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Computers in the classroom – do they really make a difference in student learning?

Colleen Fitzgerald
Rowan University

COMPUTERS IN THE CLASSROOM-

DO THEY REALLY MAKE A DIFFERENCE IN STUDENT LEARNING?

by
Colleen Fitzgerald

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ABSTRACT

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Dr. Richard Meagher
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The purpose of this study was to determine if the utilization of computers in the classroom would increase student learning. The participants were eighty-two seventh grade students from Demarest Middle School in Demarest, New Jersey. The students were organized into four heterogeneously mixed classes. The study was conducted over approximately two weeks. All students received introductory instruction on amphibians and frog anatomy and physiology. Two classes then completed the traditional specimen dissection, while the other two classes completed a computer-simulated dissection. The classes then switched and performed the alternative dissection procedure. Their performance was measured by the results on the test administered after each dissection. Prior to the study and after the study, students responded to a survey to assess the qualitative aspects of the research. The t Tests performed on the test scores resulted in no significant differences. However, the survey results indicated a positive perception of learning with the computer and a general enjoyment of its use. It was concluded that additional research is necessary due to the limited nature of the assessment in relationship to the possibilities afforded by current computer technology.

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The purpose of this study was to determine if the utilization of computers in the classroom would increase student learning. Assessment of this learning was made by examining the results of the tests administered and the responses to preliminary and culminating surveys. Test scores were statistically analyzed by performing the t Test. Though students indicated a positive response to using the computer, no statistical differences in achievement were noted

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I. Introduction

As the millennium comes to an end, we look back on the events and technological advances that have taken place. The computer stands out as one of the most influential tools that has shaped our past and present. It has transformed how businesses are run and how society interacts. People are now able to shop, access seemingly limitless information, conduct conferences, and complete academic course work without ever leaving their homes or offices. The AT&T advertising slogan, "Reach Out and Touch Someone" certainly has taken on new meaning as adults and children alike communicate to family, friends, and others via e-mail. A tool, that was once only accessible to large corporations, is now as common a site in many homes as a television.

School systems across the country are striving to gain greater computer access for their students. The concept of infusing the use of computers into the various curriculum areas is a goal of many districts. However, as this educational reform effort takes place, one must stop and ask, "Does it really make a difference?"

Educators have been charged with the responsibility of preparing students to take their place as informed and productive members of society. With the scientific and technological capabilities we possess, what we know to be true today may not be true tomorrow. Therefore, the question arises if traditional teaching methods, such as lecture, are effective in enabling educators to carry out such an important responsibility. Would

incorporating the use of computer software and the Internet increase students' learning? Realizing the pace at which information is changing and being updated, should educators begin relinquishing some of their classroom "authority" and become "guides on the side," as opposed to "sages on the stage?" Would such an approach encourage and create greater opportunity for students to delve deeper into a subject and develop their critical thinking skills? Educators are taught form their first college methods course the importance of attaining student interest to increase students' focus and time on task. Would utilization of the computer assist us in doing just that?

II. Literature Review

The presence of computers in schools has been rapidly increasing over the past several years. According to the Center for Applied Special Technology, the computer inventory in public schools increased by approximately 50% between 1989 and 1992. In addition, access to the Internet also drastically increased from 35% of public schools having such access in 1994 to 78% having access in 1997 (Halpert,1999). However, does this increased access to technology result in greater learning by students? Or, as posed in "From Now On- The Educational Technology Journal," "Has this just been another great educational bandwagon or boondoggle?"

The Secretary's Conference on Educational Technology stated in its publication, "New Directions in the Evaluation of the Effectiveness of Educational Technology" in 1999 that United States eighth grade math students on average score below their peers in 41 countries. In science, on average they score below their peers in Hungary, Korea, Japan, Czech Republic, and Singapore. Although one might question the acquisition of such statistics, the effectiveness of computers in student learning may also be questioned.

It is a fact, though, that computers have become an integral part of American life. Pre-schoolers to adults are actively engaged in the use of computers. Most adults, however, are "painfully aware of how little they really understand of our technological world. Consequently, they are generally quick to appreciate and support the new content and method of technology education. (Sanders,1999). The proof that the seemingly

endless possibilities that are afforded to students by technology is resulting in increased learning must be presented to support such enthusiasm.

Much of the thrust behind the race for computer access for all students is the belief that traditional teaching practices are inadequate. Teachers lecturing to a class of 30 students goes contrary to all that research has discovered about the way children learn. Traditional teaching methods focus on students acquiring an accumulation of well-established facts. Activities/Assessments are not only designed and selected by someone other than the student, but are "well-defined with single known outcomes." Generally, all children are "forced" to conform to the standard curriculum. This method of learning "bears little to no resemblance to the question-centered, collaborative practice of real scientists (Follansbee,98)."

Instead, students should be taught how to develop their own questions or problems, as well as their own method to investigating them. Not only does this type of learning more accurately reflect "real -life," but allows them the opportunity to develop a greater feeling of ownership towards the learning process. Furthermore, it promotes what would be better characterized as true investigation, where the possible outcomes are many. It is the ability of the integration of computer technology to achieve such means that fosters the aforementioned thrust for computers in the schools.

However, our belief and or hope that computers can bring about such an educational revolution must be supported by assessments of student learning as a result of their use. In the 1980s, the computer was expected to be a source of such change,

especially in mathematics and language arts. The results were mixed at best. Consequently, the expectations of computers was reduced from the "cure-all" to a valuable tool in bringing about change (Bracewell, 1996). As of 1995, very little credibility could be given to the research and/or assessments conducted to determine the effectiveness of computers in student learning. According to the article, "Did Anybody Learn Anything?," early assessments were highly biased and flawed. Rather than examining the impact of technology in increasing students' higher order thinking skills, the focus was on students' mastery of lower order tasks and basic skills. Furthermore, "most performance data were anecdotal or testimonial program evaluations."

The limitations of these early assessment devices leaves one still wondering about the effectiveness of computers on student learning. Early studies did note improvement in student test scores. However, these test scores reflected the learning of very limited information . For instance, many of these tests were limited to what was learned on material covered in specific math or geography packages. Today, computer graphics far surpass what was available in the past (Blasi, 1999). Additionally, with networking and Internet access, the information and skills the student can acquire are far in excess of what these initial studies measured.

With these innovative uses of computer technology comes the necessity of improved evaluation measures as well. In response, the evaluation process has undergone a major transformation. Multiple methods, criteria, measures, perspectives, audiences, and interests are now taken into consideration. Community involvement, special education referrals/placements, portfolios, learning records, and exhibitions are possible evaluative measures that might be used (Blasi, 1999).

The Secretarial Conference on Educational Technology has suggested some guidelines to be followed in improving the evaluative process. Naturally, it's expected the assessment methods will produce knowledge that is relevant. However, these assessments should include not only quantitative, but qualitative measurements, such as class observations and informal and in-depth interviews. Evaluations should take place over several years after it has been determined that the program has been full implemented to accurately assess its effectiveness (Blasi, 1999).

Even with such suggestions, many difficulties or challenges stand in the way of determining if computers are effective in increasing student learning. To begin, there is little agreement about the purpose of technology. While the government was higher test scores, teachers and the general public see the role of technology to increase student interest and preparation for the work force, a tool to access information and to develop learning as a more active process. Though all of the preceding goals may result in higher test scores, that is not the ultimate goal. Additionally, there are so many factors that come together to produce the performance outcome it is nearly impossible to assess the impact of each toward the end product. The goals of various technology based educational projects by nature differ from each other and may not be able to be measured by one evaluative design. While one outcome measurement may be the increase in students' higher order thinking skills, another may be the increase in their general communications skills. The students' perception of the program, whether they express interest in it and demonstrate significant time on task, may be an additional outcome measurement (Blasi, 1999).

