EVALUATION OF AN INTERACTIVE MULTIMEDIA EDUCATIONAL TOOL USED TO TEACH VETERINARY NEUROBIOLOGY

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Abstract

Objective

The objective of this study was to evaluate an interactive multimedia educational program, which was used to teach veterinary neurobiology at Colorado State University. The software application was evaluated for usability and functionality.

Design

This was a descriptive study in which first year veterinary students ($n = 134$) were the participants. During winter semester these students utilized a software program called *Veterinary Neurobiology, Interactive Programs.*

Measurements

The study subjects were required to complete two questionnaires. A computer use survey was used to assess the students' computer experience and computer knowledge. A computer system usability questionnaire assessed the students' perceptions of the software's usability and its value to the learning process. Grades, course evaluations and class web site information were also analyzed.

Results

Fifty-four percent (54 %) of the students used the CD 6 to 10 times per week. Overall usability ratings for the CD were very favorable. On a seven point likert scale, overall usability was rated the highest possible score, i.e., 7, 60.3% of the time. Neither computer sophistication nor previous computer experience had a significant ($p < 0.05$) effect on

usability rating. Students' grades were one of the variables used to measure functionality. For their final grade, 131 of 134 students (97.8%) accumulated more than 342 points (90%).

Conclusions

The surveys utilized in this study were effective and appropriate measurement tools. The software received high scores for usability and the students' assessments indicated that the software was useful and appropriate for the course.

Introduction

It has been well documented that there is an enormous and ever-increasing amount of information with which medical professionals need to be concerned. Medline indexes approximately 400,000 new articles from 3,900 journals each year. It has been proposed that the weight of the Cumulated Index Medicus reflects the amount of medical knowledge. Estimates are that the Index Medicus will reach a weight of 1,000 kg by the year 2027. [1] Trying to keep up to date is currently a difficult task. It becomes an even more daunting task for today's medical professional student when you consider that students graduating in 2001 may practice well beyond the year 2027. It is hard to imagine how many thousands of scientific advances may develop between now and then.

It is increasingly apparent that both medical and veterinary medical students will need active, independent and lifelong learning skills to supplement their formal education. Advances in information and computer technology and a change toward problem-based learning have the potential to radically change the way all medical professional students are educated. Interactive learning tools, especially computer-based multimedia programs, may play a tremendous role in facilitating this change. In fact, it is not hard to believe that the potential to change the content and the process of teaching may rest squarely on the shoulders of those developing computer-based educational programs.

Definition of Terms

Multimedia: any software program that uses multiple types of media to display information. The media formats can include digital sound, digital video, animation, pictures, text and/or hypertext links. It has been said that using multimedia is like "watching a documentary on TV except that [in most cases] you can choose exactly what you see and hear." [2]

CD-ROM or Compact Disc with R(ead) O(nly) M (emory): a computer disc that contains a large amount of data. These data cannot be edited, thus the term read only memory. This form of data storage is used frequently for multimedia presentations because they often require large amounts of memory. In the future the designation CD will refer to CD ROMs.

Interactive: any software program that allows the user to participate by providing a response and that involves the exchange of information between the user and the computer. [3]

Computer-Aided Instruction (CAI): sometimes also called computer-based learning (CBL) or computer-based education (CBE). In the strictest definition computer-aided instruction can be any educational tool that is on a computer. It is *not necessarily synonymous with the use of multimedia,* although multiple types of media easily lend themselves to use in computer-aided instruction.

<u>Rationale and Significance</u>

A number of multimedia programs have been developed and many more are in the process of being developed for use in veterinary medical education in the United States. [James Miller, DVM, personal communication], [4-8] Dr. Miller, who teaches at the University of Georgia College of Veterinary Medicine, won a national teaching award in 1999 for his work with multimedia CAI, using this medium to help veterinary students understand the functional anatomy of the equine digestive tract. When asked, "If you could choose any area of research relating to the use of computer-aided instruction in veterinary medical education, what would it be?" he responded, "The greatest need is to develop a good way to evaluate whether or not the [multimedia] programs do what we hope they do… and for [the development of] good solid evaluations with appropriate control groups and tests."

These tasks are not as easy as they might seem. First, it has to be determined what we hope they do. Does multimedia technology in education enhance learning by making it fun? Are time and money saved? Do these applications teach by encouraging problem solving methodologies? Do they do all of the above or none of the above? Does multimedia instructional technology inhibit learning in the student who is not technologically advanced? Are there other measurable factors involved? There are many questions that beg to be answered. This descriptive study was designed in an attempt to answer some of these questions. The question of primary importance is, "Are computer-based, interactive multimedia educational programs effective tools for use in veterinary medical education?" And more specifically:

1. Does the perceived usefulness of multimedia programs influence what and how veterinary students learn?
2. Does prior access to computers or a student's attitude toward computer technology affect that student's ability to learn with interactive multimedia educational programs?
3. Are multimedia educational programs appropriate for problem-based learning in the basic veterinary medical sciences?

Background

Computer-aided instruction has been used in one form or another for several decades. The earliest computer-aided instructional tools were text-based tools written in COBOL or FORTRAN. They lacked sophistication and required extensive programming knowledge to create. Next came the DOS-based programs that were basically computerized slide show presentations, sometimes appropriately called multimedia textbooks. In 1990 Walsh and Bohn described a DOS-based system which had greater functionality. It was used to teach human anatomy to undergraduate medical students. They said that "human anatomy is a visually oriented discipline and thus particularly well suited to microcomputer applications that utilize graphic images." [9] Since then, numerous multimedia software products have been designed and used to teach medical professionals. [10, 11] Instructional technology has changed greatly, becoming much more sophisticated and the CAI learning programs are becoming both easier to use and to create. A number of virtual reality learning tools have been developed within the last 2-3 years. [12, 13] It is safe to say that CAI is in the process of adding a completely new dimension to undergraduate medical training.

Mooney and Bligh categorized CAI tools into five categories. [14]

1. Information resources/reference tools - Medline would be an example
2. Electronic textbooks - the computerized slide shows that are mentioned above
3. Tutorials - directs the course of study that a student takes, as a private tutor would
4. Mind tools - programs which help learners to organize and plan learning or structure and record knowledge
5. Study guides - programs designed to support the educational processes of a program teaching problem-based learning

They further state that mind tools and study guides are the most educationally sophisticated and offer the greatest potential for the education of medical professionals since they encourage an "enquiry-driven" approach to learning, enabling the learner to organize ideas and to propose hypotheses during the learning process. Both of these processes are important in problem-based learning.

Developing the Multimedia

There are numerous published reports that provide guidelines for those interested in creating multimedia educational tools.[2, 15, 16] It is important, however, to remember that the production of even the smallest multimedia CAI program requires hours of research and development. It can be a labor-intensive experience, made even more so by the fact that the content experts (faculty) are rarely the multimedia design experts (developers).

There are often more than one or two people involved with the development of CAI products. The multimedia team can include: the project manager, who is responsible for the development and the implementation of the project; the instructional/interface designer is in control of the color, layout and graphics and navigational interfaces; the graphics designer, who must design high quality graphics which help to maintain visual interest; the media specialist, whose main function is to produce sound and video files for incorporation into the finished product; a programmer to integrate the pieces into the finished product; and the content expert, who is responsible for collecting appropriate content (text, video, audio and graphics) and advises on the accuracy of the final product. [15]

Previous Research

Evaluations of multimedia educational products in medical education have been done in the U.S.,[17-20] in Europe[21] and in Australia. [22, 23] Evaluations of veterinary medical multimedia educational products have taken place in Europe [24], and there are published reports describing the use and development of CAI in veterinary medical education in the United States,[7, 25] but few attempts to assess its utility.

The development and use of CAI for veterinary medical education seems to be more advanced in Europe and the United Kingdom than it is in the United States. This is most probably caused by two things. IT based teaching has been supported in the UK by two centrally funded initiatives. The Computers in Teaching Initiative was funded as early as the late '80s and more recently the Teaching and Learning Technology Program was initiated.[26] Also, for some time it has been illegal in Europe to use animals for the purposes of research and teaching.[27] This has fueled the development of technologies, which take the place of animal subjects in both teaching and research. A qualitative assessment done in 1995 showed that multimedia tools were being used in the place of animals in many areas of the world, including the United States, but that the use of these educational tools was greater in the European countries.[27]

Student Assessment

How do we measure what students learn? Obviously some sort of measurement is necessary to determine if learning goals are being met. Written examinations are the most common tool used to evaluate student educational outcomes. Short answer and/or multiple choice questions have long been accepted as being the most objective and for that reason are the most popular for student assessment. It is difficult, however, to measure the cognitive dimension of problem-solving using this examination format. Medicine requires problem-solving skills. It is natural to assume that those skills or the problem-solving methods associated with those specific skills would be those commonly assessed. Sadly, that has not generally been the case.

The best assessments to measure any type of skill level are practical examinations. They are, however, logistically difficult to administer in most traditional educational environments. The large number of students makes the cost and the feasibility of practical exams impractical. As computer simulations approach realism, computer-based practical exams become more of a possibility. They may soon provide adequate training and competent appraisal for skills of all kinds.

Assessment of Computer-based Learning Tools

Computer-based learning is often required to be "better" than traditional methods of teaching in order for it to be considered as an alternative teaching method, and in some cases multimedia educational tools are subjected to distinctly different evaluation processes. Booth, et al., recommend that instructional technology should not be subjected to different procedures that make it look special or unique. CAI should be tested as other instructional methods are tested.[26] If it is an appropriate tool for the educational method and is effective, it should be used appropriately.

A number of evaluation tools have been developed in attempts to determine the educational value of computer-based programs.[28-32] These tools differ greatly in their scope and utility. A number of evaluation studies have also been done.[4, 9, 18, 19, 22, 33-37] In most cases pre-testing and post-testing are used to determine how much students learned. In general, these evaluation studies found that multimedia educational tools were at least as effective as traditional teaching methods.

In much of the evaluation work that has previously been done, however, there has been failure to control one or more of the following confounding factors. [38]

1) *Different instructional methods were used between treatment groups.* For example, if one group, the control group, is taught using traditional techniques, having access to a textbook and lectures by the instructor, while the 'treatment' group uses a multimedia educational

program, there is the possibility that any variation in learning may be caused by the inherent differences in the didactic methods. Institutional Review Boards (IRB) are becoming less likely to approve studies of this type, fearing that a student may be cheated because he or she does not have access to the same learning tools.

2) *Different informational content was presented to the different treatment groups.* In the above example, if one 'treatment' group has access to information in the multimedia program that is not available to the other 'treatment' group, it becomes difficult to assess the differences in learning between the two groups since the instructional content presented to the student participants is different.

3) *The studies were short-term interventions lasting 4 to 5 weeks or less.* If there is any learning curve associated with the use of a software product, a short investigational period may not allow for flattening or spiking of the learning curve.

When assessing multimedia tools it is as important to assess the method of delivery as well as the information content. In 1994, Devitt proposed the following requirements for computer-aided instructional programs:[39]

1. The program must be relevant and applicable to the clinical curriculum, i.e., must include case-based, problem-solving methodologies.
2. The software must be easy to use by individuals who may not be familiar with the use of computers.
3. Editing to add problems and change instructional information can be done by clinicians, not programmers.
4. The learning tool must be interactive and self-paced. Otherwise the same information can be presented with a lot less trouble by using slides and lecture notes. This format

forces students to go through each problem in a logical sequence, but allows them to wander off on tangents if they so desire or to choose the less than ideal way of dealing with a problem.

5. In an attempt to ensure that the use of a software product is a cost-effective endeavor, the program must be suitable for all medical undergraduate students or at least have relevancy for as many students as possible.

Obviously, not all software is appropriate for all educational programs. It is of utmost importance to remember that multimedia technology should not be used just because it is available. The software must be appropriate for the class being taught, i.e., the technology must meet an identifiable educational need in an actual course. It is easier to build CAI tools around a pre-existing class than it is to try to re-build the class around inappropriate software. If suitable CAI material already exists and is available, it is not necessary to reinvent the wheel.

Advantages and Disadvantages of Multimedia Educational Tools

Proponents of CAI are quick to point to the numerous advantages of interactive multimedia. Its opponents just as vigorously point to its disadvantages. Together they paint a picture of reality.

Advantages

Faculty are freed from repetitive teaching tasks that are especially prevalent in the teaching of basic medical sciences. This frees up class time for other learning activities. The multimedia product itself also produces greater variety in teaching by allowing the use of simulations, case studies and hypertext links to other appropriate information sources. Simulations and case studies are extremely appropriate in medical education because they promote problem-solving methodologies and develop decision-making skills, both of which are important for clinical reasoning. Student assessments are often included in the software packages now commercially available for CAI. It has also been reported that well designed applications consistently allow students to increase their ability to retain and use information by 15-25% or more.[40]

Computer aided instruction is very flexible. It removes the 'same time - same place' constraint, allowing the student to skip a study section that he or she feels comfortable with or to repeatedly drill information until the subject matter is mastered, putting the student in charge of his or her own educational experience. The instructors are also able to utilize this flexibility. Since they are no longer tied to the blackboard, they are free to experiment with other new and exciting educational methodologies. Distributed education has also benefited greatly from the removal of the 'same time – same place' constraint that the use of interactive multimedia educational tools and other computer technologies has permitted.

One of the most exciting but least mentioned advantages of CAI is that it enables students to receive instruction in fields of study even when expert teachers are not available. It also allows for interaction between faculty and staff at different institutions. Sharing of faculty expertise has already been proposed and successfully completed in veterinary medicine. In 1996 Russell proposed the creation of expansive multimedia food safety materials on a CD to facilitate the teaching of food safety by helping to compensate for the lack of knowledgeable instructors in that area of veterinary medical education.[8]

Disadvantages

By removing the instructor from the classroom, education has the potential to become depersonalized. Students who thrive on personal interaction or are uncomfortable with computer technology may be at a disadvantage using interactive, multimedia educational programs. Also, if the multimedia application is added to the curriculum rather than integrated into the total learning plan, more study time will be required of students who perceive that they already have too much to do in too little time.

Faculty resistance to the use of CAI may occur for a number of reasons. First, it can take a lot of work to change the content material in a course to correspond with the information in a purchased computer-based program and to change the format in which the course material is delivered. To have to do both and still have to integrate the resulting product into an already existing curriculum seems to be a daunting task. Second, it may be a lot more difficult to change the data in a computer application to correspond to changing information needs than it is to write different information on the blackboard or in a handout. To those committed to 'traditional' educational methods the reluctance to change will be great. They fear the loss of control of course content and delivery to a computer, and they may even fear a computer program may eventually replace them.

