<.34
1,3	-1.00	0.60	<.01*
1,4	-1.95	0.95	<.01*
2,3	-0.58	0.47	<.01*
2,4	-1.54	0.87	<.01*
3,4	-0.95	0.84	<.02*

*p<.05

Factorial ANOVA results (Table 52) indicated that there was significant difference between a measure of computer confidence and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between the comparison of all categories except intermediate/expert (Table 53).

Table 52.
ANOVA of Computer Expertise and Computer Confidence

Source	**SS**	**df**	**MS**	**F**
Between	29.23	3	9.74	26.05*
Within	21.69	58	0.37	

*p< .01

Table 53.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Computer Confidence

Comparison	Mean Difference	Critical Difference	p-Value
1,2	-0.74	0.72	<.04*
1,3	-1.63	0.67	<.01*
1,4	-2.51	1.06	<.01*
2,3	-0.88	0.52	<.01*
2,4	-1.77	0.97	<.01*
3,4	-0.88	0.94	<.07

*p< .05

Factorial ANOVA results (Table 54) indicated that there was significant difference between a measure of perceived computer control and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between the comparison of all categories (Table 55).

Table 54.
ANOVA of Computer Expertise and Computer Control

Source	**SS**	**df**	**MS**	**F**
Between	33.46	3	11.48	27.55*
Within	24.61	59	0.42	

***p<** .01

Table 55.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Computer Control

Comparison	Mean Difference	Critical Difference	**p**-Value
1,2	-0.79	0.75	<.04*
1,3	-1.71	0.70	<.01*
1,4	-2.82	1.12	<.01*
2,3	-0.92	0.54	<.01*
2,4	-2.03	1.02	<.01*
3,4	-1.11	0.99	<.02*

***p<** .05

Factorial ANOVA results (Table 56) indicated that there was significant difference between a measure of computer "liking" and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between the comparison of the beginner/intermediate categories (Table 57).

Table 56.
ANOVA of Computer Expertise and Computer Liking

Source	**SS**	**df**	**MS**	**F**
Between	5.27	3	1.76	4.20*
Within	23.82	57	.42	

*p< .01

Table 57.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Computer Liking

Comparison	Mean Difference	Critical Difference	p-Value
1,2	-0.42	0.79	<.50
1,3	-0.82	0.74	<.02*
1,4	-0.88	1.14	<.19
2,3	-0.40	0.55	<.23
2,4	-0.45	1.02	<.65
3,4	-0.05	0.99	<.99

*p< .05

Factorial ANOVA results (Table 58) indicated that there was significant difference between computer programming ability and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between the comparison of all categories except for beginner/novice (Table 59).

Table 58.
ANOVA of Computer Expertise and Programming Ability

Source	**SS**	**df**	**MS**	**F**
Between	56.60	3	18.87	25.68*
Within	43.34	59	0.74	

*p< .01

Table 59.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Programming Ability

Comparison	Mean Difference	Critical Difference	p-Value
1,2	0.20	1.00	<.95
1,3	-0.94	0.93	<.04*
1,4	-3.67	1.48	<.01*
2,3	-1.14	0.72	<.01*
2,4	-3.87	1.36	<.01*
3,4	-2.73	1.31	<.01*

*p< .05

Factorial ANOVA results (Table 60) indicated that there was no significant difference between a measure of computer use for task activities and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). It appears that regardless of computer expertise the respondents used computer support tools when necessary

Table 60.
ANOVA of Computer Expertise and Use of Computers for Task Activities

Source	**SS**	**df**	**MS**	**F**
Between	2.18	3	0.73	2.59
Within	16.31	58	0.28	

p> .06

Factorial ANOVA results (Table 61) indicated that there was significant difference between a measure of computer usage and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found no significant results between the comparison of all categories (Table 62).

Table 61.
ANOVA of Computer Expertise and Computer Usage

Source	**SS**	**df**	**MS**	**F**
Between	3.73	3	1.24	3.73*
Within	19.65	59	0.33	

***p**< .02

Table 62.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Computer Usage

Comparison	Mean Difference	Critical Difference	p-Value
1,2	-0.18	0.67	<.89
1,3	-0.48	0.63	<.20
1,4	-0.98	0.99	<.06
2,3	-0.30	0.49	<.38
2,4	-0.70	0.91	<.11
3,4	-0.50	0.88	<.46

$p < .05$

Factorial ANOVA results (Table 63) indicated that there was no significant difference between a measure of computer usefulness and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). It appears that regardless of expertise that the respondents recognized the usefulness of computer support tools.

Table 63.
ANOVA of Computer Expertise and Computer Usefulness

Source	**SS**	**df**	**MS**	**F**
Between	1.36	3	0.46	2.11
Within	12.74	59	0.22	

$p > .10$

Factorial ANOVA results (Table 64) indicated that there was significant difference between a measure of the use of computers for non-task activities and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). A Scheffe Post Hoc test to study the amount of variance that each of the four categories of expertise contributed to the overall variance found significant results between the comparison of beginner/expert and novice/expert categories (Table 65).

Table 64.
ANOVA of Computer Expertise and Use of Computers for Non Task Activities

Source	SS	df	MS	F
Between	8.98	3	2.99	5.58*
Within	31.63	59	0.54	

*p< .01

Table 65.
Scheffe Post Hoc Test Examining Computer Expertise Categories and Use of Computers for Non Task Activities

Comparison	Mean Difference	Critical Difference	p-Value
1,2	-0.12	0.85	<.98
1,3	-0.63	0.80	<.17
1,4	-1.46	1.27	<.02*
2,3	-0.51	0.61	<.14
2,4	-1.34	1.16	<.02*
3,4	-0.83	1.12	<.22

*p< .05

Factorial ANOVA results (Table 66) indicated that there was no significant difference between a measure of the use of computers for mathematical computing and data processing and the four self-reported categories of computer expertise (1=Beginner, 2=Novice, 3=Intermediate, 4=Expert). It appears that regardless of expertise that the respondents did not vary in their use of computer support tools to perform mathematical computing and data processing.

Table 66.
ANOVA of Computer Expertise and Use of Computers for Mathematical Computing and Data Processing

Source	SS	df	MS	F
Between	1.71	3	0.57	1.52
Within	22.14	59	0.38	

$p > .21$

Effect of Anxiety on the Use of Computer Support Tools

The respondents were split into dichotomous groups based on the mean of the anxiety index to study the effect of anxiety on the use of computer support tools (Table 67). Unpaired t-tests (**p** < .05) indicated that there was no significant difference between the low and high anxiety groups on ratings of frequency and usefulness of the computerized histology slides. There was a significant difference (**t**=3.52, **df**=61, **p**< .05) between the two groups on the opinion statement "I will use a computer in my future occupation". There was no significant difference on the opinion statement "Knowing about computers will make my job easier". There was no significant difference between the groups on the use of the computer for task purposes and for math computing and data processing. However, there was a significant difference between the groups on the use of computer for non-task activities (**t**=2.43, **df**=61, **p**< .05), usage of computer support tools (**t**=2.45, **df**=61,**p**< .05) and a measure of the usefulness of computer support tools (**t**=2.92, **df**=61,**p**< .05).

Table 67.
The Effect of Anxiety on the Use of Computer Support Tools

Item	Anxiety (Lo)	Anxiety (Hi)	**df**	**t**-Value
Frequency of use of the computerized histology slides (Q. A-13)	Mean =2.29 *SD*=0.72 n=34	Mean=2.14 *SD*=0.69 N=29	61	0.87
Rating of Usefulness of the computerized histology slides (Q. A-13)	Mean=4.24 *SD*=0.99 n=34	Mean=3.86 *SD*=1.35 n=28	60	1.27
I will use a computer in my future occupation (Q. E-6)	Mean=4.68 *SD*=0.59 n=34	Mean=4.17 *SD*=0.54 n=28	61	3.52*
Knowing about computers will make my job easier (Q. E-8)	Mean=4.47 *SD*=0.56 n=34	Mean=4.31 *SD*=0.54 n=29	61	1.15
Use of Computer Support Tools for Task Activities	Mean=2.38 *SD*=0.51 n=33	Mean=2.18 *SD*=0.59 n=29	60	1.40
Use of Computer Support Tools for Non-Task Activities	Mean=4.03 *SD*=0.69 n=34	Mean=3.55 *SD*=0.87 n=29	61	2.43*
Use of Computer Support Tools for Mathematical Computing & Data Processing	Mean=1.59 *SD*=0.74 n=34	Mean=1.30 *SD*=0.39 n=29	61	1.88
Usage of Computer Support Tools	Mean=2.90 *SD*=0.74 n=34	Mean=2.54 *SD*=0.39 n=29	61	2.45*
Usefulness of Computer Support Tools	Mean=4.57 *SD*=0.45 n=34	Mean=4.24 *SD*=0.46 n=29	61	2.92*

***p**<.05

Effect of Attitude on the Use of Computer Support Tools

The respondents were split into dichotomous groups based on the mean of the attitude index to study the effect of attitude on the use of computer support tools (Table 68). An unpaired t-test (**p**<.05) indicated that there was no significant difference between the low and high attitude groups on a rating of frequency of use for the computerized histology courseware. There was a significant difference between the two groups on a rating of usefulness of the computerized histology courseware (**t**= -2.21, **df**=60,**p**< .05). There was a significant difference (**t**= -3.65, **df**=61, **p**< .05) between the two groups on the opinion statement "I will use a computer in my future occupation". There was no significant difference on the opinion statement "Knowing about computers will make my job easier". There was no significant difference between the groups on the use of the computer for task purposes. However, there was a significant difference between the groups on the use of computer for non-task activities (**t**= -2.17, **df** =61, **p**< .05), use of computers for math computing and data processing activities (**t**= -2.20, **df**=61, **p**< .05), usage of computer support tools (**t**= -2.43, **df**=61,**p**< .05) and a measure of the usefulness of computer support tools (**t**= -3.46, **df**=61,**p**< .05).