Beyond the evaluative measurements generated, the effectiveness of computer

usage in the enhancement of student learning can not be adequately determined if computers are not be integrated appropriately within the classroom. The capacity of computers to afford students unparalleled learning experiences means nothing if they are not being optimally utilized. Many changes in teacher training and district and community mind set must take place to allow for this to happen. Only then can we develop and use outcome measurements to determine the true effectiveness of computers in the learning process for students.

At the district and community level, exploration must be valued as "real teaching and real learning." Many teachers feel limited in the amount of such exploration they can allow their students due to the overwhelming amount of curricular topics they are expected to cover by year's end (Schrum,1999). Teachers have been trained for too long to be dispensers of great quantities of facts that must be "poured into their students' heads."

If computers are going to be optimally implemented in the classroom to allow meaningful learning on the part of the students, teachers need to be properly trained. Also, they need time and the expertise to find the best on-line projects, web sites, and software to use and to then plan and organize how to carry the projects out in their classrooms . There are many questions that need to be addressed in adequately meeting the challenge of incorporating computers effectively in the classroom. How are they being integrated into the educational setting? How can one best match the technological capacities with the learners' needs and interests? How can the technology be incorporated to interact with and support other change in the school, such as administration and curriculum (Honey, 1999). Support in various forms needs to be put in place to assist the

teachers. For instance, technical and media support, as well as an on-line community of peers and experts are recommended (Halpert, 1999).

Even if school districts follow the suggestions/guidelines mentioned above, challenges and struggles still exist in the assessment of computers' role in the classroom. Though the information students can access on the Internet is vast, there are few quality controls. Therefore, the difference between a reliable and an unreliable site may be difficult or impossible to distinguish for students and educators alike (Roempler,1999). The same lack of quality exists for many soft ware programs as well.. The mere task of keeping up with the ever changing developments associated with computer usage is a challenging task. The greatest challenge, though, may be changing the ingrained view of education and the unfortunate bureaucracy involved in change, as stated in "The Current State of Technology and Education: How Computers are Used in the Classrooms."

Considering the limitations at this point in time of developing an assessment system to accurately and thoroughly assess the impact of computers to student learning, the results of studies conducted to date bring somewhat conflicting results. One study, conducted in 1998 through the joint efforts of the Center for Applied Special Technology, Scholastic Network, and the Council of the Great City Schools, pointed to computers having a positive role in the learning process for both students and teachers in areas of skills acquisition, as well as perception and attitude toward the learning process. Five hundred students in fourth and sixth grade from seven urban school districts: Washington, D.C., Chicago, Dayton, Miami, Oakland, Detroit, and Memphis were divided into two groups. Each group carried out a common unit of study (civil rights) based on the schools' curriculum in conjunction with a curricular framework, activities

and worksheets developed by CAST (Center for Applied Special Technology). The difference between the two groups was that the fourteen experimental classes were afforded on-line access to the Internet and Scholastic Network. The fourteen control classes did not have on-line access.

The unit was taught by teachers in their classrooms and developed based on group preferences, while participating in a small set of common activities. All students, regardless of group, participated in three general learning activities: 1) Communications-discussing civil rights with their peers, teachers and community, 2) Research – used many sources to explore and pull together their information, 3) Creation of a final project. They were encouraged to use technology based resources, such as multimedia references and video tapes ,as well as the computer when appropriate, in developing their projects. Of course, only the experimental groups could take part in the on-line resources, activities and communications. During the unit, emphasis was placed on integrated learning, being able to see connections among people, their actions, and the real world.

The students' projects were then evaluated by experienced school teachers that had received formal training in assessment methods. The evaluators were not provided with any information about the study or the schools participating in the study to eliminate bias. Detailed explanations were provided to them on the nine learning measures they were to assess: 1) Effectiveness of presentation, 2) Effectiveness in stating a civil rights issue, 3) Accuracy of information in relation to a selected issue, 4) Presentation of a complete picture (who what, when...) 5) Demonstration of insight into civil rights, 6) Effectiveness of bringing together different points of view, 7) Completeness, 8) Organization, and 9) Demonstration of "best work" (well planned, neat reflecting

initiative). Each measure was assessed on a four point scale. To further substantiate the scoring, one-quarter of the projects were randomly selected and scored by another evaluator.

In addition to the quantitative evaluation described, information on performance and attitudes toward the instructional process were gathered through pre and post questionnaires given to students and teachers, observations in class, teacher phone interviews, and records of the time spent on-line. Since the time frame of this study was very short-term, standardized test scores were not included in the assessment process. A much more in-depth and long-term study would be needed to lend credence to any connection made to a change or lack thereof in such scores.

The results seemed to concur that more student learning occurred in those groups with on-line access. Out of the nine learning measurements, there was a statistical difference noted for five: presentation of their work, statement of civil rights issue, presentation of a full picture, bringing together different points of view, and production of a complete project. The information they found was not only retrieved more quickly, but came from more sources. These students also dealt with the information in a manner that made it more relevant to their lives. Their access to e-mail and message boards assisted them in the learning process. The attitudes of the students with on-line access also changed. They became more confident in their ability to create and present projects, while the attitude of those in the control group became quite the opposite.

Students were not alone in the gains attributed to Internet access. The teachers involved in the experimental groups also demonstrated a positive change in their teaching practices . Rather than utilizing computers for basic skills or as a reward, as was done in

the control group, they had their students using computers as adults use them in real-world types of activities. Their own body of knowledge increased with their students as they dealt with a greater range of information about civil rights than their colleagues in the control groups. Their general attitude to the role of technology and their behavior in using it changed as well. Furthermore, they reported an increase in positive interaction with parents that the control group teachers did not. They stated they had more effective conferences, were able to communicate with parents on-line, and had more parent involvement within the classroom.

The conclusion reached by the researchers of this study was that "Scholastic Network and the Internet can help students become independent critical thinkers, able to find information, organize and evaluate it, and then effectively express their new knowledge and ideas in compelling ways." Through access to the Internet, students are able to interact with experts, mentors, and peers on-line. They have the opportunity and support, while in the classroom setting, to master real-world information and communication skills. However, the fact that the conductors of the research may have a vested interest in the results would point to the need for more support to the aforementioned conclusions to the benefit of the Internet to student learning.

The literary review conducted by George T. Fitzelle, Jr. and William M.K. Trochim would seem to support the conclusions of the study described above. In 1991, Kulik and Kulik's study concluded computer tutorials produced learning outcomes on the average 20% or greater above average. Khali and Shashaani's 1994 comparative studies found computer assisted instruction resulted in improved performance on exams by an average of .38 standard deviations. Finally, in 1995, Ester's research concurred that

computer assisted instruction increased student achievement, but also student attitude while decreasing instruction time.

Based on these findings, Fitzelle and Trochim implemented their own research. Their goal was to find out if an educational web site increased student perceptions of learning. To accomplish this, they surveyed sixty-eight Cornell University undergraduates in a research methods class after using the web site. Most of the students were female and high achievers which does limit how broadly the results can be applied The survey consisted of twenty items using Likert scaling, ranking, and qualitative questions. Questions one through twelve focused on their perception of learning through use of the web site, such as the pace at which they maneuvered through it, their enjoyment in using the site, and the ease of access. They were then asked questions about which features of the site they found most helpful.

The results were mixed. The belief that the web site enhanced their learning of the course content varied among the students. Also, the belief that the web site improved their computer skills depended on the initial skill level of the student. Most preferred a paper copy of the notes to a web site, however. The most helpful learning device, in their opinion, was a game that had been incorporated to review course content through questions and enabled them the opportunity to get extra credit. The question then arises, did they find the review helpful, or just liked getting extra credit. In any case, the study certainly didn't seem to overwhelming support improved enjoyment of the learning process due to computer use, at least in this format. Though their goal was strictly qualitative in nature, you would be hard pressed to find an educator that would not state that students' attitudes toward learning did not impact on their performance.