Research and development is an expensive process as is the initial investment (computers, software and technology personnel) required to make a commitment to computer aided instructional methods. It is also be expensive to develop assessment tools within the software that actually measure what the student is learning or not learning. At this time most of the assessment tools are self-assessments, and the student is in charge of determining the next step in his or her learning process. It may not be long until the software is in charge of each student's evaluation and makes the appropriate changes in his or her path to the learning objective. Software continues to become more complex. And as complexity increases so will cost.

Methods

Choice of Intervention

A number of interventions and study sites were originally considered for this research project. A multimedia software program used to teach the anatomy of the cat to lab animal technicians (CatLab®, developed by Interactive Technology Group of Eugene, OR) was available for evaluation. Five veterinary teaching hospitals were originally considered as locations for intervention. They were Oregon State University, Michigan State University, Washington State University, Ohio State University and Colorado State University. Two veterinary teaching hospitals, Ohio State University and Oregon State University, previewed CatLab® and found it unsuitable for use in their curriculum. The small number of students enrolled at Oregon State University ($n \approx 15$) further removed that institution from consideration. Michigan State University and Washington State University have early start semester systems. Institutional Review Board (IRB) approval could not be obtained in time for study interventions to be in place by the start of the fall semester. Ohio State University was removed from consideration because the person in charge was not interested in participating.

The second computer learning program considered for inclusion in this study was an interactive multimedia software program developed at Colorado State University for the teaching of veterinary neurobiology (Veterinary Neurobiology, Interactive Programs). This software application was developed by the faculty in the department of Anatomy and Neurobiology at Colorado State University, Fort Collins, CO. This educational tool is beta software that is even now undergoing changes and further development. Dr. Ray Whalen, the project leader and head of the team that is teaching the neurobiology course at CSU, professed a strong interest in collaborating on this research project. Furthermore, since veterinary neurobiology was taught during the spring semester at Colorado State, there was adequate time to obtain IRB approval. The large number of students (n = 134) enrolled in the basic sciences program at CSU further added to its desirability as the study location.

This interactive program has a user-friendly interface and is intuitive in design. It contains a number of study modules, training aids and self-assessment tools, as well as, interactive case studies. It has the ability to download updated materials from a password protected web site. The case studies provided in this software package are excellent examples of the application of the basic science knowledge in clinical medicine and vice versa.

<u>Assessment Tools</u>

Three survey instruments were used as assessment tools: a computer use survey was given at the end of the first full week of winter semester, a usability questionnaire was administered near mid-term and a web-based course evaluation was given subsequent to the final examination. Copies of any or all of the surveys can be obtained from the investigator. The course evaluation was administered on the course web site. It was a generic survey that is given at the end of all CSU courses. Students were encouraged to fill out the course evaluation but they were not required to do so. Even so, about half (53.7%) of the students completed this survey.

The computer use survey used in this study was a modified version of a computer use survey that was developed and previously validated for use by physicians at academic health institutions. The original survey was designed to measure: 1) computer use, 2) computer knowledge, 3) demands for high-level functionality, 4) demands for ease of use, and 5) expectations of computers.[41] Since the subjects of this study were veterinary medical professional students and not practicing academic clinicians, questions or responses that related to primarily to practicing clinicians were removed. An example of one of the questions that was removed is: "What percentage of your time do you spend in a) teaching b) research c) administration, etc.?" Questions or responses that were of a purely clinical nature were also removed: For example, "Do you use a computer to document patient information?" Additionally, any comment or response relating specifically to human medicine was also removed. One example would be references to ICD-9 codes, which are not used in veterinary medicine.

Two sections were added to the computer use survey. Part I-Section e asked students to assess the different hardware and software they had on their home computer(s). Part III, an assessment of "Your Attitude toward Computers" was also added. The investigator developed both of these additional sections in an attempt to further quantify student computer knowledge and technology awareness. None of these questions or the formats that they were presented in had been previously validated. The format, however, was very similar to that seen in other sections of the survey. Graduate level medical informatics students and instructors (n = 4) at Oregon Health Sciences University assessed the questions and subject matter of both surveys for clarity and readability. It was estimated that it would take approximately 15 minutes to complete the computer use survey.

The usability questionnaire attempted to measure the students' opinion of the application's usability and design. An on-line computer usability questionnaire, developed to determine the usability of business software applications,[29] was adapted for this purpose. A section requesting general information about the students' use of the CD and the class web site was added to the beginning of the usability questionnaire. The second part of the questionnaire directly addressed the usability of the CD. It contained four sections. The first eight questions evaluated system usefulness and the next seven evaluated information quality. Questions 16-18 estimated interface quality and question 19 assessed overall system utility.

This course included a significant amount of web-based material. The web site was on a WebCT platform. It was not the intention of this study to evaluate the web site, but some information regarding its functionality and usability was collected. The neurobiology class web site had the ability to keep a record of student access. It was hoped that this information would identify specific patterns of usage by the students. A self-assessment tool was also included with the software package. Self-assessment information, however, was not available for evaluation. In setting up the self-assessments, the software designers/instructors wanted to ensure that students felt free to take any and all of the self-assessments as many times as necessary. This was done in an attempt to guarantee that each student had every opportunity to master the subject material without censure for numerous repetitions.

Exams, practice tests and practical exams were given on the class web site. Tests generally consisted of a combination of multiple choice and short answer questions. The tests were graded by computer, although short answer questions, which were marked as incorrect by the computer, were re-evaluated for misspellings by an instructor. The investigator had access to the student grades, all test scores and other pertinent information.

Study Methods

This study took place during the spring semester of the 1999-2000 academic year at Colorado State University. The study subjects were first year veterinary students who were enrolled in veterinary neurobiology. There were 134 students in the basic anatomy track. This number of participants was large enough to ensure that the study population was representative of veterinary students at CSU. It was also large enough to handle an attrition rate that was nearly 10% (12/134 or 8.96%) but was still able to provide significant ($p < 0.05$) results.

The computer use survey, which has previously been described, was administered at the end of the second week of the semester. Consent from the participants was also obtained at this time. It was necessary to get consent from the study participants in order to gain access to examination scores and course and software evaluation information.

At the beginning of a scheduled laboratory session, time was made for the investigator to explain the study in detail. Students were then given sufficient time to read and sign the multi-institutional consent form. The computer use survey was also distributed. Those not wishing to participate were asked to leave at this time. All of the students that were present agreed to participate. Three students were absent. A similar procedure was followed when the usability survey was completed seven weeks later. Nine students were absent or failed to fill out the second questionnaire.

During data entry each of the student participants was randomly assigned a number which was designated as a 'student code'. Numeric coding was done to facilitate data analysis and to provide confidentiality for the student subjects. All data analysis was done using these codes as identifiers.

Study Design

This descriptive study evaluated a computer-based learning program in the form of an interactive multimedia software program used to teach veterinary neurobiology. The software was available as a stand-alone, CD-based product. The system requirements for the software were Windows 95, 98 or NT and QuickTime 3.0. A copy of QuickTime was made available on the CD. True Color capabilities were also recommended. The CD was not Macintosh® compatible. In one form or another, the CD was made available to all students. Students could purchase the CD for $20 or utilize CDs available in each computer cubicle in the anatomy and zoology building. The computers in the cubicles had variable capabilities, but they were all PCs that had adequate hardware and software capabilities to run the interactive programs on the disk. There was one cubicle for every 4 to 5 students. The students had access to the computer carrels 24 hours a day, seven days a week.

Data collection started at the beginning of the spring semester (January 5, 2000) and continued until the end of that term (May 5, 2000). The computer use survey was given during the first full week of classes. The usability questionnaire was given 7 weeks later. The data from the twelve respondents who failed to fill out one of the surveys were included in summary analyses, but were excluded from most of the other statistical comparisons.

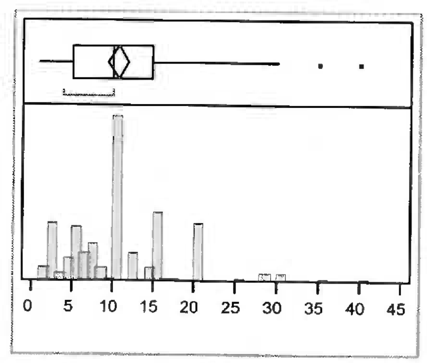
The investigator downloaded the web data from the web site database within a week after class termination. Grade information was also available approximately a week after the conclusion of the course. All grades were number grades. The students submitted course evaluation data via a web-based evaluation instrument. This information was submitted anonymously. After it was tabulated and evaluated by the faculty at CSU, a hardcopy of the results was sent to the investigator. These data were summarized but, since it was not possible to identify the respondents, this information was also excluded from most of the comparative statistical analyses.

Statistical Analysis

Statistical analyses were done using Microsoft Excel 97© SR-1 spreadsheet and the JMP-IN© statistical package, version 3.2.1. The pre-defined significance level was 5%.

Nominal and ordinal data, such as summary scores on survey responses, were evaluated using frequency histograms. Median values were determined to reference the point of central tendency for variables that were numeric scores from Likert scales. Spearman's rank correlation was the analytical test used to evaluate the associations between pairs of ordinal variables or an ordinal and a continuous variable. For example, students' perceived computer sophistication was compared to cumulative grade scores in this manner. Comparisons to test for associations between categorical variables required the use of contingency tables and the Pearson's chi square test.

The primary numeric variables were grade scores and web site hits. A scatter plot was used to evaluate associations between these variables. Descriptive statistics were then used to further elucidate the properties of the distribution. Descriptive statistics are the mean, median, mode, standard deviation and minimum and maximum values. By using a box and whisker plot (see top part of inset example) it was possible to visually characterize the distribution of a specific population of variables. In this layout, a box surrounds the middle half of the data, lower quartile to the median and then to the upper quartile (i.e. the interquartile range). The lines extending from the box show the tails of the distribution. Data points greater than 1.5 quartile ranges from the interquartile range are shown individually and are considered outliers. The mean value of the distribution is indicated by a diamond. In a normal distribution the mean and median values are equal and the interquartile ranges are equidistant from the mean. Pearson's correlation coefficient was the analytical statistic used to determine associations between continuous variables. The



Student's t-test was used for evaluations with dichotomous predictor variables while Analysis of Variance was used to compare predictor variables with categorical variables with three or more categories. Statistical differences for ANOVA were determined using the F ratio. Means comparisons used the Student's t-test and the Least Significant Difference in order to determine which groups were statistically distinct. [42, 43]

Results

Demography

The mean age of the student participants was 27.3 ± 0.52 and the median was 25. The distribution was skewed to the left with 75% of the students between the ages of 21 and 31 and 50% under the age of 25. The oldest student was 51 and the youngest 21. See **Figure 1**. Ninety-six (73%) were female and 35 (27%) were male. **Figure 2** is a representation of the most common prior deegrees conferred on these students. Eighteen students had no undergraduate degree, three had Associate degrees and 98 Bachelor of Science degrees had formerly been conferred on these students. Many students had multiple degrees. The most common undergraduate major was Animal Science (n = 23) but Biology (n = 21) was a close second. Twenty-five students had previous graduate degrees. Twenty-four of the 25 had Master's of Science degrees. One student had a Ph.D. in Chemistry and one had a Ph.D. in Biochemistry. One of the more interesting degree combinations, however, was a BS in International Trade and Marketing and an MS in Anatomy and Neurobiology.

Figure 3 is a graphical representation describing the types of computers these students utilized. Students were instructed to include any type of computer technologies they used on a consistent basis. Multiple selections could be made. They had access to many different types of computer technologies and used them for a variety of purposes. The PC was the most commonly used computer. Eighty-seven percent of the respondents marked that they utilized one routinely. Only 18% used the Macintosh.

Figure 4 represents students' prior computer training. More than one type of training could be marked by an individual student. Over 80 % (81.5%, 106 of 130) marked that they had self-guided training. Sixty-three (59.4%) of those marked self-training as their only form of training.

African-Americans (n = 1) and American Indians (n = 1) each accounted for 0.79% of the vet student population. There were eight Hispanics (6.3%) and four Asian-Americans (3.2%). Caucasians accounted for the remaining 90.3% (n = 112). Most of the students lived in the suburbs (n = 58, 45.7%). Only three lived in what they termed farming communities.

Grade Scores

The cumulative grades were arranged in a distribution that approached a normal distribution. (See **Figure 5**.) The maximum available number of points was 380, but it was possible to exceed the maximum number of total points with the accumulation of extra credit points. Extra credit points were available on most assignments and tests. The mean score was 362.5 ± 0.97. The median was 363.5 and the maximum was 386.5 while the minimum score was 325.0. One hundred thirty-one of 134 students (97.8%) scored greater than a 90% (342 points) on their final cumulative grade.

Grade scores were assessed for relationships with demographic information using either ANOVA or the Student's t-test. A significant ($p < 0.0006$) relationship was apparent by race and by practice specialty. The average mean score for Caucasians (364.1 ± 0.98) was higher than that for the sub-populations of Asian-Americans (351.5 ± 14.98, $p < 0.05$) and Hispanics (350.6 ± 3.65, $p < 0.01$). Caucasian females scored both the highest and lowest scores.

There were a number of students who had prior training in anatomy and/or neurobiology. It is logical to assume that students with prior knowledge in neurobiology might skew the grade curve to the right and that there might also be a significant effect on the distribution of the population of usability variables. Pre-testing is one method that has been used in the past to account for this variability.[19, 33] However, by running a second statistical analysis on the group with prior knowledge and comparing these results with the total group it was possible to evaluate the effects of apriori knowledge without pre-testing. There were no apparent differences in the distributions of the variables for either usability or final grade between the two groups.

In the latter group the mean was higher (370.0 vs. 362.5) and the range was smaller (375.0 - 366.0) vs. (386.5 - 325.0). There was not, however, a statistically significant difference ($p > 0.05$).

There was a significant ($p = 0.0106$, $r = 0.220$) positive effect on final grade by number of web site hits (see **Figure 6**). The estimated number of hours per week a student spent using a computer had no significant effect on his or her final grade. There was no effect relating to the student's previous computer training or his or her perceived level of computer sophistication on final grade outcome.