Table 68.
The Effect of Attitude on the Use of Computer Support Tools

Item	Attitude (Lo)	Attitude (Hi)	**df**	**t**-Value
Frequency of use of the computerized histology slides (Q. A-13)	Mean =2.14 *SD*=0.83 n=22	Mean=2.27 *SD*=0.63 N=41	61	-0.70
Rating of Usefulness of the computerized histology slides (Q. A-13)	Mean=3.62 *SD*=1.53 n=21	Mean=4.29 *SD*=0.87 n=41	60	-2.21*
I will use a computer in my future occupation (Q. E-6)	Mean=4.09 *SD*=0.61 n=22	Mean=4.63 *SD*=0.54 n=41	61	-3.65*
Knowing about computers will make my job easier (Q. E-8)	Mean=4.23 *SD*=0.53 n=22	Mean=4.49 *SD*=0.55 n=41	61	-1.81
Use of Computer Support Tools for Task Activities	Mean=2.14 *SD*=0.58 n=22	Mean=2.36 *SD*=0.52 n=40	60	-1.53
Use of Computer Support Tools for Non-Task Activities	Mean=3.52 *SD*=0.86 n=22	Mean=3.97 *SD*=0.75 n=41	61	-2.18*
Use of Computer Support Tools for Mathematical Computing & Data Processing	Mean=1.23 *SD*=0.35 n=22	Mean=1.58 *SD*=0.60 n=41	61	-2.20*
Usage of Computer Support Tools	Mean=2.49 *SD*=0.62 n=22	Mean=2.87 *SD*=0.58 n=41	61	-2.43*
Usefulness of Computer Support Tools	Mean=4.16 *SD*=0.45 n=22	Mean=4.56 *SD*=0.44 n=41	61	-3.46*

$^*p< .05$

Effect of Computer Awareness on the Use of Computer Support Tools

The respondents were split into dichotomous groups based on the mean of the awareness index to study the effect of awareness on the use of computer support tools (Table 69). Unpaired t-tests (**p**< .05) indicated that there was no significant difference between the low and high awareness groups on ratings of frequency of use and usefulness for the computerized histology courseware. There was a significant difference (**t**= -3.81, **df**=60, **p**< .05) between the two groups on the opinion statement "I will use a computer in my future occupation". There was no significant difference on the opinion statement "Knowing about computers will make my job easier". However, there was a significant difference between the groups on the use of the computer for task purposes (**t**= -2.64, **df**=59, **p**< .05), use of the computer for non-task activities (**t**= -4.23, **df** =60, **p**< .05), use of computers for math computing and data processing activities (**t**= -2.28, **df**=60, **p**< .05), usage of computer support tools (**t**= -3.43, **df**=60, **p**< .05) and a measure of the usefulness of computer support tools (**t**= -3.55, **df**=60, **p**< .05).

Table 69.
The Effect of Computer Awareness on the Use of Computer Support Tools

Item	Awareness (Lo)	Awareness(Hi)	**df**	t-Value
Frequency of use of the computerized histology slides (Q. A-13)	Mean =2.09 *SD*=0.63 n=33	Mean=2.31 *SD*=0.71 n=29	60	-1.29
Rating of Usefulness of the computerized histology slides (Q. A-13)	Mean=3.82 *SD*=1.31 n=33	Mean=4.32 *SD*=0.95 n=28	59	-1.69
I will use a computer in my future occupation (Q. E-6)	Mean=4.18 *SD*=0.64 n=33	Mean=4.72 *SD*=0.46 n=29	60	-3.82*
Knowing about computers will make my job easier (Q. E-8)	Mean=4.27 *SD*=0.52 n=33	Mean=4.52 *SD*=0.57 n=29	60	-1.76
Use of Computer Support Tools for Task Activities	Mean=2.11 *SD*=0.44 n=33	Mean=2.47 *SD*=0.61 n=28	59	-2.64*
Use of Computer Support Tools for Non-Task Activities	Mean=3.46 *SD*=0.79 n=33	Mean=4.23 *SD*=0.64 n=29	60	-4.23*
Use of Computer Support Tools for Mathematical Computing & Data Processing	Mean=1.28 *SD*=0.38 n=33	Mean=1.63 *SD*=0.78 n=29	60	-2.28*
Usage of Computer Support Tools	Mean=2.50 *SD*=0.54 n=33	Mean=3.00 *SD*=0.60 n=29	60	-3.43*
Usefulness of Computer Support Tools	Mean=4.23 *SD*=0.47 n=33	Mean=4.62 *SD*=0.39 n=29	60	-3.55*

*p<.05

Effect of Computer Confidence on the Use of Computer Support Tools

The respondents were split into dichotomous groups based on the mean of the confidence index to study the effect of confidence on the use of computer support tools (Table 70). Unpaired t-tests (**p**< .05) indicated that there was no significant difference between the low and high confidence groups on ratings of frequency of use and usefulness for the computerized histology courseware. There was a significant difference (**t**= -2.57, **df**=59, **p**< .05) between the two groups on the opinion statement "I will use a computer in my future occupation". There was no significant difference on the opinion statement "Knowing about computers will make my job easier". There was no significant difference between the two groups on the use of the computer for task purposes. However, there was a significant difference between the groups on use of the computer for non-task activities (**t**= -2.91, **df** =60, **p**< .05), use of computers for math computing and data processing activities (**t**= -2.71, **df**=60, **p**< .05), usage of computer support tools (**t**= -2.73, **df**=60, **p**< .05) and a measure of the usefulness of computer support tools (**t**= -2.34, **df**=60, **p**< .05).

Table 70.
The Effect of Computer Confidence on the Use of Computer Support Tools

Item	Confidence (Lo)	Confidence (Hi)	**df**	t-Value
Frequency of use of the computerized histology slides (Q. A-13)	Mean =2.13 *SD*=0.67 n=31	Mean=2.32 *SD*=0.75 N=31	60	-1.07
Rating of Usefulness of the computerized histology slides (Q. A-13)	Mean=3.90 *SD*=1.32 n=30	Mean=4.19 *SD*=1.01 n=31	59	-0.98
I will use a computer in my future occupation (Q. E-6)	Mean=4.26 *SD*=0.58 n=31	Mean=4.65 *SD*=0.61 n=31	60	-2.57*
Knowing about computers will make my job easier (Q. E-8)	Mean=4.32 *SD*=0.54 n=31	Mean=4.48 *SD*=0.57 n=31	60	-1.14
Use of Computer Support Tools for Task Activities	Mean=2.18 *SD*=0.51 n=31	Mean=2.41 *SD*=0.58 n=30	59	-1.65
Use of Computer Support Tools for Non-Task Activities	Mean=3.54 *SD*=0.78 n=31	Mean=4.11 *SD*=0.74 n=31	60	-2.91*
Use of Computer Support Tools for Mathematical Computing & Data Processing	Mean=1.26 *SD*=0.35 n=31	Mean=1.67 *SD*=0.76 n=31	60	-2.71*
Usage of Computer Support Tools	Mean=2.55 *SD*=0.54 n=31	Mean=2.95 *SD*=0.62 n=31	60	-2.72*
Usefulness of Computer Support Tools	Mean=4.29 *SD*=0.48 n=31	Mean=4.57 *SD*=0.44 n=31	60	-2.34*

*p<.05

Effect of Perceived Control on the Use of Computer Support Tools

The respondents were split into dichotomous groups based on the mean of the perceived control index to study the effect of perceived control over computers on the use of computer support tools (Table 71). Unpaired t-tests (**p**< .05) indicated that there was no significant difference between the low and high perceived control groups on ratings of frequency of use and usefulness for the computerized histology courseware. There was no significant difference between the two groups on the opinion statement "I will use a computer in my future occupation". There was no significant difference on the opinion statement "Knowing about computers will make my job easier". However, there was a significant difference between the groups on use of the computer for task purposes (**t**= -2.47, **df**=60, **p**< .01), use of the computer for non-task activities (**t**= -3.19, **df** =61, **p**< .05), use of computers for math computing and data processing activities (**t**= -2.18, **df**=61, **p**< .05), and usage of computer support tools (**t**= -2.96, **df**=61, **p**< .05). There was no significant difference between the two groups on a measure of the usefulness of computer support tools.