The national study to be conducted by the Center for Applied Special Technology is based in part on this belief in the importance of student motivation to promote effective learning experiences. In CoVis, a project designed for high school students to explore atmospheric and environmental sciences through inquiry-based activities, participants have access to "the same research tools and data bases and leading-edge scientists due to state-of-the-art scientific software." They have the opportunity to collaborate and communicate with remote teachers, peers, and scientists through video teleconferencing, Internet access, "multimedia scientist's 'notebook'," and related software. Students involved in this project are evaluated on their ability to generate research questions and successfully investigate them. The researchers believe that the "orientation" of the project will lead to greater student motivation and consequently improved learning. They also agree, though, that CoVis alone can't not bring about these changes in student learning. It must be implemented in connection with the creation of new curricula and instructional methodologies.

The project initiated in Union City, New Jersey, where lack of student motivation or incentive was an obstacle to be conquered, provides evidence for the need for technology-based programs to be supported with additional educational reform. Located across the Hudson River from Manhattan, it is the most densely populated city in New Jersey. Most of the population of Union City is Cuban. 68% of the people do not speak English at home and 27% live below the poverty line.

In 1992, Project Explore enabled a first, third, fifth, and seventh grades and twenty teachers to receive networked computers at school and at home. In 1995, the networking was extended to ten other schools in the district. In connection with the

initiation of technology into the school districts, other school changes took place. Classes were extended to one hundred eleven minutes a period in the elementary schools and eighty minutes in the high schools. Teacher inservice time increased from 8 hours a year to 40. Many building improvements were made, including replacing student desks with cooperative learning tables. . A substantial investment was made in technology.

Prior to these changes, the schools in this district failed forty-four out of fifty- two categories New Jersey uses to measure a school's effectiveness, such as student attendance rate, number of student drop-outs, and standardized tests. Besides students' lack of interest, their parents had limited formal education and the language barriers could not be overlooked either. After this extensive overhaul of the district, a notable increase occurred in standardized test scores in kindergarten through eighth grade. Students that had computer access at home as well as in school due to the Project Explore showed greater improvements in writing and math than their peers without such access. Explore students in grades seven, eight, and nine also performed better than their peers on the written portion of the state exam. Though "technology provides the potential to have positive impact on students' learning and the school community's view of students' capacities," it doesn't do so in isolation (Honey, 1999).Also, this project clearly illustrates the difficulties discussed earlier about how to properly assess so many factors impacting on students' learning.

As evidenced, the research on technology and its relationship to student learning spans numerous curricular areas and levels of academic pursuit. One benefit of computer's integration towards improved/increased student learning has been that of enhanced communication possibilities. This benefit was well illustrated by the "virtual

classroom" created in the instruction of a Circuit Analysis undergraduate course. This "virtual classroom" incorporated the use of interactive software This instructional design provided many advantages to the students in the course. First, when they submitted the answers to quizzes generated through this system, they were able to get almost instant feedback on the accuracy of their answer. Results were returned in approximately 15 seconds. Therefore, the students were able to redo the questions and learn from their initial mistakes in a timely manner. Also, they are able to work from home utilizing a Mac or PC. The participants are able to confer with other students or teachers for assistance, but can't merely "share" answers since the students get different questions. By examining the answers to questions posed by other students, they are further able to learn strategies they may assist them in their unique problem. In a typical lecture format of hundreds of students, interaction among them is not encouraged. On the contrary, the "virtual classroom," is geared toward such collaborative communication (Oakley, 1994).

As brought forth in the other investigations, besides increased student learning, the conductors of this research note increased student enthusiasm. Furthermore, the educator also reaps benefits from this interactive mode of teaching as well. He/She is able to obtain daily updates on his/her students' progress, not really possible following the traditional style of instruction. The teaching assistants are able to spend more time working with the students, rather than answering the same questions numerous times (Oakley, 1994).

The benefits of technology, specifically that afforded through computers, is heralded by many. In general, those supporters of the integration of technology into the school system state that it encourages students to think about what they need to learn and

to develop their own questions for investigation. Students will tend to be more persistent and dedicated when their own interests "drive the learning process"(Schrum, 1999). As a result, more initiative is demonstrated outside class through additional research (Charp, 1998). Students collaborate with each other, learning valuable communication skills for the future (Leong, 1999). They spend more time reading, writing , and problem solving, taking more responsibility for their own learning It was stated by the Presidential Committee of Advisors on Science and Technology that "students who used computers in class outperformed those taught without them by 25 to 41%"(Halpert, 1999). Even in the area of animal dissection, a common practice in many schools, numerous studies from high school to post graduate level support that those who participated in an alternate activity, including computer simulated dissections, performed as well or better than those who participated in the actual dissection (Balcombe, 1999).

The Internet allows a world of information to be accessible to all. That factor, in conjunction with the fact that students can learn at their own pace using computer-based instruction, enables them to delve into a topic in much greater depth. In addition, the ability to work at one's own pace allows students of differing ability levels to not feel lost in confusion or bored due to little challenge. In addition, the California Education Department has data supporting the proposition that "one hour on a multimedia computer is equal to two to three hours of standard classroom work

With reduced instructional time needed, teachers can spend more time mentoring and advising their students, as well as conducting small group discussions as opposed to large lectures. The use of technology by teachers opens up many doors for them as well. Through the avenues of communication allowable through Internet and computer access,

teacher isolation is remedied. They can now involve parents at a new level, as well avail themselves to many resources previously impossible. Instructors, along with the students, begin viewing the learning process with more enthusiasm. They are able to make instruction more "real" and meaningful, while creating more opportunities for interdisciplinary investigations. However, teachers used to teaching in the "traditional" manner need to rethink their role. Utilizing technology in compelling and meaningful constructs within the classroom means more of a "balance of power" between student and teacher. The teacher's role is more of a facilitator and the focus of assessment is more on the process than achieving that "one correct result/answer."(McGrath, 1998).

As studies are presented, whether supporting or refuting the impact of computers on students' learning, all must be viewed as inconclusive. As stated previously, the computer, Internet, and any other comparable technology is but a tool. The technology teachers incorporate in their lessons, how they incorporate it, the organizational and curricular changes that occur within the district to allow for this type of instruction are all pieces in the instructional puzzle. The question posed earlier still remains and is not addressed by most current studies: "How can we evaluate or measure all of the components that impact on student learning?' While many investigations result in little quantitative proof, many boast of the qualitative aspects of student progress achieved. With respect to the quantitative proof, can computers and technology take full credit or be totally to blame based on the proof? Or, are the results a deficiency in the means of evaluation or how the technology was implemented in the first place?

III. Methodology

The participants of this study were eighty-two students in the seventh grade class at Demarest Middle School in Demarest, New Jersey. The students are divided into four classes of slightly varying sizes: Period 1 (20 students), Period 2 (19 students), Period 3 (24 students), and Period 8 (19 students). These classes are intended to be heterogeneous mixes. However, since the students are tracked for math, this somewhat influences their science class placement. Furthermore, a few students participated in only one or none of the dissections and were therefore eliminated from the study. This explains the increased number of responses one will note in the subsequent initial survey data supplied.

The school day is divided into eight periods. Periods one through four occur in the morning, while periods five through eight occur in the afternoon. Each period lasts forty-two minutes. The science, language arts, social studies, and math classes meet days a week.

The study was initiated at the beginning of March 2000 and took place over a two week period of time. All students were initially introduced to general information about amphibians, as well as the external and internal anatomy and physiology of the frog. This was achieved through class lecture utilizing diagrams, notes, and overheads (see appendix).

During the first week, periods two and three completed the computer dissection of the frog in the computer lab using the Biofrog software program. Periods one and eight

completed the real dissection of the grass frog in the classroom. In order to ensure that those students involved in the real dissection were exposed to the same information on the function of the frog's organs as those doing the computer dissection, a handout of the exact information was provided to every student prior to the beginning of the real dissection.