Spearman's rho was used to compare grade variables with survey information on the students' attitudes about computers and their potential use in veterinary medicine. There was a significant positive association ($p = 0.044$, $r_s = -0.177$) between cumulative grade and the student's attitude about using a cadaver to learn anatomy. Spearman's rho is negative because as the students' grades increased so did their tendency to strongly agree (the lowest numbered response on the Likert-scale) with the statement, "Anatomy is best learned by dissection of the cadaver." No other significant associations were present. These comparisons are recorded in **List 4**.

Usability Evaluations

There were a number of questions placed throughout the usability questionnaire and the computer use survey relating to the usability of the software. These variables generally used Likert scales with the numbers 1 to 7 for their values and were evaluated using Spearman's rank correlation(r_s). Software usability variables were significantly consistent throughout. When they were evaluated for association, many of them were found to be positively and significantly related. For example, the ease of use rating on the computer use survey was correlated to TOTAL usability ($r_s = 0.366$, $p < 0.0006$) and to OVERALL usability ($r_s = 0.412$, $p < 0.0001$) on the usability survey. Since the level of significance is so high, Bonferroni's correction was not performed. A table of all usability comparisons is in **List 3**.

The evaluation process for computer usability satisfaction is described by Lewis.[29] System usability (SYSUSE), information quality (INFOQUAL), interface quality (INTERQUAL), overall system usability (OVERALL) and TOTAL usability were evaluated. Responses to each of the usability assessments, numbered 1 - 19, were in the form of numbered responses to a 7-point Likert scale. The higher number was more favorable for each of the assessment statements. Responses for each section were added together to create a score for that section. The TOTAL usability score is obtained by adding these totals together. Higher totals indicate greater ease of usability. **Table 1** displays response information and also lists the percentages of distribution and other statistical measures, which describe each of the assessments. Note that 14 out of the 19 assessment statements (73%) had responses with a mode of seven. The only notable difference was # 9, which states, "The system gives me error messages that clearly tell me how to fix problems." The mode for that response was four. **Figure 7** is a graph that shows the percent distribution for assessment # 9 and compares it to the distribution for assessment # 8. The distribution for assessment # 8 is more typical of the usability ratings. Assessment # 8 states, "I believe I became productive quickly using this system." The distributions of all individual assessments and group sums were significantly correlated (see **List 3**) except for # 9. The responses from # 9 ("The system gives me error messages that clearly tell me how to fix problems.") were, however, distributed in a pattern that was significantly similar to the overall system (OVERALL) usability distribution ($r_s = 0.218$, $p < 0.0281$) and total (TOTAL) system usability ($r_s = 0.545$, $p < 0.0001$). **Table 2** shows the relationship between assessment # 9 and the other usability variables. Spearman's rank correlation (r_s) was used for these comparisons. A frequency histogram for the overall usability and system usability is seen in **Figure 8**. As one can see, the distribution for the OVERALL quality appears very similar to the distribution of SYSUSE. The distributions of the usability variables were significantly ($p < 0.0001$) correlated for pairwise comparison of all four groups of total scores (i.e., SYSUSE, INFOQUAL, INTERQUAL and OVERALL). See **List 3** for further information.

Spearman's rank correlation was used to compare student computer sophistication with the usability variables. Computer sophistication was not significantly related to overall usability but three responses were individually related. **Table 3** lists these responses and the magnitude and direction of their relationships.

Table 4, on the other hand, shows the significant associations between student attitudes about computers and the overall system usability. Attitudes were scored on a Likert scale with five categories. Response one corresponded with *strongly agree* and response five corresponded with *strongly disagree*. It is important to remember that since the Likert scale is reversed in relation to the previously mentioned ones, a positive relationship meant that, as the student rated the usability of the software more highly, he or she strongly disagreed with the statement that was being evaluated with the same intensity.

There were no significant associations apparent when comparisons were made between overall usability and computer experience. There were, however, individual computer experience responses that showed significant correlations to system usability. These are also listed in **Table 4**. The Likert scale for the computer experience section had five possible responses. Response *one* corresponded to the statement, *never perform this task using a computer,* and response *five* corresponded to *always use a computer to perform this task.*

Gender, age, race and area of specialty had no significant relationships with usability variables.

Computer Sophistication

Computer sophistication was self-evaluated by each student. Each student rated themselves in one of five categories ranging from very sophisticated to very unsophisticated. The middle category was neither. A majority (50.8% or 66 of 130) of students rated themselves in this middle category. **Figure 9** is a chart of the frequency distribution of the students' computer sophistication. Only three students of 130 (2.3%) rated themselves as very sophisticated while six (n = 6 of 130, 4.6%) rated themselves as very unsophisticated. These ordinal variables were compared to the other ordinal variables from the computer use survey using Spearman's rank correlation and with categorical variables, such as training, with contingency tables. There was no significant association between computer sophistication and training. It is interesting to note, however, that all 6 of the students rated as very unsophisticated and 2 of the 3 students who rated their computer proficiency very high (i.e., "very sophisticated") marked self-guided as their only training method. A strong positive correlation was evident in comparisons between computer sophistication and computer knowledge. Students were asked to rate their knowledge on sets of paired computer-related terms. Eighteen of nineteen showed significant, ($p <= 0.0024$) positive relationships with computer sophistication. Only the paired terms "backward chaining and forward chaining" had responses that were not significantly related to computer sophistication. Comparisons between computer sophistication and computer knowledge variables and their levels of significance can be found in **List 7.**

Significant relationships also existed between computer use and computer sophistication. Significantly ($r_s = 0.340$, $p < 0.0001$) more hours per week using a computer were reported by those students having a higher computer sophistication rating. Seven of nine responses (77.8%) relating computer sophistication to computer use were also significantly ($p < 0.01$) related. **List 8** is a list of all computer experience variables and their association to computer sophistication. When students were asked to respond to the extent that they used a computer for a task, only "Communicating with a colleague or friend" and "Using any type of educational program" were tasks that failed to be significantly correlated to computer sophistication. No significant correlations were evident when comparisons were made between computer sophistication and demographic variables.

Student Course Evaluations

The course evaluations were very favorable. **Table 5** is a tabulation of the questions on the course evaluation and the number of responses to each question. Responses could vary from strongly agree, which corresponded to the number one or strongly disagree, which corresponded to the number five. There was one non-responder for three questions. Students strongly agreed (n = 64 of 73, 87.7%) that "they learned a great deal from this

Miscellaneous Results

Web hits:

Actual web hits were significantly ($r_s = 0.4054$, $p < 0.0001$) and positively related to the students' estimates of their web access.

Attitudes about Computers:

Students (n = 60 of 129, 46.5%) strongly agreed that, "Anatomy is best learned by dissection of the cadaver" and students agreed (n = 111 of 123, 90.2%) that, "Multimedia programs will help me learn anatomy." They strongly disagreed (n = 95 of 129, 73.6%) with the statement, "I know how to write code for computer programs."

Potential Effects of Computers:

Students thought that computers would have highly beneficial effects on continuing education and veterinary medical education and would have highly detrimental effects on the rapport between clinicians and clients.

Required Capabilities of Computers:

That a computer-based system had the capability to "clearly explain the rationale for advice it gives on the care of patients" was rated vitally necessary or necessary by 91.5% (n = 119) of the study participants. The availability of 24 hour system support (n = 79, 61.2%) and confidentiality (n = 77, 59.2%) were also considered vitally necessary.

Other Student Comments:

A few of the students had problems with the CD running properly on their home computers. Two stated that the CD was not compatible with their Macs. The following statements were taken verbatim from the computer use survey.

1. "I found the CD to be excellent. Very helpful in viewing the nerves of the spinal cord."

2. "Interactive multimedia tools are helpful but should not replace instructors, lectures or cadavers."
3. "The biggest mistake we can make as a society and as clinicians in a medical field is to become too reliant on computers to think for us!"
4. "I think Cds [sic] and computer usage is a valuable teaching tool as supplemental, but classroom teaching can't be replaced."
5. "It had display problems that preclude the use of the CD on my computer. I would prefer a hard copy for objectives. The CD is difficult to use as a reference, you must be at a computer, boot up, wait… In order to look up something. This is a major drawback."
6. "The CD is a great idea! It is very easy to use and you can utilize it at home (very convenient)…very excellent CD."

a relevant topic for students from the time they see their first cadaver until they retire from the practice of veterinary medicine.

Assessments of student learning in this course were made using tests that were web-based and contained multiple choice and short answer questions. Practical examinations were also given. Some of the assessments included questions that were case-based simulations and required the use of problem-based thinking. A certain amount of the course work also required interaction within a group. As long ago as 1985 Abrahamson stated that "the marriage of the PC and CD technology has produced the capability to offer students the challenge of a clinical problem in both an interactive… and a visual mode," which allows for both the acquisition of information and the solving of the problem.[44] Hooper further states that "medicine is highly dependent on problem-solving since this is the process by which diagnoses are made," and that "problem-solving methods of education are designed to stimulate deep rather than superficial understanding."[45] It is obvious from the statements made by the students in the course evaluations that they not only enjoyed this class, but enjoyed learning. That is reflected by their extremely high level of achievement.

Students who spent more time on the class web site (as determined by their higher number of web hits) had higher mean grades. Since hits on the web site could be an indicator of study time, it seems logical to conclude that the higher grade scores were a result of more time spent studying. However, since removal of two outlying data points eliminated the significant effect, it seems more likely that web hits were not actually related to the amount of effort a student put into the learning process, but were instead related to some other factor, such as poor ISP connections. This assertion is supported by the findings of McNulty, et al.,[46] who studied web-based computer-aided instruction in a basic science course for undergraduate medical students and found that web-based variables had little effect on final grade outcomes.

Since the students' estimates of number of web hits were strongly correlated to actual web hits and since students' estimates of system utility were statistically consistent between the surveys, it is very likely that student estimates of other parameters on the surveys are accurate to the same degree. This assertion is further supported by the very positive significant relationship between students' estimates of computer sophistication and their answers to questions about their computer knowledge. For this reason, estimates of the degree of system usability are also very likely to be accurate.

The distribution of the usability variables was skewed strongly to the right, indicating a high degree of satisfaction by the students that used the software. When compared to the distribution of assessments for a software product used to teach dental implantology in Germany [21] and one used to teach animal reproduction, the neurobiology CD was assessed to have a higher degree and ease of utility. This high degree of usability is supported by the course evaluations and by student comments.

The responses to assessment # 9 had a significantly different distribution from many of the other usability variables. Number nine states, "The system gives me error messages that clearly tell me how to fix problems." It is possible that a lot of students felt neutral about this statement because they had not had the opportunity to "fix problems." This may explain the neutral score of "4." This assertion is further supported by the fact that 64 students marked this statement with na (not applicable). Only a few students mentioned problems in the comment section of the usability survey and scored this statement accordingly, e.g., strongly disagree.

In exploring the relationships between computer sophistication and usability, it seems that there may have been a slight learning curve associated with the use of the software. Students who were more familiar with computer technology rated the ease of use significantly higher in productivity and in the ability to recover from mistakes than those who rated themselves with less computer sophistication.

There was a significant tendency for students who rated the software with a high degree of utility to strongly agree that information retrieval and educational uses of computer technology are important in the field of veterinary medicine. They also felt strongly that this study would serve a useful function in providing information about how veterinary students learn with interactive multimedia. The use of computers for all types of educational purposes was important when related to students' attitudes, expectations and the potential effects of computers. It is exciting that, even though a majority of these students felt that they were not sophisticated computer users, they apparently felt more comfortable with computer technology than might have been previously expected for a similar population of medical professionals.[41] As society as a whole becomes more proficient with computers it is likely that veterinary students will also become more competent. And they will expect and deserve the learning opportunities that computer-based learning and computerized information retrieval and decision support can afford them as they proceed through their educational adventure. If the learning opportunities are not provided, students cannot take advantage of them. And if the learning opportunities are in the form of computer-aided instruction, it is imperative that these products are usable, effective, well made and properly evaluated.

The neurobiology CD, Veterinary Neurobiology-Interactive Programs, fits the above description. It has been evaluated as being very easy for all students to use, regardless of their background and it had an extremely high degree of success 'teaching' neurobiology. As one of the students said, "... it helped make a potentially difficult subject easy to understand and fun to LEARN."

Limitations and Future Research

One of the limitations of this study was its small scale and its relatively short duration. Since the study lasted for only one term, there was no way to determine whether this multimedia educational program had an effect on students' long term retention or whether there was an effect on future learning processes. Furthermore, there was no way to compare this year's students against those from previous years. The relatively small scale of this study, also, made it hard to determine whether a priori knowledge had an influence on learning or whether a priori knowledge affected how each of the student's used this learning tool. It appeared that a small number of students might have prior knowledge in neurobiology and/or anatomy. This number of students was small enough that statistical comparisons between students with priori knowledge and those without was difficult.

It could also be said that this study was not truly unbiased. The developers of the software were significantly involved in teaching the course. It was in their favor to have the software appear useful. The software was evaluated by the primary investigator to see if it met pre-set criteria for usefulness. Use of this software in courses taught by other instructors, i.e., by people or persons not involved in software development will add generalizability to future findings. Also, previously validated measurement tools were used to assess the software. These surveys were not used in the populations for which they were designed and were modified from medical to veterinary medical settings.

An investigation that is longer in duration and one which could take place at multiple veterinary colleges would go a long way in dealing with a number of the limitations of this study. By taking one software product and evaluating it over a two or three year period, it would be possible to maximize the evaluation of the software. If data could also be collected for one to two years prior to the study, comparisons of learning outcomes between different teaching systems could be made. Validation of the surveys in the veterinary student population would further reduce sources of error.

More and better learning software is being developed daily. Research in virtual reality (VR) techniques and its use in teaching are also on going. Future studies could incorporate these methods. Comparisons between VR and traditional multimedia software and conventional teaching methods could be made. It is doubtful that teaching methods will catch up with technology in the near future. There will remain much to do.

Summary and Conclusions

Primary Conclusions

1. Interactive, multimedia, computer-based learning is appropriate for teaching problem-solving skills to undergraduate veterinary medical students.
2. Computer-based multimedia is an effective tool for teaching the basic sciences to undergraduate veterinary medical students.