Table 71.
The Effect of Perceived Control on the Use of Computer Support Tools

Item	Control (Lo)	Control (Hi)	**df**	**t**-Value
Frequency of use of the computerized histology slides (Q. A-13)	Mean =2.09 *SD*=0.64 n=32	Mean=2.36 *SD*=0.76 N=31	61	-1.48
Rating of Usefulness of the computerized histology slides (Q. A-13)	Mean=3.88 *SD*=1.29 n=32	Mean=4.27 *SD*=1.02 n=30	60	-1.32
I will use a computer in my future occupation (Q. E-6)	Mean=4.34 *SD*=0.55 n=32	Mean=4.55 *SD*=0.68 n=31	61	-1.33
Knowing about computers will make my job easier (Q. E-8)	Mean=4.38 *SD*=0.55 n=32	Mean=4.42 *SD*=0.56 n=31	61	-0.32
Use of Computer Support Tools for Task Activities	Mean=2.13 *SD*=0.45 n=32	Mean=2.46 *SD*=0.60 n=30	60	-2.47*
Use of Computer Support Tools for Non-Task Activities	Mean=3.51 *SD*=0.79 n=32	Mean=4.12 *SD*=0.72 n=31	61	-3.19*
Use of Computer Support Tools for Mathematical Computing & Data Processing	Mean=1.29 *SD*=0.38 n=32	Mean=1.63 *SD*=0.77 n=31	61	-2.18*
Usage of Computer Support Tools	Mean=2.52 *SD*=0.52 n=32	Mean=2.95 *SD*=0.64 n=31	61	-2.96*
Usefulness of Computer Support Tools	Mean=4.36 *SD*=0.48 n=32	Mean=4.48 *SD*=0.47 n=31	60	-1.04

*$p < .05$

Effect of Liking on the Use of Computer Support Tools

The respondents were split into dichotomous groups based on the mean of the "liking" index to study the effect of computer "liking" on the use of computer support tools (Table 72). An unpaired t-test (**p**< .05) indicated that there was no significant difference between the low and high "liking" groups on a rating of frequency of the computerized histology courseware. There was significant difference between the two groups on a measure of usefulness for the computerized histology courseware (**t**= -2.39, **df**=58, **p**< .05). There was significant difference between the two groups on the opinion statements "I will use a computer in my future occupation" (**t**= -2.68, **df**=59, **p**< .05) and "Knowing about computers will make my job easier" (**t**= -2.44, **df**=59, **p**< .01). There was significant difference between the two groups on the use of the computer for task purposes (**t**= -3.12, **df**=58, **p**< .05) . However, there was no significant difference between the groups on use of the computer for non-task purposes. There was significant difference between the two groups on the use of computers for math computing and data processing activities (**t**= -2.75, **df**=59, **p**< .05), usage of computer support tools (**t**= -2.49, **df**=59, **p**< .05) and a measure of the usefulness of computer support tools (**t**= -3.23, **df**=59, **p**< .05).

Table 72.
The Effect of Liking on the Use of Computer Support Tools

Item	Liking (Lo)	Liking (Hi)	**df**	t-Value
Frequency of use of the computerized histology slides (Q. A-13)	Mean =2.09 *SD*=0.69 n=32	Mean=2.38 *SD*=0.73 N=29	59	-1.57
Rating of Usefulness of the computerized histology slides (Q. A-13)	Mean=3.71 *SD*=1.32 n=31	Mean=4.41 *SD*=0.97 n=29	58	-2.39*
I will use a computer in my future occupation (Q. E-6)	Mean=4.25 *SD*=0.57 n=32	Mean=4.66 *SD*=0.62 n=29	59	-2.68*
Knowing about computers will make my job easier (Q. E-8)	Mean=4.25 *SD*=0.57 n=32	Mean=4.59 *SD*=0.50 n=29	59	-2.44*
Use of Computer Support Tools for Task Activities	Mean=2.09 *SD*=0.46 n=32	Mean=2.51 *SD*=0.58 n=32	58	-3.12*
Use of Computer Support Tools for Non-Task Activities	Mean=3.60 *SD*=0.84 n=32	Mean=4.01 *SD*=0.76 n=29	59	-1.98*
Use of Computer Support Tools for Mathematical Computing & Data Processing	Mean=1.27 *SD*=0.45 n=32	Mean=1.67 *SD*=0.73 n=29	59	-2.56*
Usage of Computer Support Tools	Mean=2.55 *SD*=0.58 n=32	Mean=2.93 *SD*=0.62 n=29	59	-2.49*
Usefulness of Computer Support Tools	Mean=4.25 *SD*=0.42 n=32	Mean=4.62 *SD*=0.48 n=29	59	-3.23*

*p< .05

Effect of Programming Ability on the Use of Computer Support Tools

The respondents were split into dichotomous groups based on the mean of the programming ability index to study the effect of programming ability on the use of computer support tools (Table 70). Unpaired t-tests (**p**< .05) indicated that there was no significant difference between the low and high programming ability groups on ratings of frequency of use of the computerized histology courseware, a measure of usefulness for the computerized histology courseware the opinion statement "I will use a computer in my future occupation", the opinion statement "Knowing about computers will make my job easier", the use of the computer for task purposes. However, there was significant difference between the groups on use of the computer for non-task purposes (**t**= -3.20, **df**=61, **p**< .05). There was no significant difference between the two groups on the use of computers for math computing and data processing activities, usage of computer support tools, and a measure of the usefulness of computer support tools.

Table 73.
The Effect of Programming Ability on the Use of Computer Support Tools

Item	Program. (Lo)	Program. (Hi)	**df**	t-Value
Frequency of use of the computerized histology slides (Q. A-13)	Mean =2.11 *SD*=0.71 n=36	Mean=2.37 *SD*=0.69 N=27	61	-1.46
Rating of Usefulness of the computerized histology slides (Q. A-13)	Mean=3.89 *SD*=1.35 n=36	Mean=4.31 *SD*=0.84 n=26	60	-1.40
I will use a computer in my future occupation (Q. E-6)	Mean=4.36 *SD*=0.59 n=36	Mean=4.56 *SD*=0.27 n=27	61	-1.25
Knowing about computers will make my job easier (Q. E-8)	Mean=4.42 *SD*=0.55 n=36	Mean=4.37 *SD*=0.57 n=29	61	0.33
Use of Computer Support Tools for Task Activities	Mean=2.19 *SD*=0.53 n=36	Mean=2.41 *SD*=0.56 n=26	60	-1.62
Use of Computer Support Tools for Non-Task Activities	Mean=3.55 *SD*=0.80 n=36	Mean=4.16 *SD*=0.69 n=27	61	-3.20*
Use of Computer Support Tools for Mathematical Computing & Data Processing	Mean=1.38 *SD*=0.61 n=36	Mean=1.56 *SD*=0.63 n=27	61	-1.17
Usage of Computer Support Tools	Mean=2.61 *SD*=0.63 n=36	Mean=2.91 *SD*=0.55 n=27	61	-1.95
Usefulness of Computer Support Tools	Mean=4.39 *SD*=0.48 n=36	Mean=4.46 *SD*=0.48 n=27	61	-0.61

***p< .05**

CHAPTER 5 – DISCUSSION

The aim of this research study was to examine the use of web-based technology to support medical education. In particular, the study evaluated the WWW as a delivery vehicle for courseware related to the study of histology. The objective of this research study was not to study the effectiveness of varying forms of instructional media but rather to focus on the delivery medium from a student's perspective. Rogers' (1995) five characteristics of innovations were used as a model to study how the students used and perceived web-based technology to support their medical education. Each of the five characteristics will be considered in turn to answer the three questions originally posed in chapter one of this thesis namely:

- How did the students use the Internet delivered histology courseware to support the learning of histology?
- How did the students use other computer support tools, in particular Internet based technologies, such as e-mail and the WWW, to support their medical education?
- How did the student's individual characteristics and attitudes affect their opinions and feelings on the usability and perceived effectiveness of computer support tools, including the Internet, in medical education?