Students participating in the computer dissection were directed by the instructor only on how to register/log into the Biofrog software and on basic navigation through the program. These students, working individually, were expected to complete the dissection of each system and answer the questions posed in the quizzes posed after each system. When finished, they were permitted to return to any system for review or complete a series of laboratory investigations (see appendix for details).

Those participating in the dissection of the real frog were organized into their cooperative lab groups. They were directed by the instructor on the responsibilities of the individuals within the group, as well as dissection procedure. The students were expected to examine external and internal features of the frog. Using the informational handouts , they were to identify the purpose/role of each organ or structure when located. They were encouraged to use diagrams supplied during lecture to assist them in the identification process.

The time allotted for both dissections was two days. Contrary to usual practice, the students were not required to complete a lab report. Instead, both groups completed a quiz generated by Biofrog at the end of the second day. It consisted of twenty questions that were multiple choice, true/false, and matching in nature (see appendix). The following week, periods two and three completed the real dissection, while period one

and eight completed the computer dissection. Again, at the end of the two day period, they completed the same twenty question quiz.

To eliminate some variable from impacting on the test scores, the students were not informed of their scores, nor were they aware that they would be taking the same test after each dissection. Students were also told not to study so as to hopefully be able to measure the impact of the activity rather than the degree of at home studying they did or didn't do. Rescheduling of the time period they completed the labs on the second week, however, was unavoidable due to accessibility to the computer lab.

Besides evaluating the students based on the test scores they obtained, a survey was administered prior to the study to assess their initial opinion of dissection and working with computers. All of the students have had prior computer experience. Though, the frequency with which they use the computer and for what type of activities was also surveyed. After the completion of the study, the students were given another survey to evaluate which method of dissection they preferred and from which one felt they learned the most. They were unaware of their test scores while completing this final survey. Therefore, their perceptions of their achievement would not be influenced by this knowledge.

IV. Quantitative Data and Analysis

The test scores for each class were recorded (Tables 4-1 through 4-4). Periods One and Eight, which participated in the specimen dissection during initial testing, resulted in mean test scores below that of Periods Two and Three, which participated first in the computer dissection of the frog. However, t-Tests were performed to determine the statistical significance of these results. Period One was compared to Periods Two and Three, while Period Eight was compared to Periods Two and Three. The resultant p-values for each pairing resulted in no statistical significance. In order for statistical significance to be shown the p-value must be equal to or less than .05. Although the comparison of Period Eight to Period Two results in a p-value close to this figure, it still does not meet the acceptable standard to be significant (Table 4-5).

Although the means of the test scores may appear at first glance to be significantly different, the graphs generated as a result of the t Tests performed readily show why they are not. As indicated by the vertical lines extending from each image comprising the graph, the variation within each class is greater than the score variance between the classes (Figures 4-1 through 4-4). For instance, in Period One, one student scored as high as a 95 while another scored as low as a 35. Such a difference of test scores within this class

made the difference between Period One's mean and that of Period Two and Three insignificant. This same deviation can be observed in each class.

The second column of data on Tables 4-1 through 4-4 indicate the test scores obtained after performing the follow-up dissection activity. Those that completed the traditional dissection procedure first produced a higher overall test average after participating in the computer simulated dissection. Those that participated in the traditional method after the computer simulated dissection did not yield higher scores. The statistical significance of these results were not assessed.

Table 4-1 Period 1 Test Scores

Student	Specimen score	Computer score
A	50	80
B	45	75
C	65	95
D	90	90
E	35	55
F	80	95
G	80	95
H	80	100
I	75	80
J	55	70
K	95	100
L	55	60
M	75	90
N	45	45
O	50	70
P	75	65
Q	65	90
R	50	75
S	55	55
T	70	85

	Specimen	Computer
Average	64.5	78.5

Table 4-2 Period 8 Test Scores

Students	Specimen Score	Computer Score
A	55	55
B	30	30
C	70	85
D	70	85
E	45	40
F	40	30
G	35	35
H	60	50
I	70	70
J	55	65
K	75	90
L	70	100
M	95	90
N	55	55
O	55	65
P	55	80
Q	80	85
R	55	60
S	60	55

	Specimen	Computer
Average	59.47368421	64.47368421

Table 4-3 Period 2 Test Scores

Students	Computer Score	Specimen Score
A	85	80
B	55	70
C	50	55
D	65	65
E	45	50
F	60	80
G	75	85
H	80	80
I	85	85
J	70	70
K	90	75
L	60	60
M	75	55
N	70	60
O	50	45
P	90	75
Q	80	60
R	80	80
S	45	60

	Computer	Specimen
Average	68.94736842	67.89473684

Table 4-4 Period 3 Test Scores

Students	Computer Score	Specimen Score
A	70	65
B	85	80
C	65	55
D	60	50
E	85	75
F	35	45
G	80	55
H	80	75
I	80	95
J	60	75
K	60	60
L	65	75
M	95	95
N	65	55
O	30	55
P	50	65
Q	80	80
R	60	55
S	95	80
T	85	80
U	70	90
V	45	55
W	75	70
X	65	70

	computer	specimen
Average	68.33333333	68.95833333

Table 4-5 Summary of t Test Calculations for Computer Simulated vs Traditional Dissection Test Classes

Class Pairings	Resultant p-Value from t Test	Degrees of Freedom
Per 1 vs Per 2	.39	37
Per 1 vs Per 3	.45	42
Per 8 vs Per 2	.067	36
Per 8 vs Per 3	.088	41