Secondary Conclusions

1. The surveys as modified were effective and appropriate measurement tools
2. Veterinary Neurobiology Interactive Programs received exceptionally high scores on usability.
3. The previously cited requirements for interactive educational software were met by this program.
4. The software was highly usable even for students that did not have extensive computer experience.
5. Students' attitudes about computers and computer-based technology had no effect on their ability to use and learn from this educational program.
6. Students performed exceedingly well in this course.
7. Students who found the software less usable were still able to excel.
8. Students had fun!
9. Students had fun learning!

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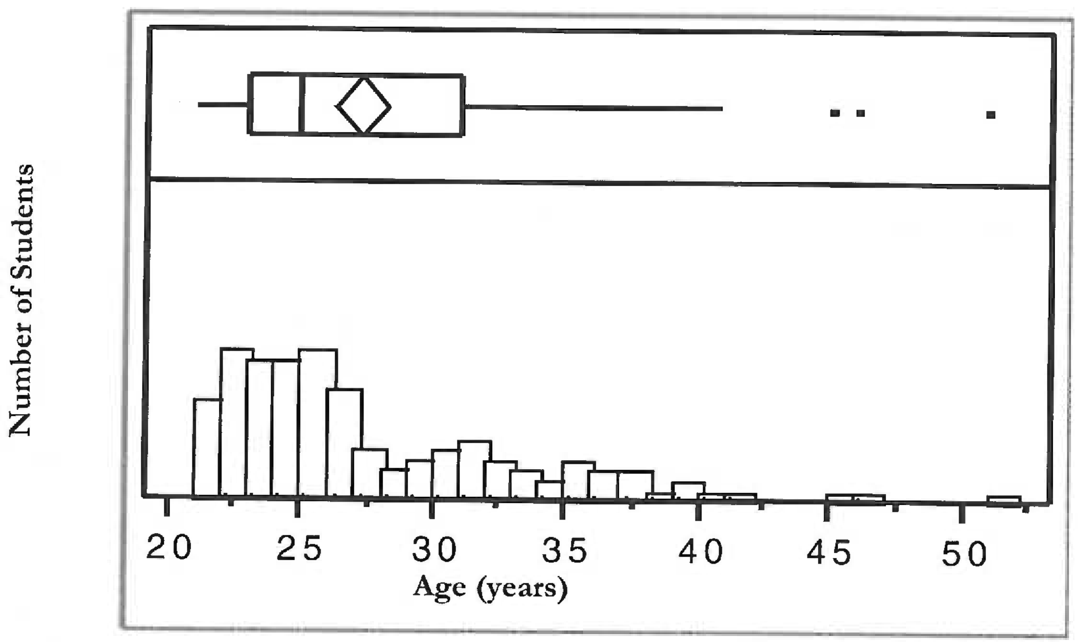