Web-Based Technology & Medical Education

Chapter two of this thesis examined literature on the future direction of medicine and medical education. It is evident that technology currently plays an important role in medicine and is likely to grow in its use and application to physicians (Pickover, 1995; Galassi, 1995). Physicians, as well as other professionals, need to be life-long learners to maintain their knowledge and skills in a rapidly changing environment (Barnard, 1997; Walker, 1997; Friesse, 1996; Rakes, 1996; Mendelson, Levinson & Gaylin, 1996; Swanson & Anderson, 1993). The Internet and other computer support tools have been advocated as an efficient and effective way to provide access to new information and to provide learning opportunities for physicians (Mendelson, Levinson & Gaylin, 1996; Chan, Fox, Clamp & de Dombal, 1996; Kaufman & Patterson, 1995; Lemm & Snell, 1995; Landini & Rippin, 1995; De Jager & Tangelder, 1995; Farman & Scarfe, 1995). Medical schools are under increased pressure to ensure that graduating students have the computer literacy skills to perform their duties and to be able to access the latest information in their respective specialties (Walker, 1997; Kaufman & Patterson, 1995; Mann & Chaytor, 1992). The challenge for medical schools is to make the use of the Internet and computer support tools ubiquitous and effortless. This challenge can be successfully met only if medical schools have a good understanding of whom its students are and what factors will affect their acceptance of any new technological innovation (Haynes et al., 1994).

Trialability to Gain Acceptance

Trialability is the degree to which an innovation may be trialled before it replaces "an old way" of accomplishing a task. The frequency of use of computer support tools was examined to gain information related to Rogers' (1995) characteristic of trialability. Ninety-four percent of respondents indicated that they used a computer to perform word-processing tasks, 38 percent used it for statistical computing tasks, 43 percent used it for spreadsheet computing tasks, 19 percent used it for database management tasks, 97 percent used e-mail for some purpose, and 89 percent used it to access some form of information from the Internet. These statistics are similar to a McMaster University study (Haynes et al., 1994) which found that students used the following computer applications: word processing (98%), statistics (18%), filing (24%), electronic mail (13%) and online searching (40%). The advent of better graphical Internet browser interfaces and greater availability of Internet connections in the last four years probably explains the higher use of e-mail and online searching by medical students in 1997.

Ninety-two percent of the respondents used Internet technology to view the computerized histology courseware. The mean score for use was 2.02, which corresponds to usage of less than once a week. However, a number of respondents identified in the open-ended portion of the survey that they used it very frequently in particular week(s) such as the time before exams. This uneven usage pattern could be explained by the fact that the respondents are engaged in problem-based learning and would not have a need to study histology until they are required to use it. Therefore the usage pattern would not be spread out over weeks but concentrated into specific periods of high activity.

Interestingly, the respondents reported that they most frequently used the Internet to e-mail family and friends, e-mail professors, e-mail other students and access general or personal information. Most of these activities can be thought of as non-task activities (Mitra, 1997). This could be indicative of the fact that the students perceive a relative advantage to using the Internet to communicate and search for information over traditional communication methods such as "regular ground" mail and the telephone

(Mitra, 1997; Anderson & Joerg, 1996). The Internet provides a service that did not exist before, namely, relatively cheap communication that is independent of time and space. The fact that the respondents did not use the Internet more frequently for task purposes could also be due to the paucity of high quality information and resources, beyond the "readers digest" variety, related to medical education (Hannah, 1998). Using the Internet to supplement or replace traditional methods of accomplishing task activities will likely take a longer period of time. Students will identify a relative advantage only when there are online resources that are valuable, available and easy to find.

Relative Advantage

Relative advantage is the degree to which an innovation is perceived to be better than the idea it supersedes. The usefulness of the Internet and computer support tools was examined to determine if the students perceived any relative advantage in their use to support medical education. The respondents were consistent in their ratings of the usefulness of computer support tools. The mean scores of respondents who commented on the usefulness of a particular tool ranged from 3.42 (Internet to access information about medical courses/objectives) to 4.82 (use of the Internet to e-mail friends and family). Only one respondent reported that a computer was not useful for a particular task, statistical computing and database management. A small percentage of students indicated that the Internet was not a useful tool for accessing information about the University of Calgary (5%), accessing information about the faculty of medicine (5%), accessing information about course schedules and objectives (13%) and viewing the computerized histology courseware (8%). The eight- percent who rated the use of Internet as not useful to view the histology courseware is consistent with the percent who identified themselves as only using the textbook to study histology (8%). These findings are consistent with the research literature which reports that students rate computer support tools that they need to use to accomplish a specific task as being more useful (Anderson & Joerg, 1996; Haynes et al., 1994).

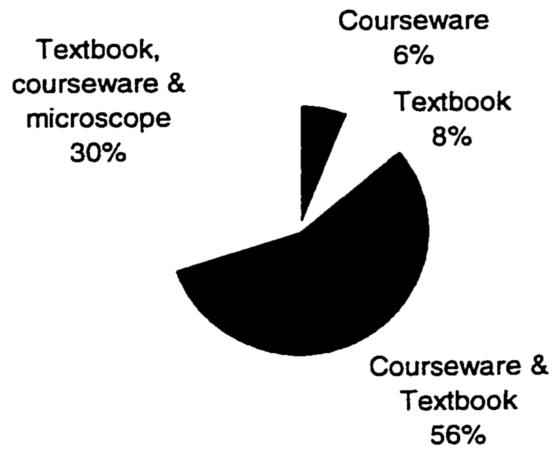

Figure 4. How respondents used various media to study histology.

It is evident that the respondents found a relative advantage to using the computerized histology courseware in their studies. Ninety-two percent rated it as a useful tool. However the majority of respondents saw its advantage as being an additional resource, rather than being the sole resource, to assist them in their learning. Only six percent of the respondents used this instructional media solely to study histology (Figure 4). Fifty-six percent used both the textbook and computerized histology courseware. Nobody used the combination of just the textbook and microscope. It is significant that none of the respondents used the microscope unless they used all other resources. Since the computerized histology courseware was designed to replace the need for microscopes and prepared slides, it appears that the respondents have readily accepted it for this purpose. But the fact that 30 percent still felt the need to include the microscope as an instructional resource shows that the introduction and acceptance of a new technology is a slow and steady process. It is important to allow a transition period where the new technology can be tried (trialability) in conjunction with the traditional method of accomplishing a task so that relative advantages can be observed (Kershaw, 1996). Interestingly 96 percent of the students used a textbook to study histology even if they augmented with other media. This is not surprising as the relative advantage of a book given its historical precedence, portability, high-quality graphics and ability to support both linear and non-linear learning styles. These factors are important considerations to any instructional designer that is considering replacing rather than augmenting the textbook as an instructional/learning resource.

Complexity

Complexity is the degree to which an innovation is perceived as difficult to understand and use. The barriers to using the Internet and computer support tools by medical students was examined to determine complexity issues arising from their point of view. As expected the barriers to using computer support tools, especially the Internet to support medical education were related to access and software problems (Starr, 1997; Friedman, 1996; Kearsley, Inglis, Fu & Kwok-Chan, 1995; Lynch & Wizer, 1995; Protti & Bannister, 1991). The barrier that was cited by respondents most often in both the closed and open-ended questions was that they wanted to be able to access material from home. Only five percent of the respondents identified computer knowledge as a problem and indicated that they had trouble learning how to operate the computerized histology courseware.

Software problems will always be identified when a number of users are using a new product. A University that is introducing new software applications or computer support tools has to ensure that they are as easy to use as possible. In addition, Universities have to ensure that any problems encountered by a student should be able to be resolved quickly through a technical support resource. If students encounter problems early in the acceptance stage of a new innovation they are unlikely to continue giving the new innovation a chance to succeed (Jennings & Dirksen, 1997; Kershaw, 1996; Rogers, 1995). A number of respondents in this study expressed that they were highly motivated to use the histology courseware from home and had even bought powerful computers and obtained high-speed Internet access. Unfortunately, relative minor difficulties for a computer literate person, such as installing a Netscape plug-in like Shockwave, can become major problems for novice users and lead to dissatisfaction and disappointment with the courseware. Timely support needs to be provided to prevent such situations.

Bandwidth access problems have plagued the delivery of multimedia based instruction to date but things are changing quickly (Starr, 1997). The Internet has become popular due to its ability to transmit detailed graphics and multimedia. However, the incorporation of these multimedia elements comes at the price of speed. The bandwidth technology utilized by most users requires long waiting periods for information to be transferred from the host computer to their personal computer. Currently, most Internet users access the Internet through a 14.4 to 28.8 kilobyte per second (Kbps) modem. Therefore, while text loads quickly, detailed graphics or short movie clips can take up to 30 minutes to download.