Periods 1 and 8 = Traditional Dissection
Periods 2 and 3 = Computer Dissection

Figure 4-1- Statistical Comparison of Period 1 vs Period 2

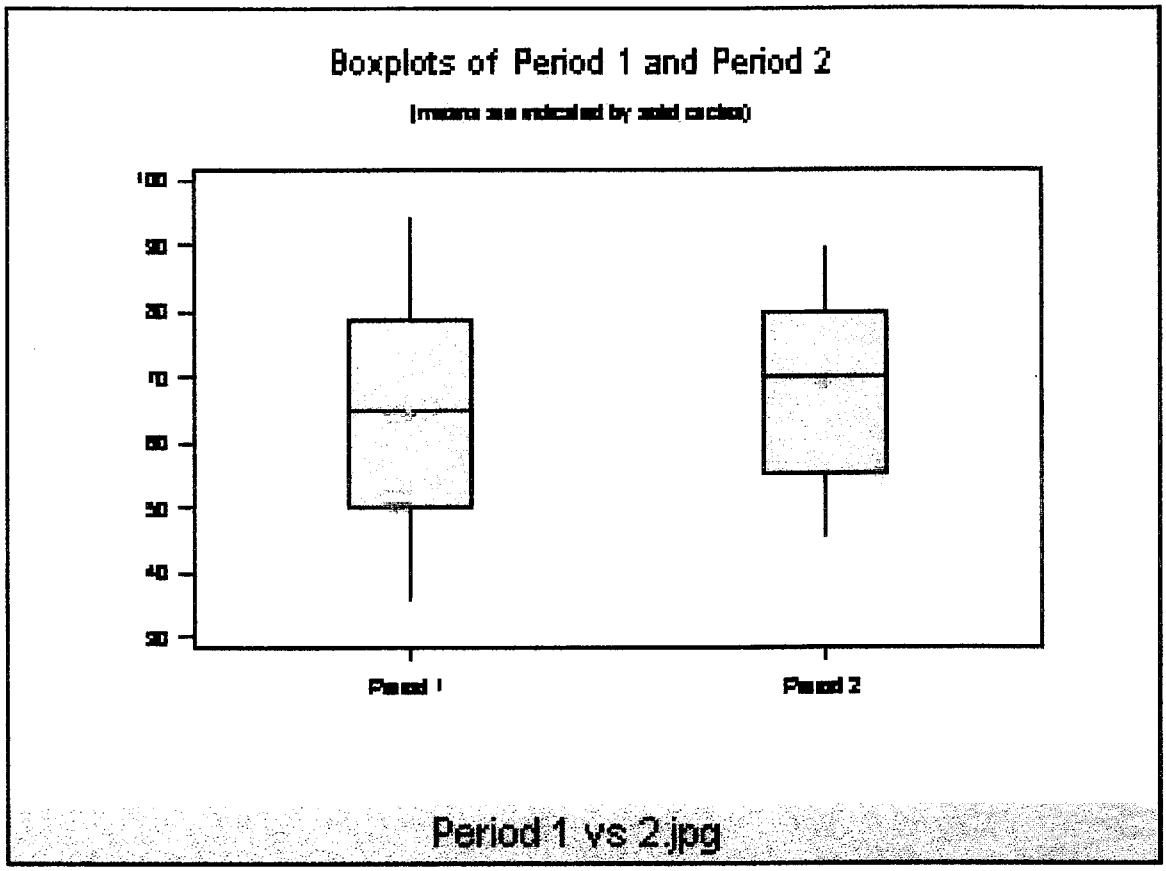


Figure 4-2 - Statistical Comparison of Period 1 vs Period 3

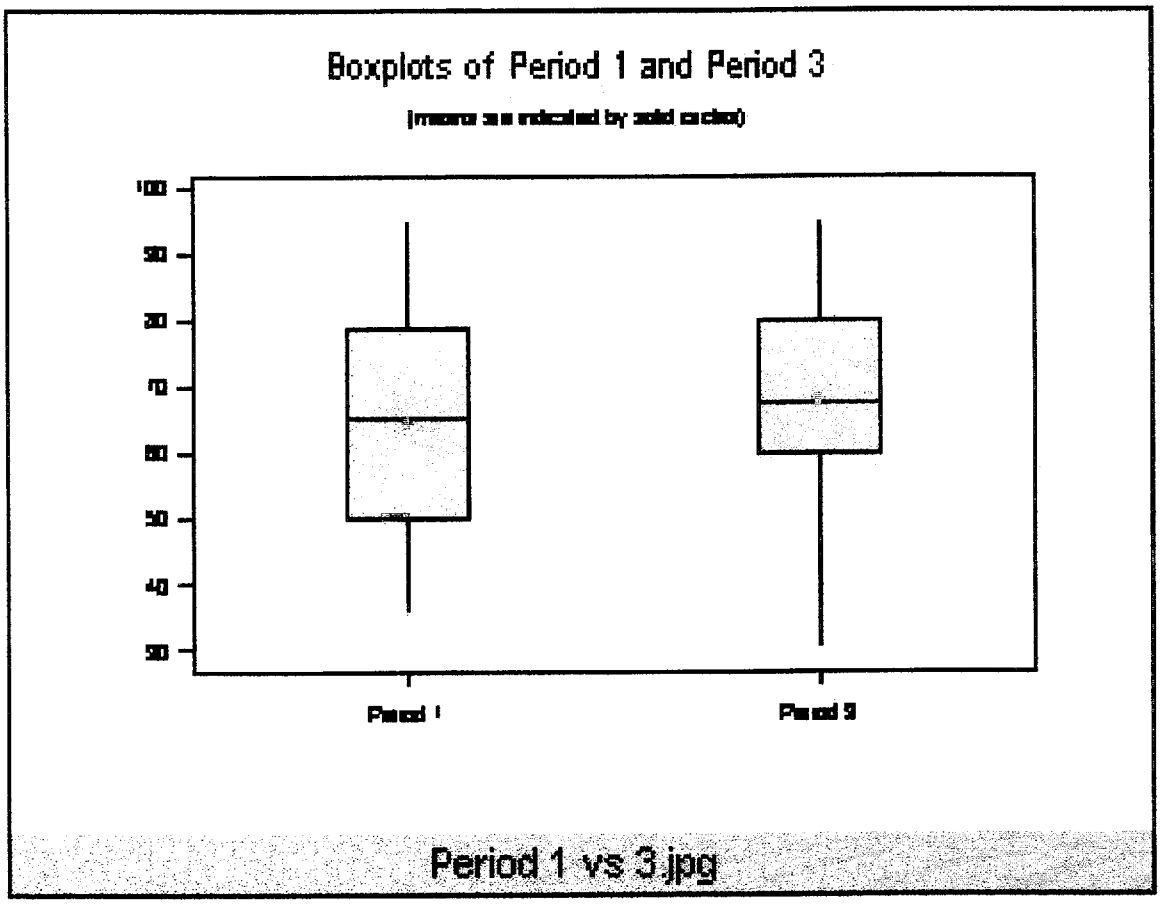


Figure 4-3 - Statistical Comparison of Period 8 vs Period 2

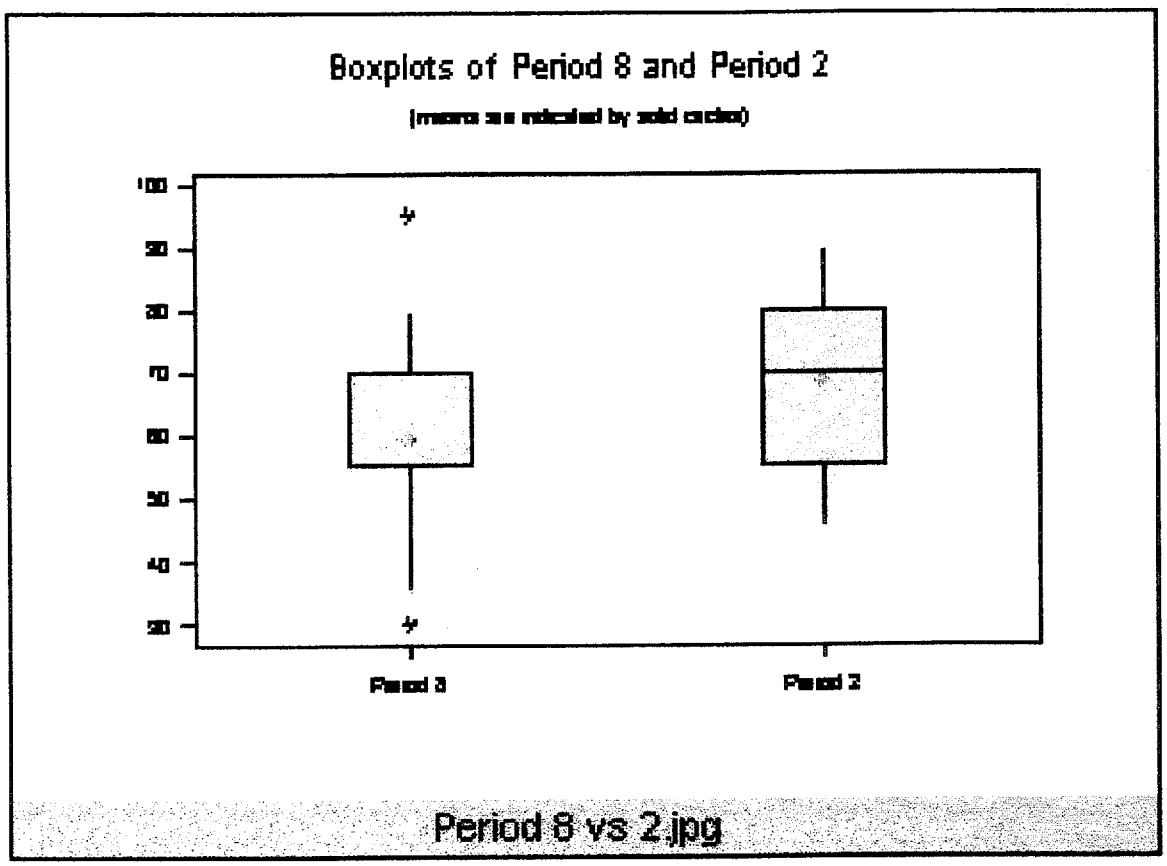
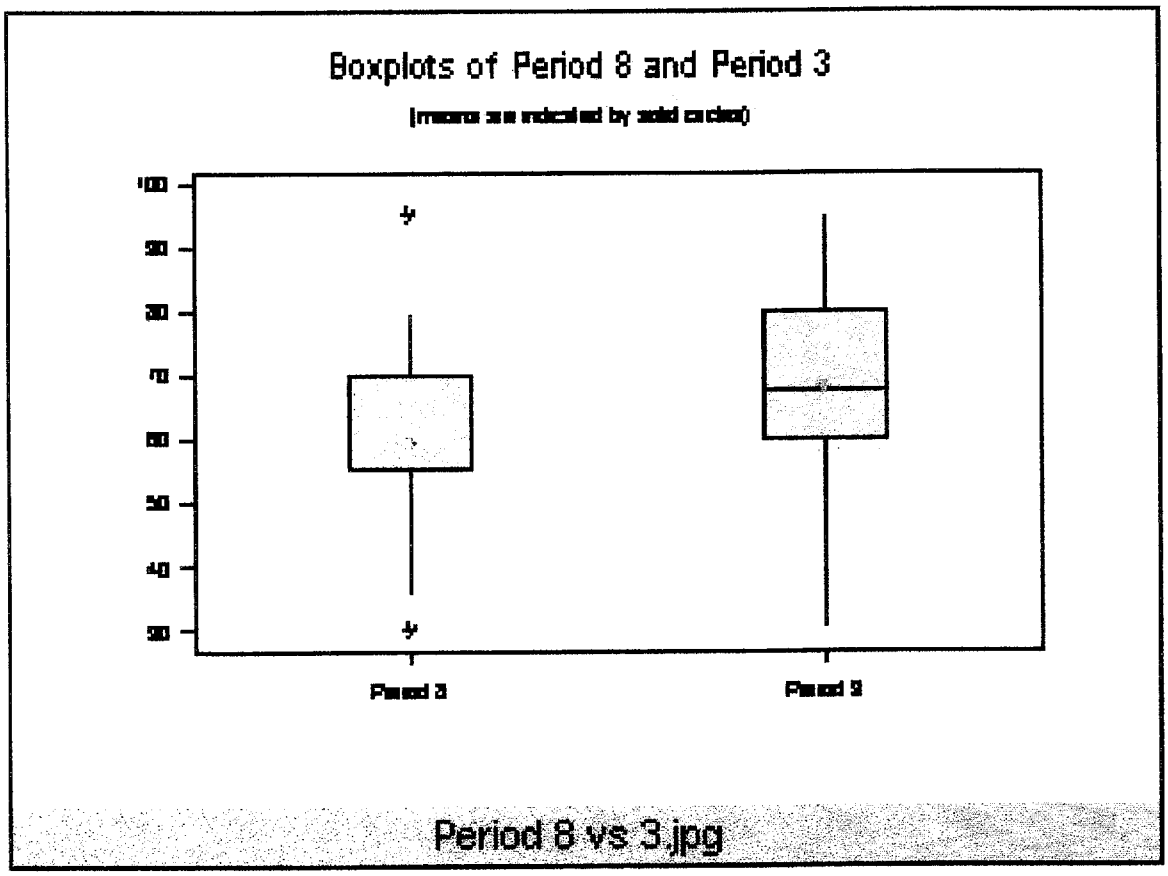


Figure 4-4 - Statistical Comparison of Period 8 vs Period 3



V. Qualitative Data and Analysis

The students' responses to the preliminary survey were recorded (Tables 5-1 through 5-5) They overwhelmingly displayed an enjoyment of computers and viewed them as a valuable tool in the acquisition of knowledge(Figure 5-3). However, a majority also enjoyed performing traditional dissections, as well as having little difficulty with the ethical questions that often surround such laboratory practices (Figure 5-1).

The responses from the students to the final survey were also recorded (Tables 5-6 through 5-10). The majority indicated an enjoyment in participating in both forms of dissection. There was only a slight final preference of performing the computer dissection to the specimen dissection, but well over half found they did learn more about the anatomy of the frog by using the computer simulated dissection compared to the traditional method (Figures 5-2 and 5-4).

Table 5-1 Period 1 Preliminary Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	0	16	3	1
2	1	5	9	5
3	1	8	7	4
4	5	8	5	2
5	12	6	2	0
6	11	8	1	0
7	7	9	2	2
8	1	8	10	1

	Frequently	Occasionally	Rarely	Never
1	19	1	0	0
2	1	8	9	2
3	7	6	7	0
4	12	5	1	2

Table 5-2 Period 2 Preliminary Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	0	16	5	0
2	1	1	12	7
3	1	3	8	9
4	5	13	2	1
5	7	13	1	0
6	10	9	2	0
7	9	10	1	1
8	2	7	8	4

	Frequently	Occasionally	Rarely	Never