Figure 1. Distribution of Student Age

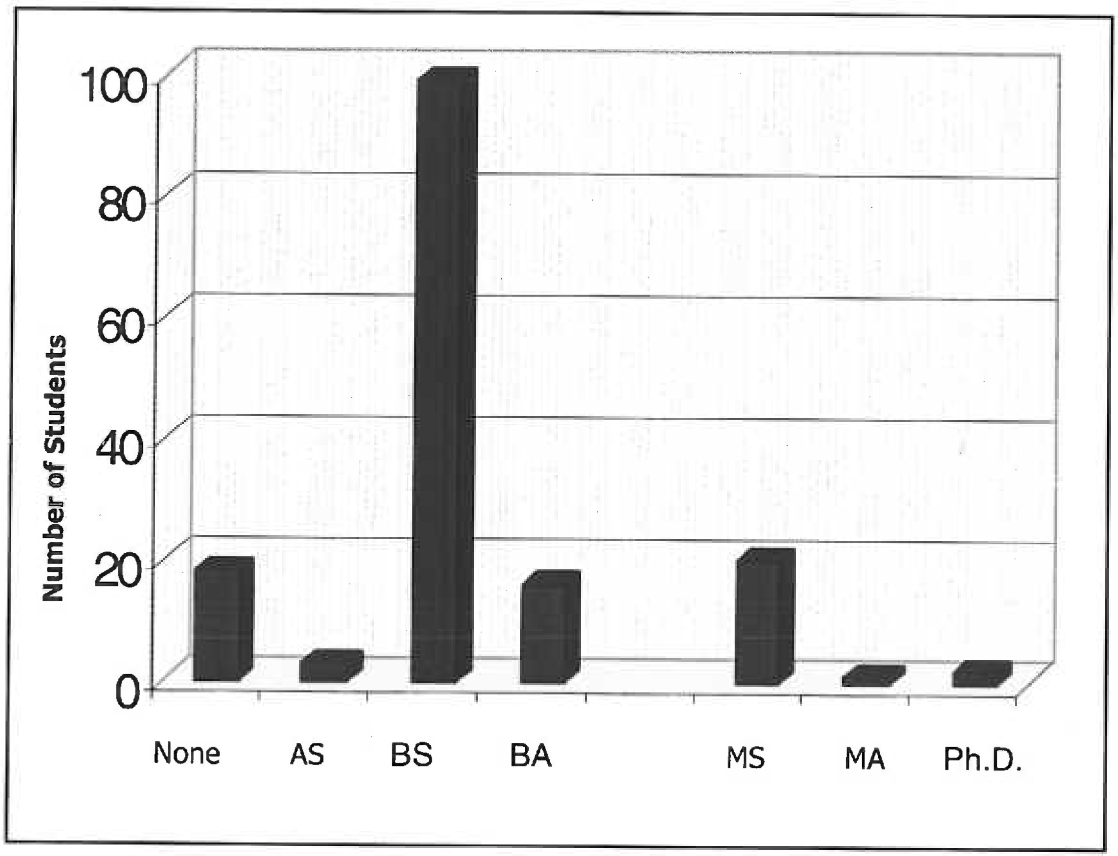

Figure 2. Prior Degrees

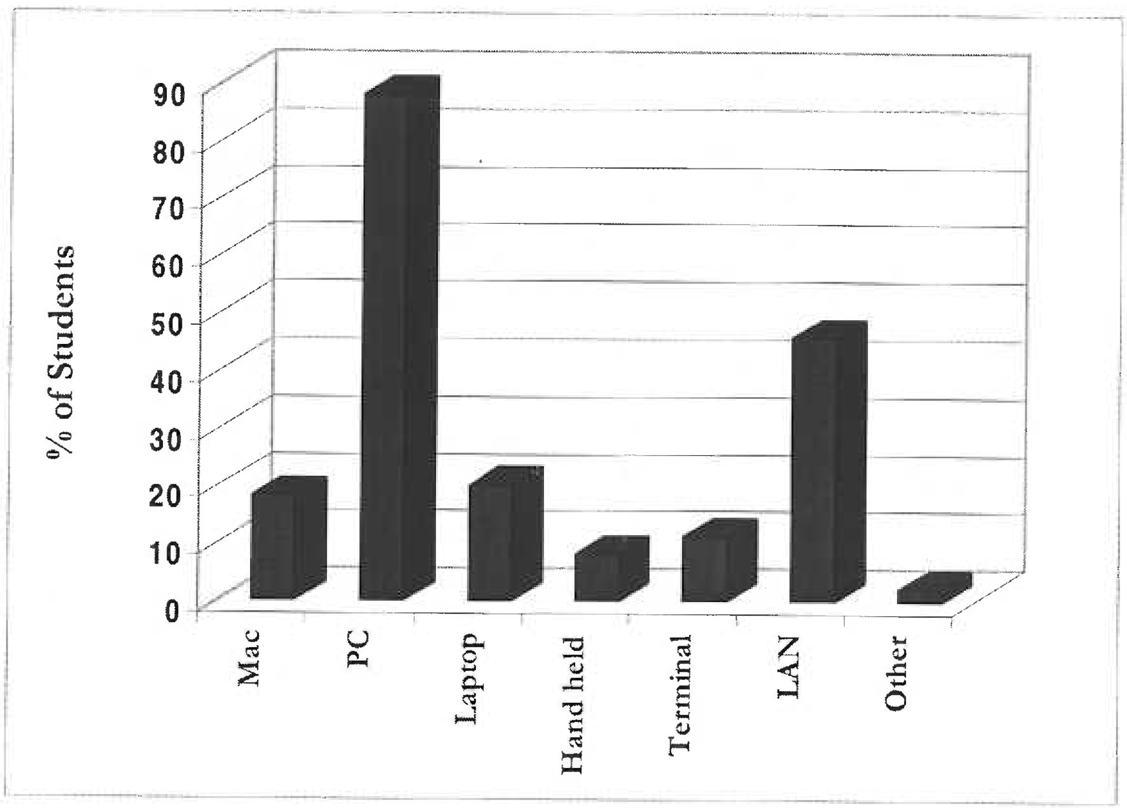

Figure 3. Student Computer Usage

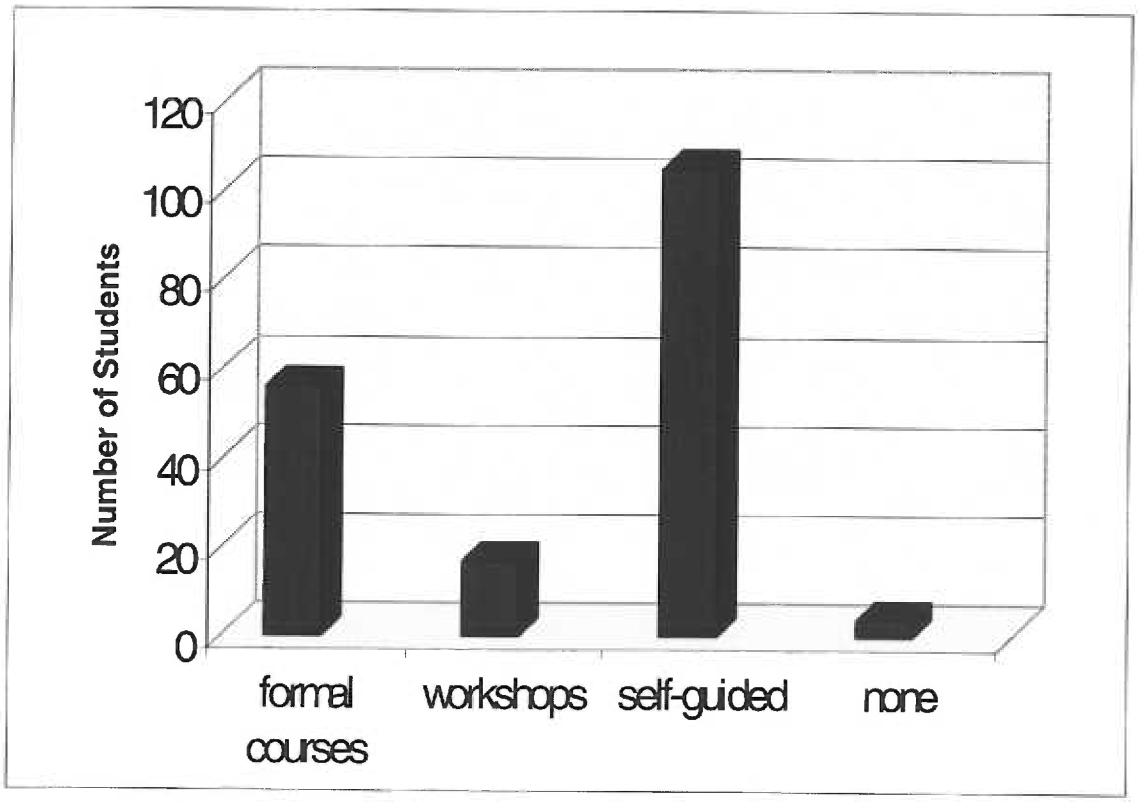

Figure 4. Prior Computer Training

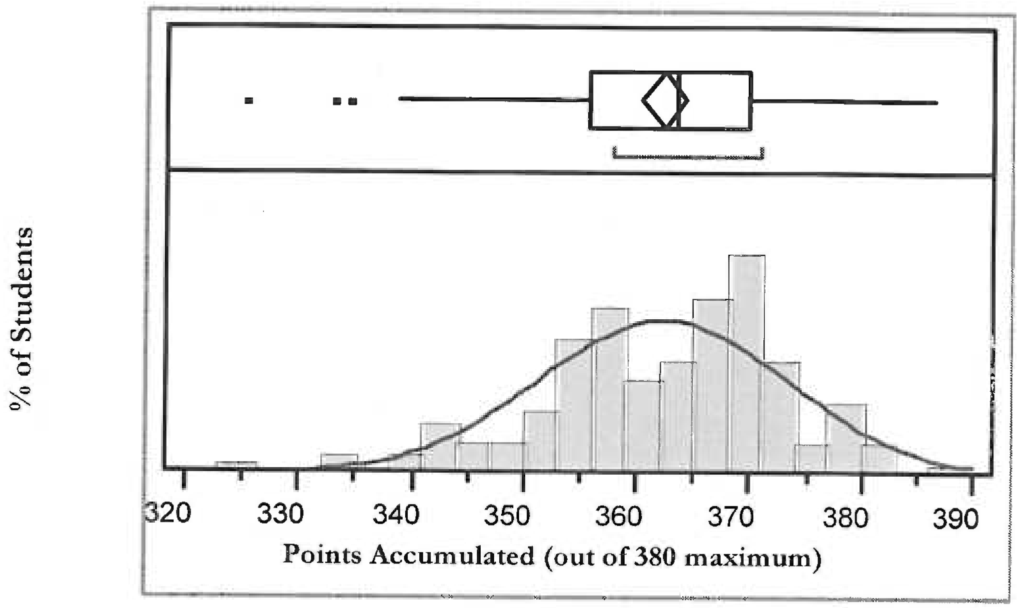

Figure 5. Distribution of Final Grade

Cumulative Grade By Web hits

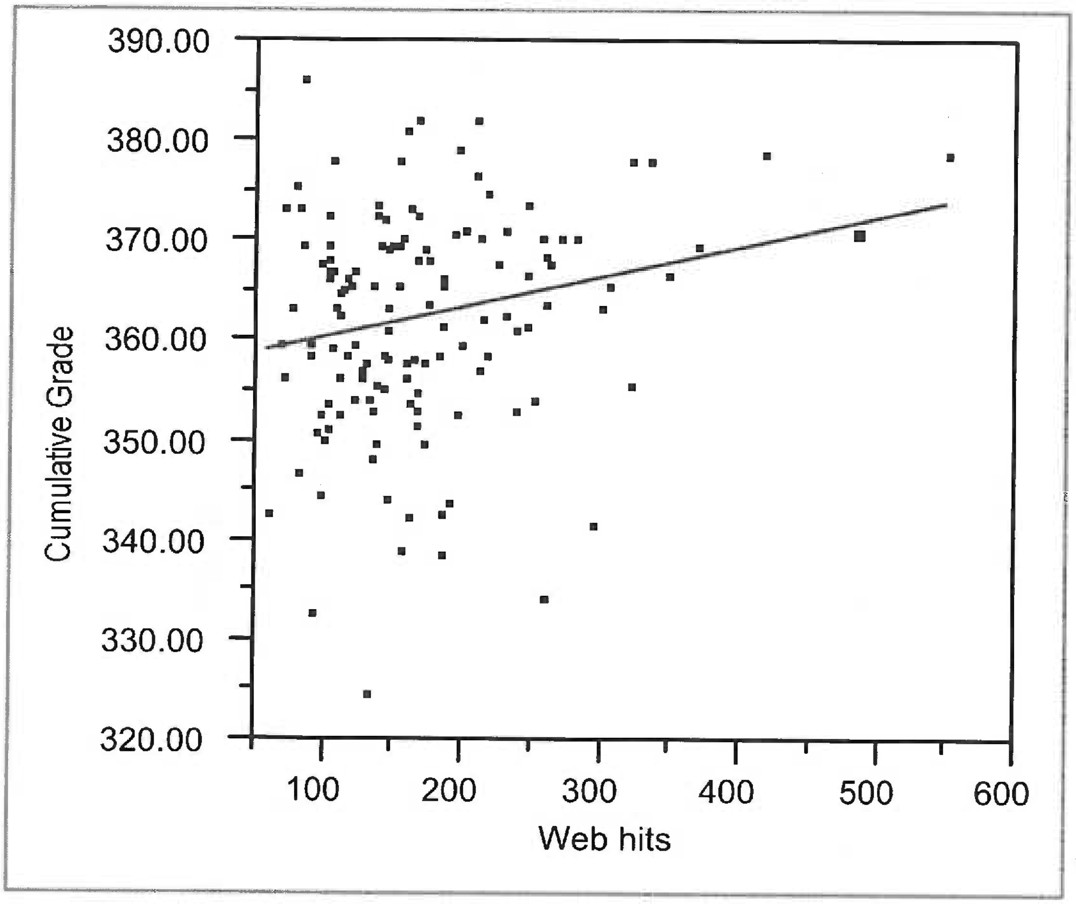

Figure 6. Cumulative Grade by Web Hits

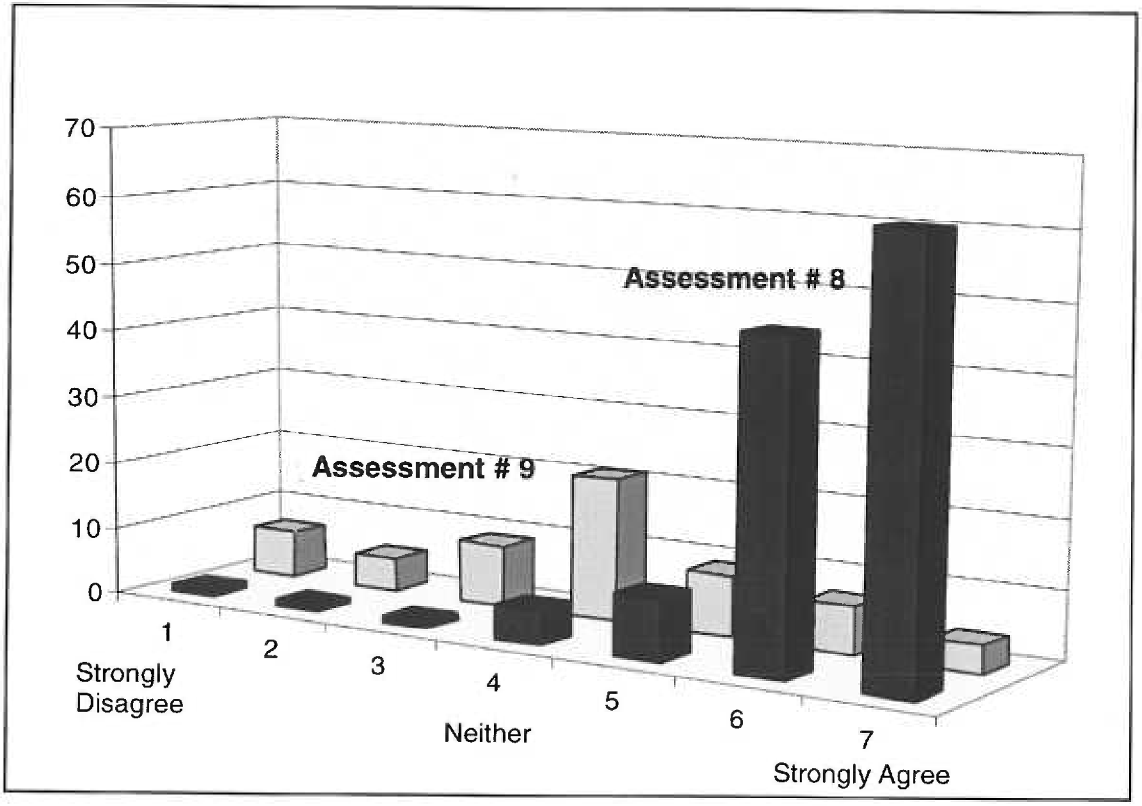

Figure 7. Comparison of Assessments #8 (typical of most usability variables) & #9
#8. "I became productive quickly using this system."

#9. "The system gives me error messages that clearly tell me how to fix problems."

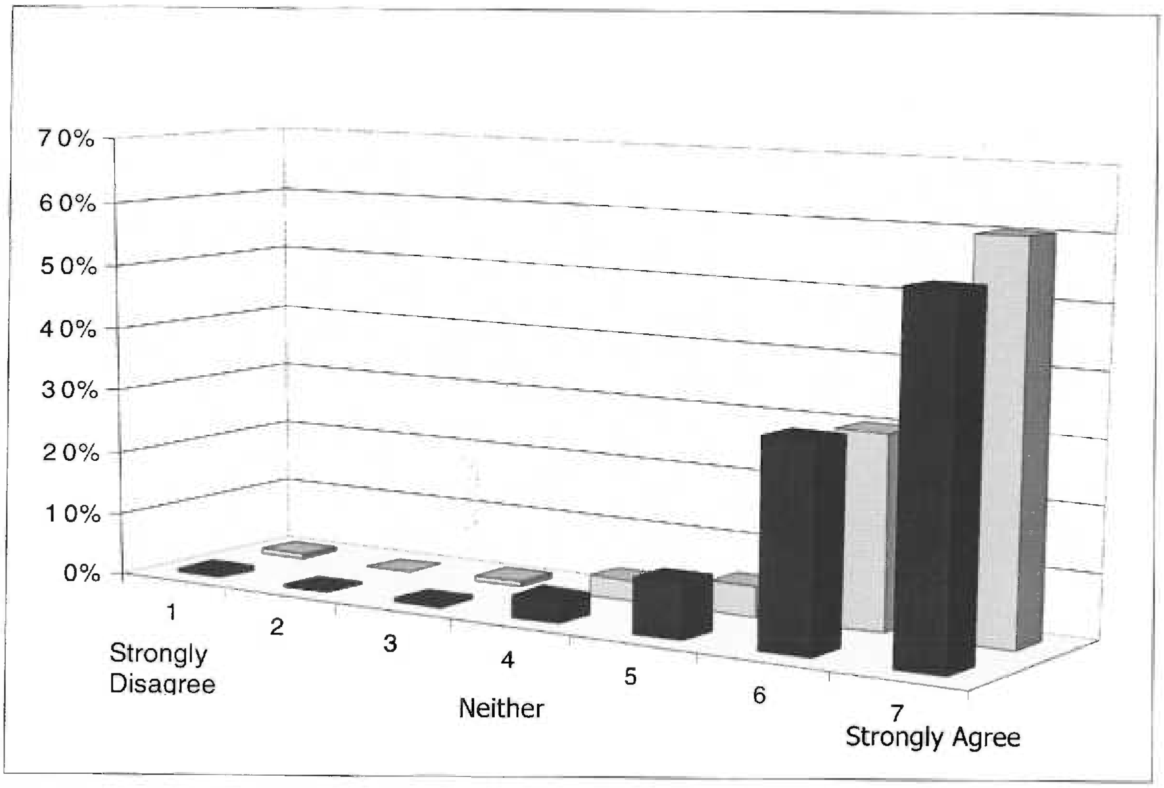

Figure 8. Distribution of SYSTEM USEFULNESS (foreground) & OVERALL USEFULNESS (background)

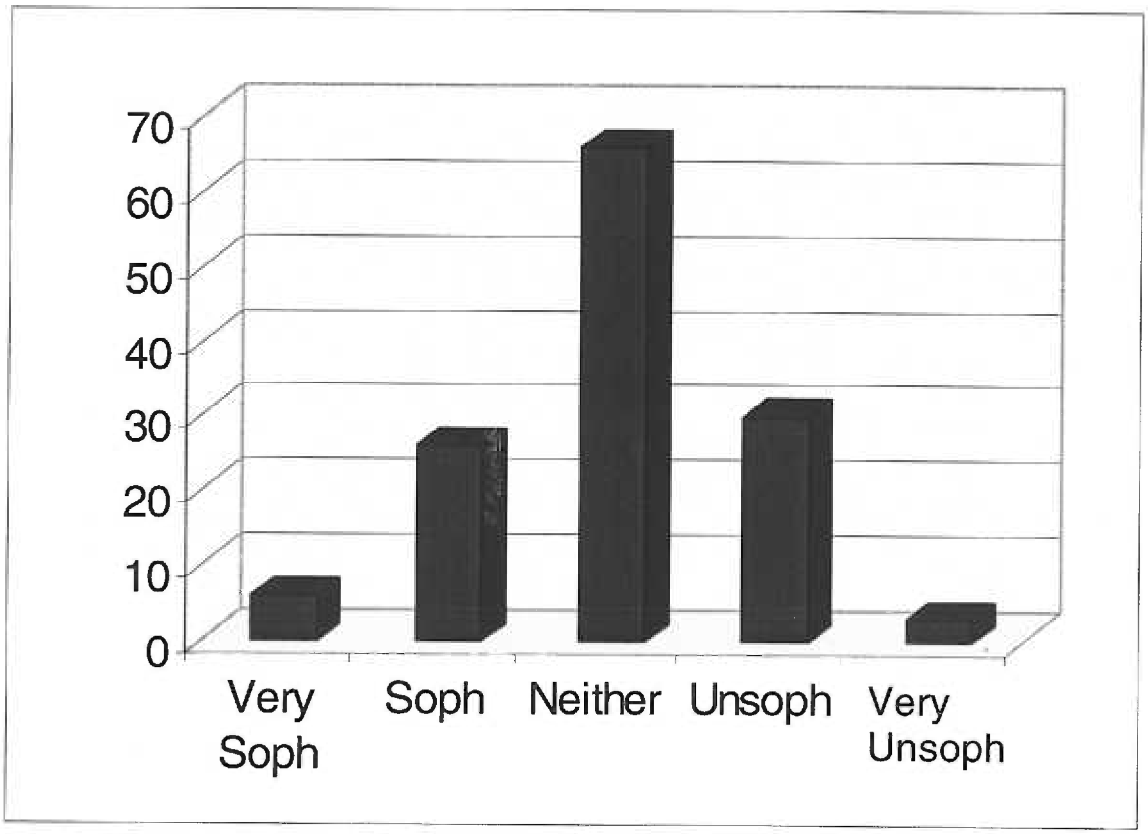

Figure 9. Students' Computer Sophistication

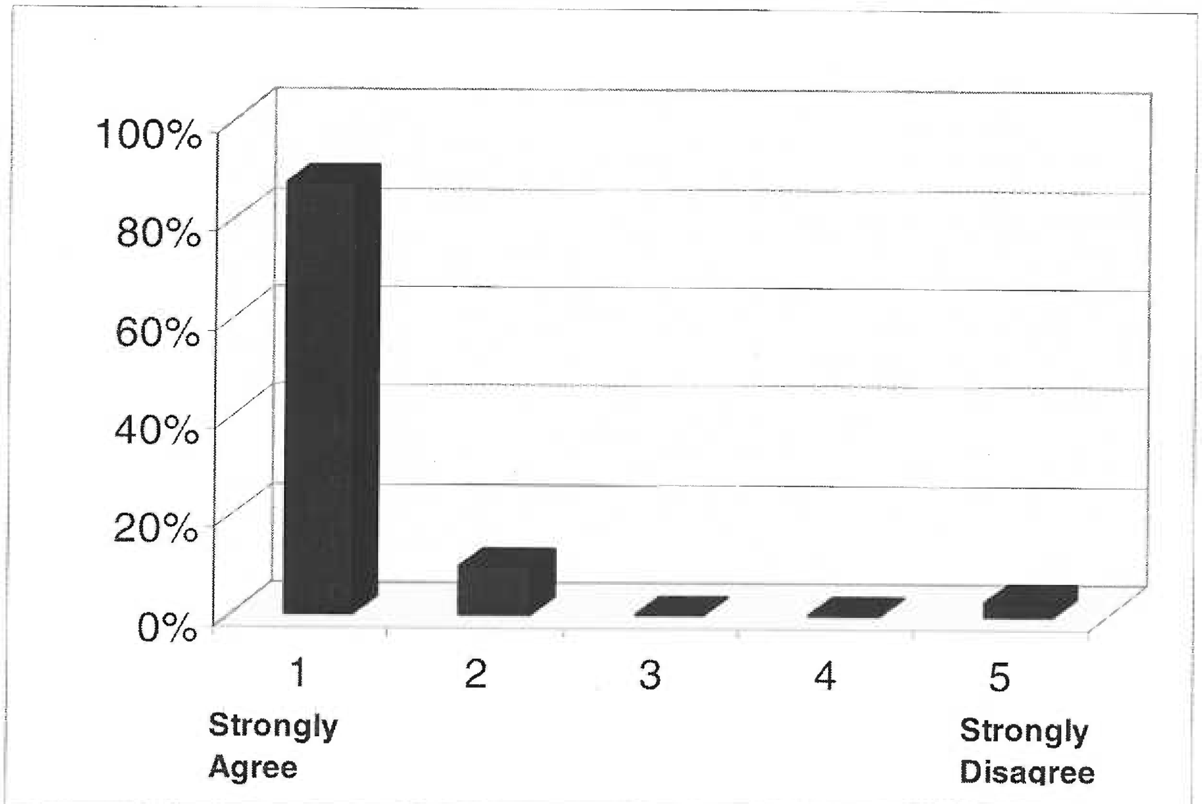

Figure 10. Distribution of Course Evaluation Question 5
"I learned a great deal from this course"