However, new technologies are starting to be utilized that will allow users to quickly access detailed multimedia on the Internet. U.S. Robotics (x2 technology) and Rockwell (K56flex) are producing analog modems that transmit information at 56.6 Kbps. ISDN and dedicated T1 lines are available to provide high speed access to the Internet but their cost and availability have kept them out of reach of most consumers. The use of fiber-optic cable by both the telephone and cable companies could greatly increase the speed access speeds to the Internet but the majority of cable lines in Canada are still coaxial cable while telephone lines are still twisted pair copper lines (Knapp, 1997). Therefore, the technologies that show the most potential for delivering high-speed access to consumers are cable modems and ASDL (Asymmetric Digital Subscriber Line). ASDL uses a regular twisted pair phone line and is capable of transfer speeds of 7 Mbps. Cable modems use coaxial cable to deliver transfer speeds of up to 10 Mbps (CyberAtlas, 1997b).

Currently cable technology is available in 200,000 Canadian homes and Shaw cable states that by the end of 1997 2,000,000 Canadian homes will have this service available (Shaw, 1997). As of November 1997, this access was available to Calgary residents for $39.95 per month, which included 5 E-mail addresses and, 10 MB of web space.

A possible solution to obtain high speed Internet for students at home would be for medical schools to explore partnerships with cable and telephone companies. This is an area that certainly deserves exploration by medical school personnel.

A large number of medical schools are requiring new students to own a computer system (AAMC, 1996; Kaufman & Paterson, 1995). The results of this research study do not support that it is a necessity for students to have a personal computer provided that they have easy access to well equipped computer labs. However, it appears that there is a strong relationship between using a computer for non-task activities and the more positive way that students will then approach its use for task activities (Mitra, 1997). To allow students to experiment and develop their computer skills in a non-threatening environment personal computer ownership should be encouraged by medical schools. A strategy that is used by many large business corporations is to provide interest free loans to employees who purchase a new computer system. This, or similar strategies should be considered by medical schools who are planning to introduce, or already are implementing, computer technology supported learning materials into the curriculum.

Observability of Benefits

The respondents expressed their opinions about the observability of the benefits to Internet delivered learning support through their responses to the items included in the "liking" index (survey items E21 to E25). Respondent's mean scores indicate that they agreed that they would like to see the Internet used more to support learning. However, the mean score for using the Internet to provide instructional materials was 2.78, which indicated that respondents disagreed with this approach. The responses to the open-ended questions provided clarification for this item. A number of respondents indicated that they saw observable benefits to using the Internet to deliver information but that it should be used to complement traditional instructional methods not replace them. The respondents indicated that a fear was that computers would replace instructors. This highlights the difficulty with the acceptance of an innovation. People can see the observable benefits but they still have trouble accepting it if it is not compatible with their existing ideas (Rogers, 1995; Kershaw 1996).

Compatibility with Existing Ideas

The last of Rogers' (1995) characteristics of innovations was an innovation's compatibility with existing ideas. In order to gain insight into existing ideas, it is important to gain an understanding of the new innovation's target users.

Sixty-three percent of the respondents were female and 37 percent were male. Females made up 52 percent of the entire population of first and second year medical students at the University of Calgary. The MANOVA reported that there was a significant gender difference ($p<.05$) between the measures used to study computer use. However, individual factorial ANOVAs based on gender did not report any significant differences ($p<.05$). The two comparisons that appear to warrant further exploration are computer liking and usage of computers where the probability measures were $p>.07$ and $p>.16$ respectively. One would expect gender differences based on the computer research literature. However the group of female respondents in this study comes from a unique subset of the female population and caution must be taken when generalizing previous gender studies towards them. It must be considered that the female respondents in this study are mature, educated, over-achieving students who already have at least one post-secondary science-orientated degree. It could be reasonably assumed that they have had at least some exposure to using computer support tools to complete both task and non-task activities. Additionally, it could be assumed that they are self-confident in their abilities and are not afraid to use new technological tools when required.

Sixty-seven percent of respondents indicated that they had access to a home computer. This proportion is what is expected based on the research literature. A 1996 AAMC survey found that between 50 and 80 percent of medical students in their first year own computers (AAMC, 1996). A 1994 report by the McMaster Health science Faculty reported that 70 percent of its medical students had access to a home computer. Both the MANOVA and individual factorial ANOVAs indicated that access to a home computer was not a significant factor ($p<.05$) when examining the measures of computer use. This factor is understandable when one considers that the histology courseware is not available from home at an acceptable speed, unless the student had a high bandwidth connection, and that there are excellent computer labs available for medical student use at the University of Calgary.

The respondents to this research survey rated themselves on a self-reported measure of computer expertise. Fourteen percent rated themselves as beginner, 30 percent rated themselves as novices, 49 percent rated themselves as intermediate, and 7 percent rated themselves as expert. These results are similar to a 1994 Portuguese study of first year medical students where 14 percent of students classified their computer knowledge as negligible and 49 percent as deficient (Gouveia-Oloveira, Rodrigues & de Melo, 1994). The respondents self-categorization of computer expertise demonstrated a strong correlation ($r = .78$) with an objective index measure of computer ability. This indicates that the respondents accurately rated themselves into expertise categories. The addition of a fifth category, in hindsight, might have helped distinguish more between the respondents who grouped themselves in the novice or intermediate categories.

Both the MANOVA and individual factorial ANOVAs found significance ($p<.05$) between computer expertise and the various measures of computer use. There was no difference ($p<.05$)between the expertise categories based on two measures: usefulness of computers and use of computers for task activities. This suggests that all categories of expertise appreciated the usefulness of computer support tools and used them when required to perform specific tasks. However, based on the significance found on all other measures, it was apparent that computer expertise was directly related to the way people approach and use computer support tools, including the Internet. An examination of the Scheffe Post Hoc tests indicated that the majority of the differences between the four expertise categories for each computer use measure was contributed primarily between the beginner/novice and intermediate/expert categories. Little variation was contributed by the difference between respondents who classified themselves as intermediate or expert. These findings suggest that students do not need to become expert users but that getting them to a competent intermediate level would improve both their frequency of use and perceived usefulness of computer support tools to support medical education.

The values, beliefs, attitudes and ability of students affect the way that students approach and use computer support tools (Clement, 1981; Loyd & Gressard, 1984;

Koohang, 1987; Dukes, Discenza & Couger, 1989; Koohang, 1989; Kay, 1993; King & Bond, 1996; Mitra, 1997). The constructs of anxiety, attitude, computer awareness, computer confidence, perceived control and liking all significantly affected (**p**<. 05) the way that the respondents approached and used computer support tools. Respondents that reported either less computer anxiety, a more positive attitude towards computers, more computer awareness, more computer confidence, more perceived control over computers or a higher liking of computers reported higher usage of computer support tools, rated computer support tools as more useful, used computer support tools more often for non-task activities and were more likely to see themselves using computer support tools in their future occupation. A high or low rating on none of the constructs had any influence over the frequency of which respondents viewed the computerized histology courseware. However, a lower attitude towards computers and/or less liking of computers resulted in a significantly lower mean score on the usefulness of the computerized histology courseware. With regards to using computer support tools for task activities the constructs that showed a significant effect, as demonstrated by less use, was low computer awareness, less perceived control and lower "liking" of computers. Programming ability only had an effect on the use of computers for non-task activities. It is believed that in hindsight that there were not enough indicators included in this index to distinguish between the programming ability of the respondents. More items should be included in any future use of this index to measure computer use.

The challenge for Universities is to identify strategies to increase computer confidence, computer awareness, and perceived computer control while lessening computer anxiety. Awareness can be addressed through seminars and practical examples and most importantly through the continued integration of the Internet and computer support tools into the curriculum so that its use is ubiquitous. These seminars should focus on how physicians of the future will use technology to manage and access information both for practice management and continued learning. This will help medical students see the relative advantage and observable benefits of technology in the practice of medicine. Confidence can be addressed through trialability by making computers and the Internet available to students so that they can use them in a non-threatening environment both for task and non-task activities. Perceived control can be addressed by providing non-threatening opportunities for students to use the Internet and computers and by providing technical support when and where they need it.

Some Universities have advocated formal computer training for their medical students. However, based on the wide range of computer expertise levels reported by the respondents, it would be difficult to design courses that would be beneficial to all levels. Rather, like the recommendations put forward by McMaster Health Science Faculty (Haynes et al., 1994), it would be more appropriate to provide just-in-time training and consultation as the need arises rather than formal courses.