1	18	3	0	0
***2**	4	7	8	1
***3**	4	9	7	0
***4**	16	3	1	0

*** One student did not complete these questions**

Table 5-3 Period 3 Preliminary Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	4	17	4	0
2	4	6	8	7
3	4	5	11	5
4	7	7	8	3
5	11	12	2	0
6	13	11	0	1
7	14	5	3	3
8	5	11	7	2

	Frequently	Occasionally	Rarely	Never
1	23	2	0	0
2	3	17	3	2
3	6	10	6	3
4	18	2	1	4

Table 5-4 Period 8 Preliminary Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	2	9	7	2
2	5	6	4	5
3	3	7	4	6
4	6	4	5	5
5	10	9	1	0
6	7	13	0	0
7	7	5	3	5
8	1	9	8	2

	Frequently	Occasionally	Rarely	Never
1	13	6	1	0
2	3	10	7	0
3	6	9	4	1
4	14	3	2	1

Table 5-5 Overall Preliminary Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	6	58	19	3
2	11	18	33	24
3	9	23	30	24
4	23	32	20	11
5	40	40	6	0
6	41	41	3	1
7	37	29	9	11
8	9	35	33	9

	Frequently	Occasionally	Rarely	Never
1	73	12	1	0
2	11	42	27	5
3	23	34	24	4
4	60	13	5	12

Table 5-6 Period 1 Final Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	3	14	2	1
2	2	9	7	2
3	7	5	4	4
4	11	9	0	0

Learned Frog Anatomy Best By...

Computer	Real	Either
15	4	1

Table 5-7 Period 2 Final Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	4	12	4	0
*2	8	8	2	1
3	2	5	11	2
4	7	12	1	0

Learned Frog Anatomy Best By...

Computer	Real	Either
12	5	3

*** Indicates one student unaccounted due to indecisiveness of answer**

Table 5-8 Period 3 Final Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	6	16	1	1
2	9	10	1	4
3	6	6	8	4
4	12	10	2	0

Learned Frog Anatomy Best By...

Computer	Real	Either
15	4	5

Table 5-9 Period 8 Final Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	3	10	3	2
2	9	3	3	3
3	3	4	5	6
4	5	9	4	0

Learned Frog Anatomy Best By...

Computer	Real	Either
8	6	4

Table 5-10 Overall Final Survey Results

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	16	52	10	4
2	28	30	13	10
3	18	20	28	16
4	35	40	7	0

Learned Frog Anatomy Best By...