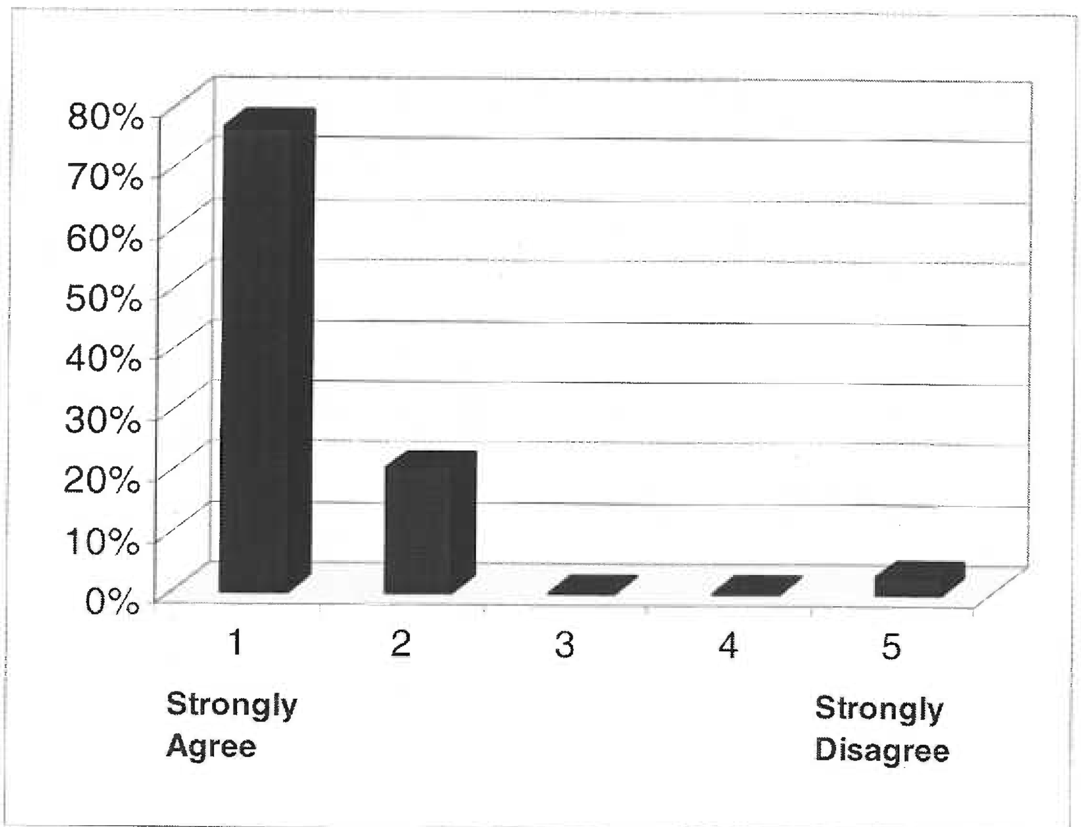

Figure 11. Distribution of Course Evaluation Question 2
"Course objectives were obtained."

Table 1. Usability Rankings

N is the total number of responses for each usability assessment, 1-19, where 7 is favorable and 1 is unfavorable.

Usability Factors	n if 7	n if 6	n if 5	n if 4	n if 3	n if 2	n if 1	mode	min
SYSUSE									
1 CD easy to use	82	31	9	3	0	0	1	7	1
2 system easy to use	81	36	8	0	1	0	0	7	3
3 completed work effectively	61	40	19	2	2	0	2	7	1
4 completed work quickly	38	53	16	15	1	1	2	6	1
5 completed work efficiently	45	52	18	8	1	0	1	6	1
6 comfortable	87	34	4	1	0	0	0	7	4
7 easy to learn	92	26	4	2	0	1	0	7	2
8 productive quickly	62	47	9	5	1	1	1	7	1
SYSUSE group sums	548	319	87	36	6	3	7		
percent of distribution	54.5%	31.7%	8.6%	3.6%	0.6%	0.3%	0.7%		
INFOQUAL									
9 error messages	4	7	9	21	9	5	7	4	1
10 recover from mistake quick	22	27	22	17	2	1	0	6	2
11 information is clear	46	36	18	6	3	1	0	7	2
12 easy to find info	52	38	25	5	2	2	0	7	2
13 easy to understand	63	42	16	4	0	0	0	7	4
14 info effective for work	80	36	7	2	0	1	0	7	2
15 info organization clear	70	39	12	5	0	0	0	7	4
INFOQUAL group sums	337	225	109	60	16	10	7		
percent of distribution	44.1%	29.5%	14.3%	7.9%	2.1%	1.3%	0.9%		
INTQUAL									
16 interface pleasant	52	49	13	6	0	0	0	7	4
17 like using interface	52	43	19	6	1	0	1	7	1
18 functions & capabilities	46	48	19	8	4	0	1	6	1
INTQUAL group sums	150	140	51	20	5	0	2		
percent of distribution	40.8%	38.1%	13.9%	5.4%	1.4%	0%	0.5%		
OVERALL									
19 overall satisfaction	76	38	6	4	1	0	1	7	1
percent of distribution	60.3%	30.2%	4.8%	3.2%	0.8%	0%	0.8%		
TOTAL quality sums	1111	722	253	120	28	13	17		
TOTAL % of distribution	**49.1%**	**31.9%**	**11.2%**	**5.3%**	**1.2%**	**0.6%**	**0.5%**		

Table 2. Relationships to Usability Assessment # 9

Similar Variable	Relationship	Unrelated Variable	Relationship
Assessment 10	$p < 0.0001$ $r_s = 0.4974$	Assessment 1	$p = 0.0576$ $r_s = 0.2445$
Assessment 11	$p = 0.0005$ $r_s = 0.4463$	Assessment 2	$p = 0.4814$ $r_s = 0.0918$
Assessment 12	$p = 0.0008$ $r_s = 0.4263$	Assessment 3	$p = 0.0720$ $r_s = 0.2320$
Assessment 13	$p = 0.0106$ $r_s = 0.3251$	Assessment 4	$p = 0.1304$ $r_s = 0.1959$
Assessment 15	$p = 0.0428$ $r_s = 0.2602$	Assessment 5	$p = 0.1343$ $r_s = 0.1939$
INFOQUAL	$p < 0.0001$ $r_s = 0.6610$	Assessment 6	$p = 0.2203$ $r_s = 0.1592$
Assessment 17	$p = 0.0199$ $r_s = 0.3050$	Assessment 7	$p = 0.7099$ $r_s = 0.0490$
Assessment 18	$p = 0.0184$ $r_s = 0.3009$	Assessment 8	$p = 0.3057$ $r_s = 0.1333$
INTERQUAL	$p = 0.0006$ $r_s = 0.4295$	SYSUSE	$p = 0.1454$ $r_s = 0.1886$
Assessment 19	$p = 0.0281$ $r_s = 0.2812$	Assessment 14	$p = 0.1921$ $r_s =0.1693$
OVERALL	$p < 0.0001$ $r_s = 0.5448$	Assessment 16	$p = 0.1062$ $r_s = 0.2162$

Table 3. Relationships Between Computer Sophistication and Usability Evaluations

Usability Response	Probability
# 8 I believe I became productive quickly.	$p = 0.0397$ $r_s = 0.1881$
# 10 When I make a mistake I recover quickly.	$p = 0.0291$ $r_s = 0.2341$
#14 The information is effective in helping me complete my coursework.	$p = 0.0394$ $r_s = 0.1884$

Table 4. Relationships with Total Computer Usability

Response	Probability
ATTITUDES	
Computerized information retrieval is very efficient.	$p = 0.0215$ $r_s = -0.2133$
Computers are too impersonal.	$p = 0.0144$ $r_s = -0.2627$
I use a computer to help me with my studies.	$p = 0.0037$ $r_s = -0.2627$
Multimedia programs will help me learn anatomy.	$p = 0.0186$ $r_s = -0.2145$
I think filling out this survey is a waste of my time.	$p = 0.0351$ $r_s = 0.1926$
This study will provide essential information about how veterinary professional students learn.	$p = 0.0004$ $r_s = -0.3181$
Computers save me a lot of time.	$p = 0.0019$ $r_s = -0.2808$
COMPUTER EXPERIENCE	
Writing documents or word-processing.	$p = 0.0126$ $r_s = 0.2262$
Using a library catalog	$p = 0.0314$ $r_s = 0.1958$

Table 5. Course Evaluation Tabulation

where 1 is strongly agree and 5 is strongly disagree

	no response	1	2	3	4	5
subject matter met course objectives	0	58	12	1	0	2
course objectives obtained	0	56	15	0	0	2
transition between instructor was good	0	37	23	7	3	3
logical progression	0	34	22	14	3	0
I learned a great deal	0	64	7	0	0	2
the amount of work was appropriate	0	50	20	1	1	1
assignments & tests were clear	1	50	18	1	1	2
course work was returned promptly	1	43	23	4	1	1
test/assignments gave helpful feedback	0	39	22	9	2	1
comfortable asking ? or discussing	1	54	12	2	1	2
classroom conductive to learning	0	54	14	2	0	2
I utilized all learning opportunities	0	25	41	2	2	2
I worked hard	0	33	35	2	2	1

List 1. Students' Comments on System Usefulness

This is a great learning tool. I would highly recommend it to other students - even those at other schools.

Efficiency of course work completion is related to the speed of computer

1) The CD works well. However, I wish I could print out of it so I had a hard copy to study. Looking at the screen too long gives me a headache. 2) Additional plugins make it hard to connect from home

better on line speed

Sometimes it seems that there is redundant info - and some screens could be eliminated

Accidentally getting into the instructions/directions for using the CD could be decreased if the same question was used for all parts of the CD. I.e. Have you used this program before Yes/No only...

I have really liked having the CD, both to learn from and as a reference. I would have spent twice the money to own it. 2) Speed of connection is variable, sometimes it is ok.

I really wish it had been emphasized at the beginning of the year that people with Macs or who do not have the right software should not buy the CD. For me it was a waste of money. The CD is excellent but I can only use the cube copies. I can't study at home even if I want to -- the CD should be made compatible for both PC's and Macs.

1) Increase constancy between sections 2) Text requires proofreading for typos and missing words

It is very helpful-especially the movies-when trying to learn. I also like the cases great to really use information.

no computer at home

1)Sometimes I feel unorganized as to what to be doing because there are so many things to look at. 2) A check off sheet like we get during exams would help ensure that we accessed the information that is recommended

An index to find a subject or word on the CD would be helpful

The only thing that would be a nice addition is just on a "total" nervous system exam.

The CD is a good tool and reference, but computer learning often seems disjointed and difficult to learn topics in a cohesive manner. Good classroom lectures are an essential complement to the CD.

It would be nice if this program was compatible with more than just windows, my macintosh at home has a different operating system

needs search index where you can type a word & it will find it in the program

Maybe.. Have option for "high speed" use which uses schematics to the execution of digitized videos & images - for quick reference work,

I've learned a tremendous amount in the course & it is mainly due to the CD - especially since I can go through it multiple times at my convenience.

The only trouble I have had is trying to download the plug-ins at home.

the CD is a wonderful tool but cannot replace the learning experience of the teacher-student relationship

I think we depend entirely too much on the CD.

Slow connect times at home affect movies. Some of the course material isn't on the CD and I would like it to all be on there (#18). I LOVE the CD and wish all classes had one!

sometimes have trouble getting pictures to work

This CD was not only educational but interesting. I could spend hours on it.. I had to watch myself!!

has trouble with computers crashing at school & at home

more detail on localizing lesions

overlying colors on the dissection pictures are hard to see (use darker colors?)

The educational program is excellent. The website and CD are extremely useful & valuable tool.

Love it, need it got it!

I think the CD is an effective learning tool but cannot replace classroom time and must be used in conjunction.

CD is very helpful

need to be able to click off things (explanations) on the pictures that cover other stuff I want to see on the same picture. What parts of the brainstem CN's are located on is not clear. E.g. myencephalon vs. ventral metencephalon for CN's VII & VIII

This CD works great - I would like to be able to download the additional features added to WebCT so that you can avoid the delay of access to the web from school.

Quizzes on all the sections would be helpful, also indexes on all of the sections would be helpful

CD is excellent for visual learners

Fonts on CD don't work at home. CD is a great supplement for lecture, but may be relied upon too heavily during lecture.

She doesn't own a computer. The only problem I have with the CD is that I often have difficulty using information on a computer screen. I often wish that I could have a hard copy of the same information. I encounter this problem with other web sites as well; in fact, I prefer to print out the information and then sit down to read it. There is something about being able to write, highlight, etc. on a hard copy versus just seeing it on a screen that really helps me learn.

Well worth the cost. I wish there were more CD's to help with the other classes, I.e. anatomy

It is hard to use this program when you don't have a computer that is up to speed with color, quickness, etc... It almost forces a person to have to get a computer to keep up with the system. I like the CD though

The CD is erratic on my home PC

Just don't loose the human element - I still use the teachers for specific problems with questions.

no computer at home

This CD is the bulk of the course- I have yet to open a hard back book. It is wonderful

need to add supplements so the CD can be used for other courses, I.e. radiographs

great idea!! Materials are excellent

relating to questions 9 & 10- I have not encountered errors

A master index would be helpful.

I don't have a home computer

I think the class lacks student/teacher interaction & relies too heavily on learning the CD in our own "free" time (like we have any)

CD is great but shouldn't take the place of the blackboard & in class learning

Slow internet connections at home tend to limit the time I use to study neuro on WebCT, but the CD is a good supplement. I think once connections speed up, info on the CD could just as easily be put on the web.

1) I wish we had this tool for ant/hist. It has been a valuable learning tool. 2) slow downloading is a Big Problem

At times it is difficult to rely so heavily on the CD & not to get as structured of a lecture.