Survey Research

This research study relied heavily on survey research methods. Survey research by its very nature relies on the opinions of a sample to infer generalizations about the population. Survey research, while a powerful tool to study social behaviour has to deal with the serious problems of sampling and generalizability (Babbie, 1990, Fowler, 1993). Survey research essentially divides the study sample into two populations, respondents and non-respondents. The effect of non-response on survey generalizability is dependent on the percentage of those not responding and the extent to which those not responding are biased and systematically different from the entire population under study (Fowler, 1993). Babbie (1990) states "it bears repeating that the body of inferential statistics used in connection with survey analysis assumes that all members of the initial sample complete and return their questionnaire". He elaborates that a 100 percent return rate rarely happens. The best that a researcher can hope for is that the respondents are essentially a random sample of the initial sample and thus a representative sample of the total population.

Babbie (1990) provides the following guidelines for response rates; however he is careful to note that they are rough guides and have no statistical basis. A response rate of 50 percent is adequate, 60 percent is good and 70 percent is very good. The return rate for the survey instrument used in this study was 42 percent. This was lower than what was expected or desired. A point to consider is that the survey was delivered to 100 percent and returned by 42 percent of the population, not a sample of the population, of first year and second year medical students at the University of Calgary. Another point to note is that this group of students is sampled on a regular basis by Medical Faculty staff. Due the medical program being problem-based they do not have regular contact with any one instructor but rather receive presentations from a multitude of Faculty and guest presenters. The students are required to submit reports on each of these presentations. Due to this fact a return rate of 20 percent on a given survey is considered a successful rate of return for University of Calgary medical students (Hannah, 1998). Babbie (1990) makes the important observation that "a demonstrated lack of response bias is far more important than a high response rate".

An examination of the demographics of the respondents to this research study offers positive indication that there was a low response bias. The survey primarily dealt with the application of web-based technology to medical education. A concern was that the respondents would have been predominately the technologically literate members of the survey population. Hence, the opinions about the use of web-based technology to support medical education would have been skewed by the respondents primarily being those who are computer literate and enjoy using the Internet to access information. However the frequency distribution for respondents on a self-reported measure of computer expertise demonstrated a distribution with 14 percent rated as beginner, 30 percent rated as novice, 49 percent rated as intermediate, and 7 percent rated as expert.

Sixty-seven percent of respondents indicated that they had access to a home computer. This proportion is what is expected based on the research literature. A 1996 AAMC survey found that between 50 and 80 percent of medical students in their first year own computers (AAMC, 1996). A 1994 report by the McMaster Health Science Faculty reported that 70 percent of its medical students had access to a home computer (Haynes et al., 1994).

Validity and Reliability

The content validity of the survey instrument is strong, as it was primarily based on a priori research from the literature (Clement, 1981; Loyd & Gressard, 1984; Koohang, 1987; Dukes, Discenza & Couger, 1989; Koohang, 1989; Kay, 1993; King &

Bond, 1996; Anderson & Joerg, 1996; Mitra, 1997). The survey items on frequency of use, usefulness, opinions, and barriers related to the use of the Internet to support education are based on research observations and results. The survey items used in section E of the survey to identify the attitudes, beliefs, values and characteristics of students were based on a number of computer use studies (Clement, 1981; Loyd & Gressard, 1984; Koohang, 1987; Dukes, Discenza & Couger, 1989; Koohang, 1989; Kay, 1993; King & Bond, 1996; Anderson & Joerg, 1996; Mitra, 1997). The fact that indexes were used to develop categories strengthens the reliability and validity of the measures because they were made up of composite measures (Babbie, 1990). All of the indexes developed to gather information in this study demonstrated high internal reliability. A note of caution is that a number of indexes in this study did not contain a large number of items. The reasons for this were the exploratory nature of the study, the relatively large number of constructs under study, and a reluctance to increase the number of questions in an already lengthy survey. Future studies should concentrate on fewer constructs relating to computer use and include more items in the indexes that measure the constructs.

The index developed to identify categories of use for computers showed high internal reliability between the items included in indexes developed for task activity (**r** = .75), non-task activity (**r**= .58) and mathematical computing and database management (**r**= .75). These values are consistent with the values that Mitra (1997) found in his much larger study. His results for the same categories were .57, .73 and .69 respectively. The index developed for the usage of computer support tools was .76. The index developed to measure attitude towards computer use was .71, which is consistent with Mitra's reported value for the same index, which was .69.

The indexes developed to measure computer anxiety, computer confidence, and computer liking produced reliability scores of .69, .86 and .83 respectively. These results are consistent with Koohang's (1989) study, from which these indexes were based, which reported coefficient alpha reliability scores of .86, .91, and .91 respectively.

The indexes developed to measure computer ability, computer awareness, programming skill, and perceived control produced reliability scores of .94, .83, .89 and .89 respectively. These results are consistent with Kay's (1993) study, from which these items were based, which reported reliability scores of .96, .94, .93, and .89 respectively.

Generalizability of Results

The low return rate for this survey, although it appears as if it has a low response bias, has to be considered when generalizing about the findings. The results are likely applicable to medical students at the University of Calgary. The University of Calgary's medical programme is unique in that it is a three year programme that is designed for more mature students who already possess at least one undergraduate degree. It is one of only two medical Faculties in North America offering a three-year degree program (University of Calgary, 1998). It is also problem-based, student-centered and mostly self-directed. Generalizability to medical education programmes outside of the University of Calgary must be more guarded. Specific findings may not be applicable to other centres. Even more caution must be used when generalizing the results to non-medical education programmes.

CHAPTER 6 – CONCLUSIONS & RECOMMENDATIONS

Conclusions

Rogers' (1995) attributes of innovations were used to develop an evaluation model to study the acceptance of web-based technology, particularly Internet delivered histology courseware, by undergraduate medical students at the University of Calgary. Rogers' attributes of innovations, as perceived by individuals, help explain the rate of adoption of any new innovation. These attributes are relative advantage, compatibility, complexity, trialability, and observability. The attributes proved to be a good framework for studying the acceptance of web-based technology into the medical curriculum at the University of Calgary. They assisted in the development of an evaluation model that used a detailed survey instrument to collect information on the way medical students approach and use the Internet.

The evaluation determined that the Internet to view the computerized histology courseware was readily used and accepted by the medical students who responded to the survey. They readily trialled it and perceived a relative advantage to its use. However, a significant percentage used it in conjunction with the learning aids it was designed to replace, specifically the microscope and prepared histology slides. This indicates that the Internet delivered courseware was compatible with the traditional way of learning histology but that more time was needed for the students to observe the benefits of the new learning strategy. As expected the primary complaints concerning the complexity of using the courseware could be attributed to access and software problems (Starr, 1997;

Friedman, 1996; Kearsley, Inglis, Fu & Kwok-Chan, 1995; Lynch & Wizer, 1995; Protti & Bannister, 1991).

This research study also found that the majority of respondents indicated that they appreciated the usefulness of computer support tools including the Internet. However, the tools that they used had to have a relative advantage associated with them. In order to use a tool frequently, the tool had to be required to perform some task activity or else allow them to perform a non-task activity easier and faster than they could before. Both frequency of use and usefulness ratings were generally dependent on the level of computer expertise indicated by the respondents.

This study also concluded that, similar to a number of other studies on computer use, that the values, beliefs, attitudes and ability of students affect the way that students approach and use computer support tools (Clement, 1981; Loyd & Gressard, 1984; Koohang, 1987; Dukes, Discenza & Couger, 1989; Koohang, 1989; Kay, 1993; King & Bond, 1996; Mitra, 1997). In this study the constructs of expertise, anxiety, attitude, computer awareness, computer confidence, perceived control and liking all significantly affected the way that the respondents approached and used computer support tools. The challenge for Universities is to identify strategies to increase computer confidence, computer awareness, and perceived computer control while lessening computer anxiety.

The Internet is an exciting delivery system that offers great potential to support the learning activities of students. The Internet can support the delivery of multi-media and offers many forms of communication that make it an ideal instructional and learning tool. Many universities and colleges have already started or intend to explore ways of using the Internet in their curricula. It is evident from the literature that the ability to use the

Internet for information access and transfer is a required competence for medical practitioners. Medical schools like the University of Calgary have recognized this need and are attempting to integrate this new technology into their curriculums. However, the integration of a new technological innovation like the Internet is often a slow process that does not always succeed for various reasons. The integration of a new learning technology, such as the Internet, needs to be done properly if it is to be accepted by its prime user, the students. Educational research into the effectiveness of various instructional delivery mediums has often focused on a comparison of "which is better"? The more appropriate question may be, which media best support the learning of the required competencies, both academic and professional. The evaluation model used in this research study based on Rogers' attributes of innovations proved to be effective in identifying student's perceptions and concerns regarding the introduction of a new technological innovation related to their education.