Computer	Real	Either
50	19	13

Figure 5-1 Ethical View of Dissection

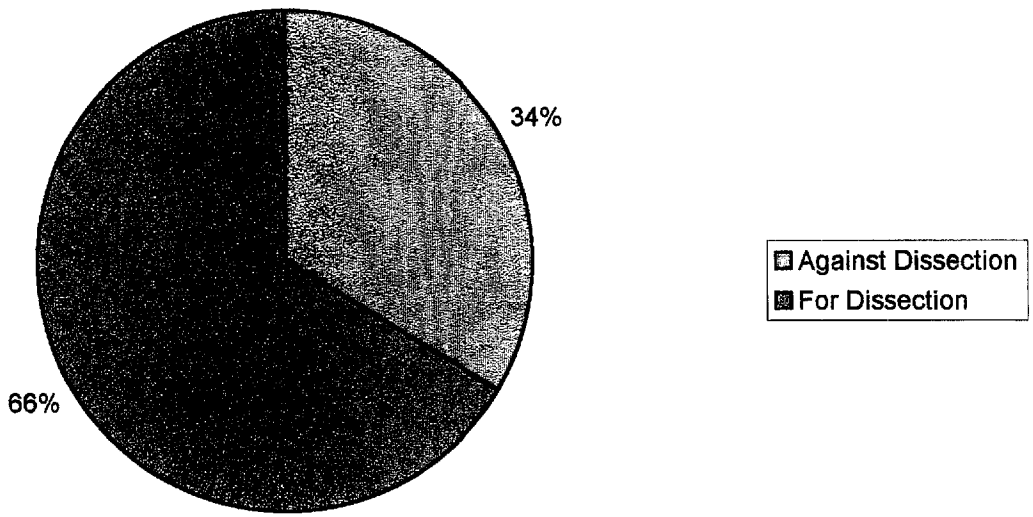


Figure 5-2 Comparison of Preliminary to Final Dissection Method Preference

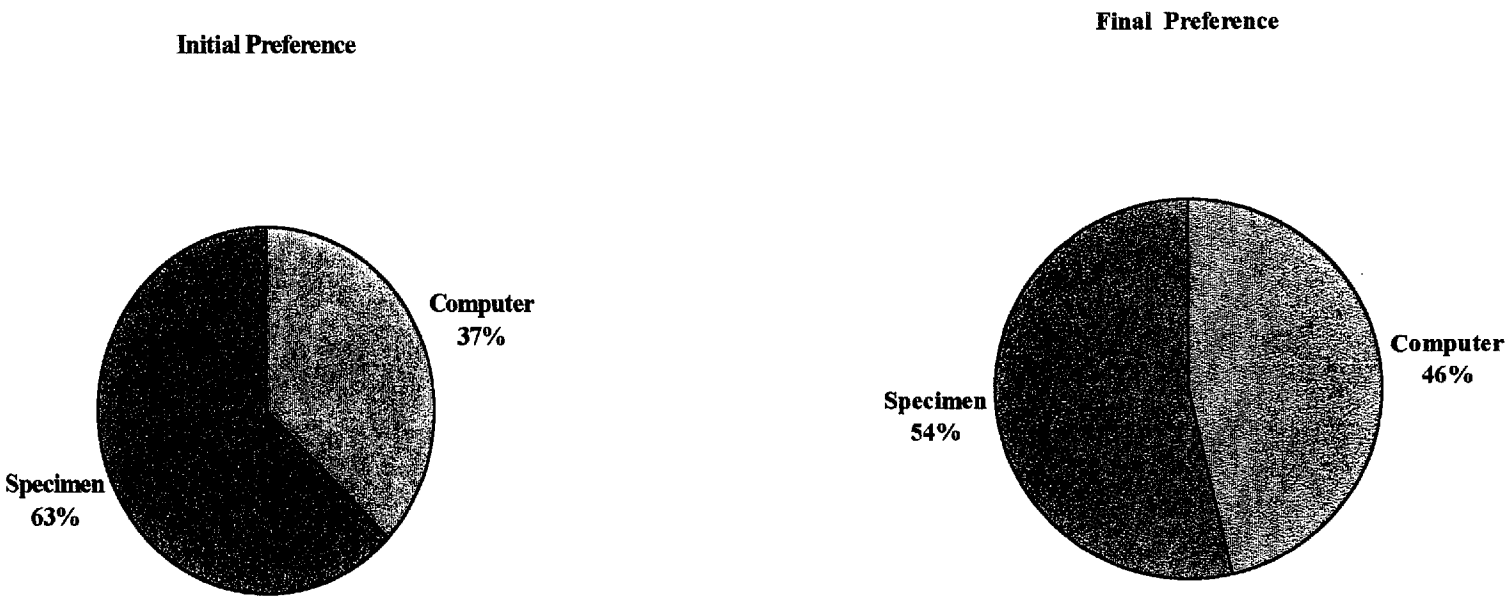


Figure 5-3 Initial View of Computer as a Learning Tool

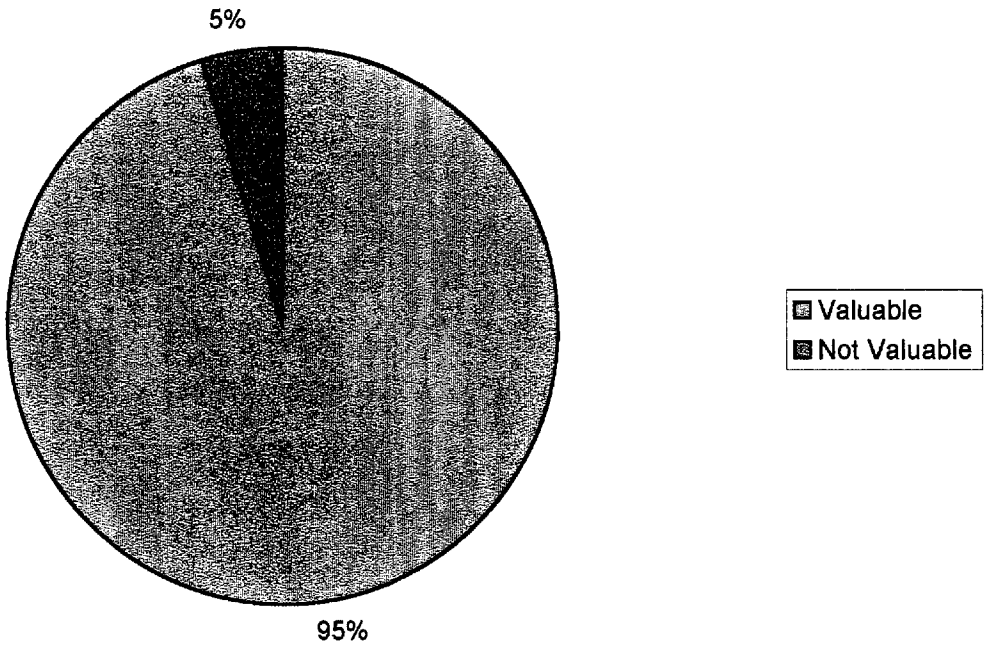
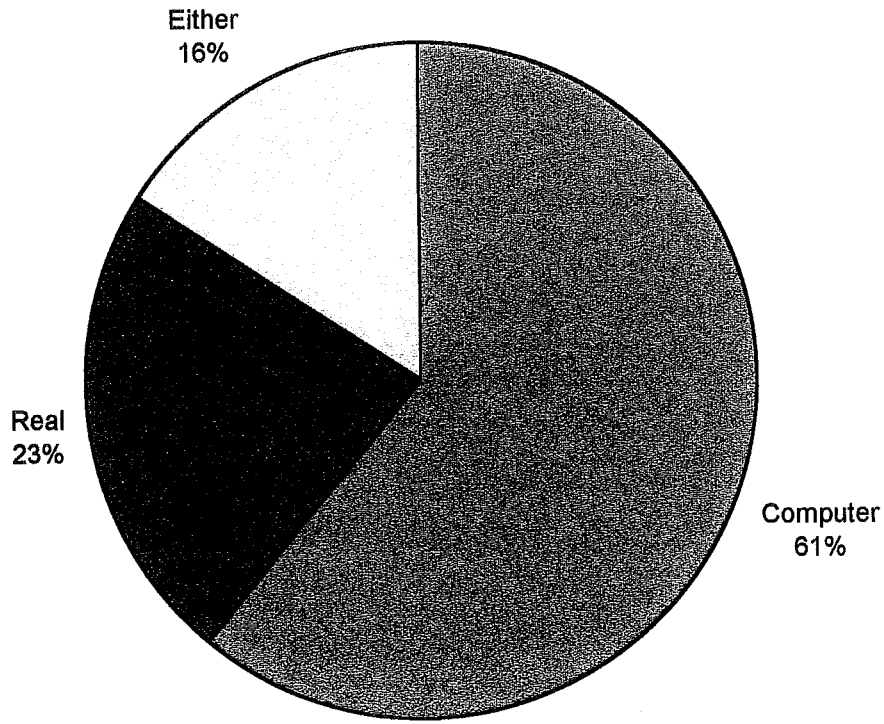