A Mac user At times it is frustrating to not be able to use it at home. The only reason I have lowered the scale of some of the questions is because of the incompatibility with Macs, Otherwise...... everything would be perfect.

List 2. Students' Comments from the Computer Use Survey

It had display problems that preclude the use of the CD on my computer. I would prefer a hard copy for objectives. The CD is difficult to use as a reference, you must be at a computer, boot up, wait..... In order to look up something. This is a major drawback.

I plan on using the CD

it is the beginning of the semester so I have not used the CD & web CT as much as I will in the future

I really liked the CD

but I suspect this is just an adjustment to a new vocab period and should change soon

question IVa. I did not indicate any lowest priority because I believe most of the items are of reasonable priority

section Iva. Of this survey did not allow us to express what we think. A possible alternative is to let us prioritize the developments. I circled 6 for least because I had to, not because I believe that situation is of a low priority.

I think some of the ? For apps in vet med are misleading because some have already been developed so therefore don't need to be for the future

I found the CD to be excellent. Very helpful in viewing the nerves of the spinal cord.

Interactive multimedia tools are helpful but should not replace instructors, lectures or cadavers

like the CD a lot so far

the Cd is a much better way to get an overview of neuroanatomy than either of the books

difficult to read at home because you cannot read all of the text

easy to use, also simple to install support software

some of the color does not come on, not compatible with my computer, program looks good but is not fast on my computer - it drives me crazy

The biggest mistake we can make as a society and as clinicians in a medical field is to become too reliant on computers to think for us!

the CD is a great idea! It is very easy to use & you can utilize it at home (very convenient)...very excellent CD

I think Cds & computer usage is a valuable teaching tool as supplemental, but classroom teaching can't be replaced.

very good learning tool

I have only used the CD 2 times so I can't give very accurate info on it.

shorten this survey

This survey was too long. I started to drift after the 3rd page. A shorter less complex survey would have kept my attention longer and thus my answers would have been less biased.

List 3. Nonparametric Measures of Association between Usability Survey Variables
Each usability variable is correlated with other usability variables or sums.

Variable	by Variable	Spearman Rho	Prob>|Rho|
2. system easy to use	1. CD easy to use	0.8391	<.0001
3. completed work effectively	1. CD easy to use	0.4879	<.0001
3. completed work effectively	2. system easy to use	0.5151	<.0001
4. completed work quickly	1. CD easy to use	0.5670	<.0001
4. completed work quickly	2. system easy to use	0.5458	<.0001
4. completed work quickly	3. completed work effectively	0.6210	<.0001
5. completed work efficiently	1. CD easy to use	0.5853	<.0001
5. completed work efficiently	2. system easy to use	0.5963	<.0001
5. completed work efficiently	3. completed work effectively	0.6647	<.0001
5. completed work efficiently	4. completed work quickly	0.7997	<.0001
6. comfortable	1. CD easy to use	0.4271	<.0001
6. comfortable	2. system easy to use	0.5130	<.0001
6. comfortable	3. completed work effectively	0.4546	<.0001
6. comfortable	4. completed work quickly	0.4722	<.0001
6. comfortable	5. completed work efficiently	0.5256	<.0001
7. easy to learn	1. CD easy to use	0.5328	<.0001
7. easy to learn	2. system easy to use	0.6658	<.0001
7. easy to learn	3. completed work effectively	0.3816	<.0001
7. easy to learn	4. completed work quickly	0.4355	<.0001
7. easy to learn	5. completed work efficiently	0.5267	<.0001
7. easy to learn	6. comfortable	0.6956	<.0001
8. productive quickly	1. CD easy to use	0.5674	<.0001
8. productive quickly	2. system easy to use	0.5844	<.0001
8. productive quickly	3. completed work effectively	0.4882	<.0001
8. productive quickly	4. completed work quickly	0.4961	<.0001
8. productive quickly	5. completed work efficiently	0.5839	<.0001
8. productive quickly	6. comfortable	0.4846	<.0001
8. productive quickly	7. easy to learn	0.4819	<.0001
SYSUSE SUMS	1. CD easy to use	0.7274	<.0001
SYSUSE SUMS	2. system easy to use	0.7555	<.0001
SYSUSE SUMS	3. completed work effectively	0.7667	<.0001
SYSUSE SUMS	4. completed work quickly	0.8398	<.0001
SYSUSE SUMS	5. completed work efficiently	0.8718	<.0001
SYSUSE SUMS	6. comfortable	0.6537	<.0001
SYSUSE SUMS	7. easy to learn	0.6402	<.0001
SYSUSE SUMS	8. productive quickly	0.7180	<.0001
9. error messages clear	1. CD easy to use	0.2445	0.0576
9. error messages clear	2. system easy to use	0.0918	0.4814
9. error messages clear	3. completed work effectively	0.2320	0.0720
9. error messages clear	4. completed work quickly	0.1959	0.1304
9. error messages clear	5. completed work efficiently	0.1939	0.1343
9. error messages clear	6. comfortable	0.1592	0.2203

Variable	by Variable	Spearman Rho	Prob>|Rho|
9. error messages clear	7. easy to learn	0.0490	0.7099
9. error messages clear	8. productive quickly	0.1333	0.3057
9. error messages clear	SYSUSE SUMS	0.1886	0.1454
10. recover quick from mistake	1. CD easy to use	0.3925	0.0002
10. recover quick from mistake	2. system easy to use	0.4323	<.0001
10. recover quick from mistake	3. completed work effectively	0.3794	0.0003
10. recover quick from mistake	4. completed work quickly	0.3734	0.0003
10. recover quick from mistake	5. completed work efficiently	0.4841	<.0001
10. recover quick from mistake	6. comfortable	0.3892	0.0002
10. recover quick from mistake	7. easy to learn	0.4033	0.0001
10. recover quick from mistake	8. productive quickly	0.3644	0.0005
10. recover quick from mistake	SYSUSE SUMS	0.5079	<.0001
10. recover quick from mistake	9. error messages clear	0.4974	<.0001
11. information clear	1. CD easy to use	0.4081	<.0001
11. information clear	2. system easy to use	0.4321	<.0001
11. information clear	3. completed work effectively	0.4420	<.0001
11. information clear	4. completed work quickly	0.4190	<.0001
11. information clear	5. completed work efficiently	0.4260	<.0001
11. information clear	6. comfortable	0.3887	<.0001
11. information clear	7. easy to learn	0.3727	<.0001
11. information clear	8. productive quickly	0.4635	<.0001
11. information clear	SYSUSE SUMS	0.5052	<.0001
11. information clear	9. error messages clear	0.4463	0.0005
11. information clear	10. recover quick from mistake	0.5962	<.0001
12. easy to find info	1. CD easy to use	0.5898	<.0001
12. easy to find info	2. system easy to use	0.5994	<.0001
12. easy to find info	3. completed work effectively	0.5356	<.0001
12. easy to find info	4. completed work quickly	0.6194	<.0001
12. easy to find info	5. completed work efficiently	0.6548	<.0001
12. easy to find info	6. comfortable	0.5426	<.0001
12. easy to find info	7. easy to learn	0.4909	<.0001
12. easy to find info	8. productive quickly	0.5720	<.0001
12. easy to find info	SYSUSE SUMS	0.6988	<.0001
12. easy to find info	9. error messages clear	0.4263	0.0008
12. easy to find info	10. recover quick from mistake	0.6558	<.0001
12. easy to find info	11. information clear	0.6682	<.0001
13. info easy to understand	1. CD easy to use	0.5584	<.0001
13. info easy to understand	2. system easy to use	0.6179	<.0001
13. info easy to understand	3. completed work effectively	0.5608	<.0001
13. info easy to understand	4. completed work quickly	0.5325	<.0001
13. info easy to understand	5. completed work efficiently	0.5946	<.0001
13. info easy to understand	6. comfortable	0.5937	<.0001
13. info easy to understand	7. easy to learn	0.6012	<.0001
13. info easy to understand	8. productive quickly	0.6104	<.0001
13. info easy to understand	SYSUSE SUMS	0.6920	<.0001
13. info easy to understand	9. error messages clear	0.3251	0.0106
13. info easy to understand	10. recover quick from mistake	0.5544	<.0001

Variable	by Variable	Spearman Rho	Prob>|Rho|
13. info easy to understand	11. information clear	0.6172	<.0001
13. info easy to understand	12. easy to find info	0.8284	<.0001
14. info effective for course	1. CD easy to use	0.5654	<.0001
14. info effective for course	2. system easy to use	0.6457	<.0001
14. info effective for course	3. completed work effectively	0.5025	<.0001
14. info effective for course	4. completed work quickly	0.5239	<.0001
14. info effective for course	5. completed work efficiently	0.5838	<.0001
14. info effective for course	6. comfortable	0.6395	<.0001
14. info effective for course	7. easy to learn	0.7292	<.0001
14. info effective for course	8. productive quickly	0.6054	<.0001
14. info effective for course	SYSUSE SUMS	0.7042	<.0001
14. info effective for course	9. error messages clear	0.1693	0.1921
14. info effective for course	10. recover quick from mistake	0.4582	<.0001
14. info effective for course	11. information clear	0.4403	<.0001
14. info effective for course	12. easy to find info	0.6338	<.0001
14. info effective for course	13. info easy to understand	0.7529	<.0001
15. organization of info clear	1. CD easy to use	0.5628	<.0001
15. organization of info clear	2. system easy to use	0.6821	<.0001
15. organization of info clear	3. completed work effectively	0.4823	<.0001
15. organization of info clear	4. completed work quickly	0.5113	<.0001
15. organization of info clear	5. completed work efficiently	0.5539	<.0001
15. organization of info clear	6. comfortable	0.5981	<.0001
15. organization of info clear	7. easy to learn	0.5705	<.0001
15. organization of info clear	8. productive quickly	0.5861	<.0001
15. organization of info clear	SYSUSE SUMS	0.6535	<.0001
15. organization of info clear	9. error messages clear	0.2602	0.0428
15. organization of info clear	10. recover quick from mistake	0.5057	<.0001
15. organization of info clear	11. information clear	0.5937	<.0001
15. organization of info clear	12. easy to find info	0.6282	<.0001
15. organization of info clear	13. info easy to understand	0.7035	<.0001
15. organization of info clear	14. info effective for course	0.6975	<.0001
INFOQUAL SUMS	1. CD easy to use	0.3369	0.0002
INFOQUAL SUMS	2. system easy to use	0.3396	0.0001
INFOQUAL SUMS	3. completed work effectively	0.3646	<.0001
INFOQUAL SUMS	4. completed work quickly	0.3803	<.0001
INFOQUAL SUMS	5. completed work efficiently	0.4636	<.0001
INFOQUAL SUMS	6. comfortable	0.3348	0.0002
INFOQUAL SUMS	7. easy to learn	0.3391	0.0002
INFOQUAL SUMS	8. productive quickly	0.3446	0.0001
INFOQUAL SUMS	SYSUSE SUMS	0.4614	<.0001
INFOQUAL SUMS	9. error messages clear	0.6610	<.0001
INFOQUAL SUMS	10. recover quick from mistake	0.6605	<.0001
INFOQUAL SUMS	11. information clear	0.5055	<.0001
INFOQUAL SUMS	12. easy to find info	0.5152	<.0001
INFOQUAL SUMS	13. info easy to understand	0.5148	<.0001
INFOQUAL SUMS	14. info effective for course	0.4243	<.0001

Variable	by Variable	Spearman Rho	Prob>|Rho|
INFOQUAL SUMS	15. organization of info clear	0.4261	<.0001
16. interface pleasant	1. CD easy to use	0.5262	<.0001
16. interface pleasant	2. system easy to use	0.5350	<.0001
16. interface pleasant	3. completed work effectively	0.5911	<.0001
16. interface pleasant	4. completed work quickly	0.4455	<.0001
16. interface pleasant	5. completed work efficiently	0.5004	<.0001
16. interface pleasant	6. comfortable	0.4301	<.0001
16. interface pleasant	7. easy to learn	0.4561	<.0001
16. interface pleasant	8. productive quickly	0.5813	<.0001
16. interface pleasant	SYSUSE SUMS	0.6168	<.0001
16. interface pleasant	9. error messages clear	0.2162	0.1062
16. interface pleasant	10. recover quick from mistake	0.4956	<.0001
16. interface pleasant	11. information clear	0.4760	<.0001
16. interface pleasant	12. easy to find info	0.6504	<.0001
16. interface pleasant	13. info easy to understand	0.7388	<.0001
16. interface pleasant	14. info effective for course	0.6328	<.0001
16. interface pleasant	15. organization of info clear	0.6809	<.0001
16. interface pleasant	INFOQUAL SUMS	0.3769	<.0001
17. like using interface	1. CD easy to use	0.5367	<.0001
17. like using interface	2. system easy to use	0.5091	<.0001
17. like using interface	3. completed work effectively	0.4994	<.0001
17. like using interface	4. completed work quickly	0.4942	<.0001
17. like using interface	5. completed work efficiently	0.5662	<.0001
17. like using interface	6. comfortable	0.4378	<.0001
17. like using interface	7. easy to learn	0.4529	<.0001
17. like using interface	8. productive quickly	0.6445	<.0001
17. like using interface	SYSUSE SUMS	0.6268	<.0001
17. like using interface	9. error messages clear	0.3050	0.0199
17. like using interface	10. recover quick from mistake	0.5307	<.0001
17. like using interface	11. information clear	0.5398	<.0001
17. like using interface	12. easy to find info	0.7174	<.0001
17. like using interface	13. info easy to understand	0.7266	<.0001
17. like using interface	14. info effective for course	0.6297	<.0001
17. like using interface	15. organization of info clear	0.6346	<.0001
17. like using interface	INFOQUAL SUMS	0.3626	<.0001
17. like using interface	16. interface pleasant	0.8906	<.0001
18. functions and capabilities	1. CD easy to use	0.5127	<.0001
18. functions and capabilities	2. system easy to use	0.4874	<.0001
18. functions and capabilities	3. completed work effectively	0.4292	<.0001
18. functions and capabilities	4. completed work quickly	0.4002	<.0001
18. functions and capabilities	5. completed work efficiently	0.4410	<.0001
18. functions and capabilities	6. comfortable	0.3187	0.0004
18. functions and capabilities	7. easy to learn	0.3283	0.0003
18. functions and capabilities	8. productive quickly	0.4698	<.0001
18. functions and capabilities	SYSUSE SUMS	0.5281	<.0001
18. functions and capabilities	9. error messages clear	0.3009	0.0184