Recommendations

It is recommended that any educational institution that is considering the introduction of web-based technology into their curriculum use a model similar to the one used in this study to identify their students' perceptions towards the new innovation. This is important because if students encounter problems early in the acceptance stage of a new innovation they are unlikely to continue giving the new innovation a chance to succeed (Jennings & Dirksen, 1997; Kershaw, 1996; Rogers, 1995).

It is also recommended that this study be duplicated with a larger sample at the University of Calgary to ensure the validity of the results. It would also be beneficial to have this study replicated by other institutions that are introducing web-based technology into the education programs for their students.

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APPENDIX A

ETHICS APPROVAL

THE UNIVERSITY OF CALGARY

EDUCATION JOINT RESEARCH ETHICS COMMITTEE

CERTIFICATION OF INSTITUTIONAL ETHICS REVIEW

This is to certify that the Education Joint Research Ethics Committee at The University of Calgary has examined and approved the research proposal by:

Applicant: Dalton J. Cote

of the Department of: GDER

entitled: Web-Based Technology to Support Medical Education.

(the above information to be completed by the applicant)

06/13/97
Date

Michael C. Pyryt
Chair, Education Joint Research Ethics Committee

APPENDIX B

CONSENT FORM

Web Based Technology to Support Medical Education

Consent Form

This consent form is provided to inform you of a research study being conducted by the Department of Anatomy. You have been provided two consent forms so that you may retain one for your own records. The Faculty of Medicine is continually searching for new ways to improve the quality of education that you receive. One of these strategies has been the introduction of web-based learning tools to assist you in your studies. Examples of this support are: personal E-Mail accounts, mailing lists (list-servs), on-line course descriptions and objectives, and computerized anatomy labs.

We are interested in assessing the usefulness of these support tools, in particular the computerized histology slides. We believe that one of the most important indicators of acceptance comes from the opinions and ideas of you, the users. Your participation will contribute to the future development and use of tools to support future medical education offered to you and your fellow students.

This research study will monitor your use of the computerized histology slides, class listservs, and class web page. The monitoring process will note when, how long, and how these learning resources were utilized. **No** attempt will be made to attribute usage to individual students. There is no reward for use or penalty for lack of use of these resources. We are only interested in studying **how** these resources are used so that we can ensure that they are beneficial to you, the user.

In January, 1998 you will be asked to complete a survey so that we can gather information on your opinions about the effectiveness and usability of these web-based learning support tools. Your participation in this survey will be completely voluntary and no student will be individually identified. Your signature on this form indicates that you have understood to your satisfaction the information regarding your participation in this research project and agree to participate as a subject. You are free to withdraw from this study at any time by indicating to the undersigned that you do not wish to have data associated with you used in this study. Your choice regarding participation will have no impact on your Grade in the course or standing in the Faculty of Medicine. If you have any concerns about your participation in this research, please contact, Karen McDiarmid, Office of the Vice-President (Research) at 220-3381. If you have further questions concerning matters related to this research study, please contact:

Dalton Cote	Faculty of Education	246-8662	djcote@acs.ucalgary.ca
Dr. R. Hannah	Faculty of Medicine	220-6898	rhannah@acs.ucalgary.ca
Dr. W.B. Clark	Faculty of Education	220-7363	bclark@acs.ucalgary.ca

____

(Name)

____

(Signature)

____

(Date)

APPENDIX C

SURVEY INSTRUMENT

Histology On-Line - Survey

The Faculty of Medicine is continually searching for new ways to improve the quality of education that you receive. One of these strategies has been the introduction of computer supported learning tools to assist you in your studies. Examples of this support are: personal E-Mail accounts, mailing lists, on-line course descriptions and objectives, and **computerized anatomy labs**.

We are interested in assessing the usefulness of these support tools, in particular the computerized anatomy slides. We believe that one of the most important indicators of acceptance comes from the opinions and ideas of you, the users. Your responses will contribute to the future development and use of tools to support future medical education offered to you and your fellow students.

Your participation in this survey will be completely voluntary and no student will be individually identified. We are interested in your candid judgments and opinions so please do not indicate your name. Your choice regarding participation will have no impact on your Grade in the course or standing in the Faculty of Medicine. If you have any concerns about your participation in this research, please contact, Karen McDiarmid, Office of the Vice-President (Research) at 220-3381. If you have further questions concerning matters related to this research study, please contact:

Dalton Cote	Faculty of Education	246-8662	djcote@acs.ucalgary.ca
Dr. R. Hannah	Faculty of Medicine	220-6898	rhannah@acs.ucalgary.ca
Dr. W.B. Clark	Faculty of Education	220-7363	bclark@acs.ucalgary.ca

Your assistance in this survey is greatly appreciated.

Please return the completed surveys to Dr. R. Hannah, in the box provided in the Bacs Centre.

A. Please rate the both the Frequency and Usefulness of the following computer support tools (circle the most appropriate answer. *Note: < =less than and > = greater than*):

1. Use of the computer to do word-processing tasks (i.e. write papers, assignments).

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

2. Use of the computer to do statistical computing tasks.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

3. Use of the computer to do spreadsheet computing tasks.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

4. Use of the computer to do database management tasks.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

5. Use of E-Mail to converse with friends or family.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

6. Use of E-Mail to communicate with other students.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

7. Use of E-Mail to communicate with professors.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

8. Use of the Internet, either from home or through the Medical Faculty computer lab, to access general or personal information (i.e. hobbies, news).

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

9. Use of the Internet, either from home or through the Medical Faculty computer lab, to access information about the University of Calgary.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

10. Use of the Internet, either from home or through the Medical Faculty computer lab, to access information about the Faculty of Medicine.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

11. Use of the internet, either from home or through the Medical Faculty computer lab, to access information about medical course schedules and objectives.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

12. Use of the Internet, either from home or through the Medical Faculty computer lab, to locate medical resources external to the University of Calgary.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

13. Use of the Internet, either from home or through the Medical Faculty computer lab, to view the computerized histology slides.

	1	2	3	4	5
Frequency	Never Used	< Once per Week	Once per Week	> Once per Week	Used Everyday
	1	2	3	4	5
Usefulness	Not Applicable	Not Useful	Useful	Quite Useful	Very Useful

B. The following section deals specifically with your opinions about the computerized histology slides. Please use the following rating scales to indicate your feelings. Circle the most appropriate answer.

1. Extremely bad	1	2	3	4	5	6	7	Extremely Good
2. Difficult to use	1	2	3	4	5	6	7	Easy to Use
3. Boring	1	2	3	4	5	6	7	Interesting
4. Unproductive	1	2	3	4	5	6	7	Productive
5. Unpleasant	1	2	3	4	5	6	7	Pleasant
6. Time wasting	1	2	3	4	5	6	7	Time Saving
7. Frustrating	1	2	3	4	5	6	7	Satisfying
8. Difficult to Access	1	2	3	4	5	6	7	Easy to Access
9. Not Valuable	1	2	3	4	5	6	7	Valuable

C. The following questions deal with how you studied the following topics: principles of medicine, cardiovascular, & muscular-skeletal (1st Year students only) *OR* anatomy of the GI and reproductive systems (2nd Year students only).

1. Please circle the one statement that best describes how you studied the body systems listed above:

   a) I did not study
   b) I studied using only the textbook (Wheaters)
   c) I studied using only the prepared slides/microscope
   d) I studied using only the computerized histology slides
   e) I studied using only the textbook and prepared slides and microscope
   f) I studied using only the textbook and the computerized histology slides
   g) I studied using only the prepared slides/microscope and the computerized histology slides
   h) I studied using the textbook, prepared slides/microscope and computerized histology slides

2. If you did not use the computerized histology slides or used both the computerized histology slides and the prepared slides/microscope, please indicate why (you can circle more than one answer).