Variable	by Variable	Spearman Rho	Prob>|Rho|
18. functions and capabilities	10. recover quick from mistake	0.4308	<.0001
18. functions and capabilities	11. information clear	0.5178	<.0001
18. functions and capabilities	12. easy to find info	0.5986	<.0001
18. functions and capabilities	13. info easy to understand	0.5523	<.0001
18. functions and capabilities	14. info effective for course	0.4859	<.0001
18. functions and capabilities	15. organization of info clear	0.4899	<.0001
18. functions and capabilities	INFOQUAL SUMS	0.3269	0.0003
18. functions and capabilities	16. interface pleasant	0.6110	<.0001
18. functions and capabilities	17. like using interface	0.6132	<.0001
INTQUAL SUMS	1. CD easy to use	0.5765	<.0001
INTQUAL SUMS	2. system easy to use	0.5314	<.0001
INTQUAL SUMS	3. completed work effectively	0.5502	<.0001
INTQUAL SUMS	4. completed work quickly	0.5018	<.0001
INTQUAL SUMS	5. completed work efficiently	0.5730	<.0001
INTQUAL SUMS	6. comfortable	0.3717	<.0001
INTQUAL SUMS	7. easy to learn	0.4146	<.0001
INTQUAL SUMS	8. productive quickly	0.5310	<.0001
INTQUAL SUMS	SYSUSE SUMS	0.6406	<.0001
INTQUAL SUMS	9. error messages clear	0.4295	0.0006
INTQUAL SUMS	10. recover quick from mistake	0.5138	<.0001
INTQUAL SUMS	11. information clear	0.5304	<.0001
INTQUAL SUMS	12. easy to find info	0.7057	<.0001
INTQUAL SUMS	13. info easy to understand	0.6780	<.0001
INTQUAL SUMS	14. info effective for course	0.5744	<.0001
INTQUAL SUMS	15. organization of info clear	0.5879	<.0001
INTQUAL SUMS	INFOQUAL SUMS	0.3979	<.0001
INTQUAL SUMS	16. interface pleasant	0.8851	<.0001
INTQUAL SUMS	17. like using interface	0.8646	<.0001
INTQUAL SUMS	18. functions and capabilities	0.7658	<.0001
19. overall satisfaction	1. CD easy to use	0.6533	<.0001
19. overall satisfaction	2. system easy to use	0.7616	<.0001
19. overall satisfaction	3. completed work effectively	0.5663	<.0001
19. overall satisfaction	4. completed work quickly	0.5913	<.0001
19. overall satisfaction	5. completed work efficiently	0.6031	<.0001
19. overall satisfaction	6. comfortable	0.5198	<.0001
19. overall satisfaction	7. easy to learn	0.6171	<.0001
19. overall satisfaction	8. productive quickly	0.5315	<.0001
19. overall satisfaction	SYSUSE SUMS	0.7103	<.0001
19. overall satisfaction	9. error messages clear	0.2812	0.0281
19. overall satisfaction	10. recover quick from mistake	0.4443	<.0001
19. overall satisfaction	11. information clear	0.4825	<.0001
19. overall satisfaction	12. easy to find info	0.6370	<.0001
19. overall satisfaction	13. info easy to understand	0.6719	<.0001
19. overall satisfaction	14. info effective for course	0.7259	<.0001
19. overall satisfaction	15. organization of info clear	0.6461	<.0001

Variable	by Variable	Spearman Rho	Prob>|Rho|
19. overall satisfaction	INFOQUAL SUMS	0.3876	<.0001
19. overall satisfaction	16. interface pleasant	0.5941	<.0001
19. overall satisfaction	17. like using interface	0.5977	<.0001
19. overall satisfaction	18. functions and capabilities	0.6204	<.0001
19. overall satisfaction	INTQUAL SUMS	0.6071	<.0001
OVERALL SUMS	1. CD easy to use	0.6533	<.0001
OVERALL SUMS	2. system easy to use	0.7616	<.0001
OVERALL SUMS	3. completed work effectively	0.5663	<.0001
OVERALL SUMS	4. completed work quickly	0.5913	<.0001
OVERALL SUMS	5. completed work efficiently	0.6031	<.0001
OVERALL SUMS	6. comfortable	0.5198	<.0001
OVERALL SUMS	7. easy to learn	0.6171	<.0001
OVERALL SUMS	8. productive quickly	0.5315	<.0001
OVERALL SUMS	SYSUSE SUMS	0.7103	<.0001
OVERALL SUMS	9. error messages clear	0.2812	0.0281
OVERALL SUMS	10. recover quick from mistake	0.4443	<.0001
OVERALL SUMS	11. information clear	0.4825	<.0001
OVERALL SUMS	12. easy to find info	0.6370	<.0001
OVERALL SUMS	13. info easy to understand	0.6719	<.0001
OVERALL SUMS	14. info effective for course	0.7259	<.0001
OVERALL SUMS	15. organization of info clear	0.6461	<.0001
OVERALL SUMS	INFOQUAL SUMS	0.3876	<.0001
OVERALL SUMS	16. interface pleasant	0.5941	<.0001
OVERALL SUMS	17. like using interface	0.5977	<.0001
OVERALL SUMS	18. functions and capabilities	0.6204	<.0001
OVERALL SUMS	INTQUAL SUMS	0.6071	<.0001
OVERALL SUMS	19. overall satisfaction	1.0000	0.0000
TOTAL SUMS	1. CD easy to use	0.6293	<.0001
TOTAL SUMS	2. system easy to use	0.6399	<.0001
TOTAL SUMS	3. completed work effectively	0.6488	<.0001
TOTAL SUMS	4. completed work quickly	0.6554	<.0001
TOTAL SUMS	5. completed work efficiently	0.7349	<.0001
TOTAL SUMS	6. comfortable	0.5459	<.0001
TOTAL SUMS	7. easy to learn	0.5506	<.0001
TOTAL SUMS	8. productive quickly	0.5785	<.0001
TOTAL SUMS	SYSUSE SUMS	0.8053	<.0001
TOTAL SUMS	9. error messages clear	0.5448	<.0001
TOTAL SUMS	10. recover quick from mistake	0.6449	<.0001
TOTAL SUMS	11. information clear	0.5985	<.0001
TOTAL SUMS	12. easy to find info	0.7541	<.0001
TOTAL SUMS	13. info easy to understand	0.7479	<.0001
TOTAL SUMS	14. info effective for course	0.6663	<.0001
TOTAL SUMS	15. organization of info clear	0.6440	<.0001
TOTAL SUMS	INFOQUAL SUMS	0.8350	<.0001
TOTAL SUMS	16. interface pleasant	0.6622	<.0001

Variable	by Variable	Spearman Rho	Prob>|Rho|
TOTAL SUMS	17. like using interface	0.6507	<.0001
TOTAL SUMS	18. functions and capabilities	0.5896	<.0001
TOTAL SUMS	INTQUAL SUMS	0.7485	<.0001
TOTAL SUMS	19. overall satisfaction	0.6790	<.0001
TOTAL SUMS	OVERALL SUMS	0.6790	<.0001

List 4. Nonparametric Measures of Association between Grade and Computer Attitudes

bold indicates a significant ($p < .05$) value

Variable	by Variable	Spearman Rho	Prob>|Rho|
1. IR	grade	0.0263	0.7702
2. Phone	grade	0.0235	0.7922
3. surf the web	grade	-0.0502	0.5724
4. Word process.	grade	-0.0662	0.4541
5. Dissection	**grade**	**-0.1776**	**0.0441**
6. Chat rooms	grade	0.0117	0.8949
7. Programming	grade	0.0273	0.7592
8. Impersonal	grade	0.1472	0.0946
9. Studies	grade	-0.0361	0.6832
10. Comfortable	grade	-0.1083	0.2202
11. Books	grade	0.1112	0.2076
12. Multimedia	grade	-0.0439	0.6197
13. Save time	grade	-0.0940	0.2873
14. Curriculum	grade	0.0048	0.9563
15. Survey	grade	-0.0035	0.9686
16. Web info	grade	-0.0140	0.8744
17. Vet std learn	grade	-0.0920	0.2999

List 5. Nonparametric Measures of Association between Usability Variables and Computer Sophistication

bold indicates a significant ($p < .05$) value

Variable	by Variable	Spearman Rho	Prob>|Rho|
Computer Sophistication	1. CD easy to use	0.0895	0.3308
Computer Sophistication	2. system easy to use	0.0608	0.5098
Computer Sophistication	3. completed work effectively	0.0709	0.4413
Computer Sophistication	4. completed work quickly	0.0585	0.5258
Computer Sophistication	5. completed work efficiently	0.1269	0.1690
Computer Sophistication	6. comfortable	0.1266	0.1683
Computer Sophistication	7. easy to learn	0.1221	0.1860
Computer Sophistication	**8. productive quickly**	**0.1881**	**0.0397**
Computer Sophistication	SYSUSE SUMS	0.1247	0.1748
Computer Sophistication	9. error messages clear	0.1707	0.1921
Computer Sophistication	**10. recover quick from mistake**	**0.2341**	**0.0291**
Computer Sophistication	11. information clear	0.1195	0.2246
Computer Sophistication	12. easy to find info	0.1474	0.1112
Computer Sophistication	13. info easy to understand	0.1081	0.2421
Computer Sophistication	**14. info effective for course**	**0.1884**	**0.0394**
Computer Sophistication	15. organization of info clear	0.1169	0.2034
Computer Sophistication	INFOQUAL SUMS	0.1118	0.2241
Computer Sophistication	16. interface pleasant	0.0598	0.5274
Computer Sophistication	17. like using interface	0.0559	0.5510
Computer Sophistication	18. functions and capabilities	0.0499	0.5881
Computer Sophistication	INTQUAL SUMS	0.1579	0.0850
Computer Sophistication	19. overall satisfaction	0.0602	0.5134
Computer Sophistication	OVERALL SUMS	0.0602	0.5134
Computer Sophistication	TOTAL USABILITY	0.1740	0.0573

List 6. Nonparametric Measures of Association between Total Computer Usability and Computer Attitudes and Experience

bold indicates a significant ($p < .05$) value

Variable	by Variable	Spearman Rho	Prob>|Rho|
communicate	TOTAL USABILITY	0.0642	0.4842
documents	**TOTAL USABILITY**	**0.2262**	**0.0126**
presentations	TOTAL USABILITY	0.1112	0.2245
stats	TOTAL USABILITY	0.1047	0.2530
med lit	TOTAL USABILITY	0.1352	0.1410
ed	TOTAL USABILITY	0.1724	0.0587
library catalogue	**TOTAL USABILITY**	**0.1958**	**0.0314**
games	TOTAL USABILITY	0.1639	0.0724
graphics	TOTAL USABILITY	0.1596	0.0803
1. IR	**TOTAL USABILITY**	**-0.2133**	**0.0215**
2. Phone	TOTAL USABILITY	0.1480	0.1097
3. surf the web	TOTAL USABILITY	0.0624	0.5002
4. Word process.	TOTAL USABILITY	0.0012	0.9898
5. Dissection	TOTAL USABILITY	0.0819	0.3760
6. Chat rooms	TOTAL USABILITY	0.0241	0.7939
7. Programming	TOTAL USABILITY	0.0275	0.7669
8. Impersonal	TOTAL USABILITY	0.2229	0.0144
9. Studies	**TOTAL USABILITY**	**-0.2627**	**0.0037**
10. Comfortable	TOTAL USABILITY	-0.1680	0.0667
11. Books	TOTAL USABILITY	0.1686	0.0656
12. Multimedia	**TOTAL USABILITY**	**-0.2145**	**0.0186**
13. Save time	**TOTAL USABILITY**	**-0.2808**	**0.0019**
14. Curriculum	TOTAL USABILITY	-0.1529	0.0954
15. Survey	**TOTAL USABILITY**	**0.1926**	**0.0351**
16. Web info	TOTAL USABILITY	-0.1196	0.1933
17. Vet std learn	**TOTAL USABILITY**	**-0.3181**	**0.0004**

List 7. Nonparametric Measures of Association between Computer Sophistication and Computer Knowledge

Variable	by Variable	Spearman Rho	Prob>|Rho|
Hardware > Software	Computer Sophistication	0.4084	<.0001
Free text > Coded data	Computer Sophistication	0.3370	0.0001
LAN > WAN	Computer Sophistication	0.3164	0.0002
Field > Record	Computer Sophistication	0.3261	0.0002
Relational database > Flat file db	Computer Sophistication	0.2948	0.0007
Data in memory > Data on disk	Computer Sophistication	0.3892	<.0001
Images > Graphics	Computer Sophistication	0.5401	<.0001
Floppy disk > Hard disk	Computer Sophistication	0.4785	<.0001
Full text database > Bibliographic db	Computer Sophistication	0.3011	0.0005
Interpreter > Compiler	Computer Sophistication	0.3742	<.0001
Mainframe computer > Personal Comp.	Computer Sophistication	0.3856	<.0001
Worldwide web > Internet	Computer Sophistication	0.4391	<.0001
Electronic mail >Electronic bulletin board	Computer Sophistication	0.4512	<.0001
Client > Server	Computer Sophistication	0.3742	<.0001
Digital > Analog	Computer Sophistication	0.3483	<.0001
Database > Knowledge base	Computer Sophistication	0.3669	<.0001
Entities > Relationships	Computer Sophistication	0.2748	0.0016
Forward chaining > Backward chaining	Computer Sophistication	0.1472	0.0947
Personal digital assistsnt > PDF	Computer Sophistication	0.2645	0.0024

List 8. Nonparametric Measures of Association between Computer Sophistication and Computer Usage

bold indicates a significant ($p < .05$) value

Variable	by Variable	Spearman Rho	Prob>|Rho|
Computer Sophistication	communicate	0.1504	0.0877
Computer Sophistication	**documents**	**0.2557**	**0.0033**
Computer Sophistication	**presentations**	**0.3240**	**0.0002**
Computer Sophistication	**stats**	**0.2690**	**0.0020**
Computer Sophistication	**med lit**	**0.2396**	**0.0062**
Computer Sophistication	ed	0.0285	0.7478
Computer Sophistication	**library cat**	**0.2342**	**0.0073**
Computer Sophistication	**games**	**0.2213**	**0.0114**
Computer Sophistication	**graphics**	**0.3703**	**<.0001**