• Did not trust the computerized slides.	True	False
• Did not like using the computer version.	True	False
• Computer version was hard to access.	True	False
• Wanted to use all available resources.	True	False
• Microscope provided more viewing options.	True	False
• Prefer the hands on activity associated with the microscope.	True	False

<u>**Comments**</u>:

3. I studied the computerized histology slides on my own.

1	2	3	4	5
Never	25% of the time	50% of the time	75% of the time	Exclusively

4. I studied the computerized histology slides in the company of at least one other student.

1	2	3	4	5
Never	25% of the time	50% of the time	75% of the time	Exclusively

5. I accessed this material from home.

1	2	3	4	5
Never	25% of the time	50% of the time	75% of the time	Exclusively

D. Please rate the degree to which the following were barriers to using the computerized histology slides.

1. Inconvenient access to terminals in the labs

1	2	3
No Barrier	Somewhat a Barrier	Major Barrier

2. Inadequate knowledge on using the technology.

1	2	3
No Barrier	Somewhat a Barrier	Major Barrier

3. Difficulty in accessing or using the program.

1	2	3
No Barrier	Somewhat a Barrier	Major Barrier

4. Difficulty of reading materials on a computer screen.

1	2	3
No Barrier	Somewhat a Barrier	Major Barrier

5. Slow speed of the system impaired my learning.

1	2	3
No Barrier	Somewhat a Barrier	Major Barrier

6. Inability to connect from home.

1	2	3
No Barrier	Somewhat a Barrier	Major Barrier

7. Slow speed to connect from home.

1	2	3
No Barrier	Somewhat a Barrier	Major Barrier

8. Difficulty in learning to use the system.

1	2	3
No Barrier	Somewhat a Barrier	Major Barrier

E. Please rate your opinions about the use of technology. Circle the most appropriate answer.

Statement	Response				
1. Increased use of technology makes learning easier.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
2. The introduction of computers to teaching is too rapid.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
3. I feel comfortable using computers.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
4. I have a certain apprehension to using computers.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
5. Computers in teaching make the learning process too impersonal.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
6. I will use a computer in my future occupation.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
7. I will do as little work as possible with computers.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
8. Knowing about computers will make my job easier.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
9. I like learning new software applications.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
10. Computers don't scare me at all.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
11. I could teach someone to use a computer software package.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
12. I can surf the web.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
13. I could explain the internet to someone.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
14. I have participated in a listserv and/or newsgroup.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
15. I can write a simple computer program.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
16. I can alter and/or debug the control files on my computer (i.e. autoexec, config, or ini files).	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
17. I could probably teach myself most of the things I need to know about computers.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree

18. I can make the computer do what I want it to do.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree
19. If I had a problem using a computer, I could solve it one way or another.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree
20. I prefer to learn about new programs or applications on my own.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree
21. I would like see the computer used more to support medical education.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree
22. I would like to be able to access more course information via the internet either from home or through the Medical Faculty computer lab.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree
23. I would like to see the internet, either from home or through the Medical Faculty computer lab, used more by faculty to present instruction (i.e. information that is usually provided through a lecture).	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree
24. I would like to see the internet, either from home or through the Medical Faculty computer lab, used more by students to communicate with each other.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree
25. I like using the internet to access information.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree
26. I like learning independently.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree

F. Please provide the following demographic information. This information will be held in confidence and will not be use to identify you.

Age ________ Gender ________ Academic Year ___________

Previous Education (List Degrees) _________________________________

Do you have a computer at home? Yes No

Do you have access to the internet from home? Yes No

Level of computer expertise. Beginner Novice Intermediate Expert

G. Comments. Please feel free to provide comments on this blank page.

APPENDIX D

RESPONSES TO OPEN ENDED QUESTIONS

RESPONSES PROVIDED IN OPEN-ENDED SECTIONS OF THE SURVEY

Survey 01
- Histology program too basic
- Too few images in the histology program
- Preferred working at home and histology program difficult to access
- Used a better web site called webpath

Survey 05
- Not enough detail in the histology slides
- Need more than one example of one item

Survey 06
- Slow speed of system a major barrier especially from home

Survey 08
- Difficult to access from home
- Would be more valuable if available from home
- Too slow to be accessed from home
- Great idea but needs to be available at home. Distribute on CD-ROM?
- Needs to be developed for other body systems

Survey 10
- Not enough control over slide viewing. Needed more control ("fast forward" and "rewind") controls

Survey 11
- Not enough controls of the slides. Need to be able to pause to take notes.
- Hard copy of dictation of slides would be valuable
- Need to be able to view this at home (CD-ROM?)

Survey 12
- Histology slides are great
- Easy and efficient to use. No need to re-load a slide into the microscope. All you need to do is click on a slide.
- Histology section is well suited to computer use
- Enjoy learning from a human teacher and does not want to them replaced by a computer

Survey 15

- Histology slides were great
- Found it more efficient and effective to take notes while viewing histology slides than having to read entire chapters in a textbook
- Wished that all anatomy systems were available via the computer

Survey 17

- Computer saves time
- Images are not as good
- Wanted a self-test or quiz
- Did not trust the detail of computerized slides

Survey 18

- Use textbook to study because it is easier to access
- Computerized slides are a good idea but only as a complement ot prepared slides and textbook
- While slideboxes replaced with computerized slides the anatomy lectures have replaced with nothing and concern about the level of anatomy taught.

Survey 22

- Hard to access from home
- Preferred to use prepared slides but used computerized slides because they were easier to access
- Computer program required more viewing controls (pause and rewind button)
- Faster to study using a textbook and resolution of pictures is better

Survey 23

- The use of prepared slides is difficult and time consuming because one views the structure with little guidance or confirmation of what they are looking at.
- The computer program and text are better because they provide associated explanations and highlight important features.
- Tried accessing the material from home but it was slow and frustrating. Would prefer to access material from home.
- Concerned about the transfer of learning from a 2D interface of a computer to application in a 3D clinical/surgical application. *(Note: would this not hold true for prepared slides?)*

Survey 24

- Too few slides on the computer

Survey 25

- Need a photocopy of audio so that reviewing is easier instead of having to replay the audio many times.

Survey 26
- Require more viewing controls (pause & rewind)
- Slides should be numbered and accessible through an index

Survey 28
- Use of computers to learn histology makes the learning easier
- A computer cannot replace a teacher because you cannot ask the computer probing questions
- Needs to be a balance between CAL and live instruction. Each has its advantages and disadvantages.

Survey 29
- Computer histology is great
- Very disappointed because had technical problems getting the shockwave plug-in to work at home

Survey 30
- Computer resolution is inadequate for histology
- Need formal anatomy instruction in the curriculum

Survey 32
- Prepared slides are much better but require a teacher to guide learning
- Computerized slides are an adequate substitute
- Program requires more viewing controls
- Information should never be available only on computer because some people cannot afford a computer
- Do not like to study off of a computer screen

Survey 33
- CAL should supplement traditional teaching not replace it
- Some things difficult to convey over a computer

Survey 35
- Part of learning histology is handling prepared slides. Holding them to the light for initial recognition. Cannot scan computer slides to look for different things on the same specimen like you can with prepared slides (looking for transitional states).

Survey 36
- Hopes that they will not use a computer in their future occupation.

Survey 37
- Computerized slides definitely save time
- Prepared slides allow you more viewing options at different powers (this helps put things in context)

Survey 39

- Would prefer to avoid histology as it is not relevant to the clinically practicng doctor (results come from the lab)

Survey 40

- Did not feel that the computerized slides provided enough information
- Use of computers for teaching and learning in medical education is an assest. However, should not replace lectures, small group discussions and other forms of interactive teaching

Survey 41

- Did not connect from home because could not install shockwave

Survey 42

- Really liked the histology on-line courseware
- A review section at the end of the entire section would be helpful

Survey 45

- Really liked the computerized slides
- Used it with textbook and wrote notes right into textbook
- Surprised by the quality of the program

Survey 46

- Use of computers for histology is great
- Other course could benefit by using the computer (neurology and ophthalmology)

Survey 47

- The histology computer program is excellent
- Found prepared slides next to useless because there was no one to point out things and it was difficult to find pathology with no histology background
- The computer slides were at a great level for beginners and provided a solid base for learning pathology

Survey 48

- Technical difficulty downloading the shockwave plug-in

Survey 49

- Not the same type of specimens on the computer as the prepared slides

Survey 54

- Review of microscope slides is faster
- Liked the computerized histology slides
- Liked the fact that sound was used to help point out what to look for
- Found the quiz option useful
- Good pathology website at the University of Utah

Survey 55

- Histology on the computer is a poor representation of the field
- Students memorized images instead of understanding what they were looking at unlike if they would have used the microscope
- Histology images on the GI final exam were of poor quality

Survey 56

- Learning histology on the web is a great idea
- Want to see histopathology up on the web soon
- Computer is a good tool to learn but must be augmented with other strategies
- Do not like reading extensive amounts of text on the screen. Provide a handout.

Survey 58

- Would love to see histopathology on the web
- Need more Pentium machines in the computer lab

Survey 59

- More convient to use the computerized slides
- Only used prepared slides for pathohistology

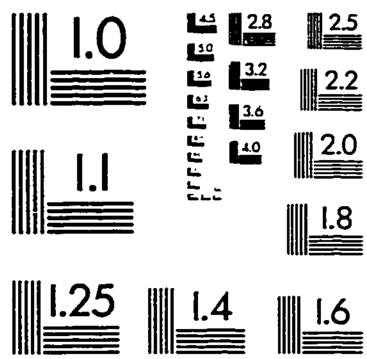
Survey 60

- The use of computers to teach histology was interesting and efficient

Survey 61

- Preferred computerized slides

IMAGE EVALUATION TEST TARGET (QA-3)



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6″

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Rochester, NY 14609 USA
Phone: 716/482-0300
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