Figure 5-4 Final Dissection Method Preference for Learning Frog Anatomy



VI. Summary and Discussion

Utilization of computers in the classroom for instructional purposes is becoming more and more prevalent. The research conflicts, though, about whether or not they produce an increase in student learning. However, this conflict is due in great part to the current limitations in adequate assessment and the necessary curricular and district changes mandated to properly implement computers in the classroom (Blasi, 1999). It has always been stressed in teacher education courses the importance of making connections between what students are learning in the classroom and the "real" world. Furthermore, the more a part of the learning process students are involved in, the more initiative and dedication toward learning they will demonstrate. Consequently, students need to be engaged with computer technology in compelling and meaningful activities as well (McGrath, 1998).

The quantitative results of this study indicate no significant difference in learning between the students who dissected the frog according to the traditional method or the computer simulated method. However, there are many points that must be acknowledged and considered in determining the impact and/or validity of these results. The impact of the differing grouping methods for the two dissection procedures, interaction among students during dissection or between classes due to scheduling, presentation of

instructions, and the language barriers experienced by the ESL and LD students are a few. Additionally, though instructed not to study, some students may have opted to do so being aware they would be assessed at the end of the activity. It would appear that many did follow the directives not to do so, since the scores obtained were generally much lower than the students normally achieve.

Since the students took the same test after completing the alternate dissection method, it was initially anticipated that test scores would generally improve regardless of the dissection method. However, this was not the case. Only those that completed the traditional method of dissection first and then completed the computer simulated dissection showed notable gains. The significance of these results can't be addressed though, since the original experiment proved not to be significantly different. Furthermore, since the test administered to the students was generated by the same computer software as used in the computer simulated dissection, distributing the information in handout form as described earlier may or may not have been appropriate compensation.

Qualitatively, the students' results did concur with a lot of the current research that computers are an engaging and informative tool that promotes students to continue their learning outside the classroom by their own initiative (Charp, 1998). However, their interest in using the computer did not dissuade an overwhelming amount of the students from wanting to participate in the traditional dissection, though they did not necessarily believe they learned more from it.

Though the study did attempt to incorporate quantitative and qualitative tools of assessment, additional study needs to be done to determine the impact of computers on

student learning. This investigation only focused on the impact of one computer software program. Additional research is needed on the impact of the more advanced, "real life" learning opportunities afforded through the Internet In conjunction with this, attention must be turned to the development of assessment methods that can more adequately take into account the many factors involved in such instruction.

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Appendix

Name _____ Period_____
Date _____

For each of the statements below, indicate if you strongly agree , agree, disagree, or strongly disagree by circling the corresponding abbreviation.

1) I learned a lot from the worm dissection lab.
SA A D SD

2) I am against dissections for ethical reasons.
SA A D SD

3) I would prefer to dissect using a computer simulation.
SA A D SD

4) I enjoy the actual act of dissecting.
SA A D SD

5) I enjoy working with computers.
SA A D SD

6) I believe I have learned a lot through my use with computers.
SA A D SD

7) I am looking forward to the frog dissection.
SA A D SD

8) I am looking forward to the computer simulated frog dissection.
SA A D SD

Please indicate the frequency with you participate in the following activities by circling the most appropriate response for each question.

1) How often do you use computers for research?
Frequently Occasionally Rarely Never

2) How often do you use educational software?

Frequently Occasionally Rarely Never

3) How often do you use a computer to play games?

Frequently Occasionally Rarely
Never

4) How often do you use the computer to e-mail or instant message other people?

Frequently Occasionally Rarely Never

Name _____
Frog Dissection Final Survey

Circle the choice for each statement that best expresses your opinion. There are some open-ended questions at the end of the survey for you to complete. Please answer honestly and thoroughly.

1) I enjoyed participating in the computer dissection of the frog.
SA A D SD

2) I enjoyed participating in the "real" dissection of the frog.
SA A D SD

3) I preferred doing the computer dissection over the "real" dissection.
SA A D SD

4) I found the Biofrog computer program easy to use.
SA A D SD

5) I would rate the graphics on the computer program as_____.
excellent very good good fair

What I liked best about the computer dissection was _____
_____

What I liked least about the computer dissection was _____
_____

What I liked best about the ""real" dissection was _____
_____

What I liked least about the "real" dissection was _____
_____

I learned the placement of the frog's organs best with _____.
a)the computer dissection
b) the "real" dissection
c) either. I didn't notice a difference.

State with which method of dissection you learned the most and explain why.

If I could choose only one way to dissect a frog, I would choose to conduct a _____.
a) computer dissection
b) "real" dissection

Additional Comments :

Frog Test

Name _____

Section _____

Date _____

Select the term that best answers or completes the statement.

1. Amino acids and monosaccharides are absorbed in the...
   A. stomach B. pancreas C. small intestine D. gall bladder

2. The ___ removes nitrogenous wastes.
   A. skin B. liver C. pancreas D. kidney

3. The ___ receives products of the reproductive, digestive, and excretory systems.
   A. cloaca B. large intestine C. skin D. kidney

4. The large bone of the frog's upper leg is the...
   A. radius B. femur C. tibio-fibula D. scapula

5. The female frog does not have...
   A. ovaries B. vocal sacs C. Eustachian tubes D. vomerine teeth

6. The ___ stores the bile produced by the liver.
   A. stomach B. urinary bladder C. gall bladder D. spleen

Indicate whether each of the following statements is true or false. Mark true or false next to each question.

_____ 7. The ventricle pumps blood to the lungs and body.

_____ 8. Eggs are fertilized in the frog's ovaries.

_____ 9. The liver is divided into three lobes.

_____ 10. Phalanges are found on both the hands and feet.

_____ 11. It is hard to drown a frog because it 'breathes' through its skin.

_____ 12. Water is chiefly absorbed by the small intestine.

_____ 13. Maxillary teeth are found on both the upper and lower jaw.

_____ 14. Food is mechanically digested by the stomach.

_____ 15. The tongue of the frog is attached to the back of its mouth.

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Match the organ or structure below with the descriptions 16 - 20. Mark the letter of the correct answer next to each question.

A. spleen	B. stomach	C. oviduct	D. glottis
E. esophagus	F. tympanic membrane	G. skull	H. kidney

_____ 16. This tube is the opening to the digestive system.

_____ 17. This structure is the outer eardrum of the frog.

_____ 18. This structure helps recycle the iron from dead blood cells.

_____ 19. This structure is the passage between the throat and lungs.

_____ 20. Eggs receive protective coats of a jelly-like material while in the ...

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II Amphibians

A. Two main groups

1. With tails as adults - salamanders, mudpuppies, newts(17448 - N.Red Salamander)
2. Without tails as adults - frog, toad (bumpier and drier skin, live further from water than frogs, return to water to spawn) (17449- American toad, 17450- frog, 17451- Poison Arrow Frog - skin has poison to kill birds and small animals, in C & S America)

   (17447 -Caecilian - 45cm-1m long, eats arthropods and worms, become nearly blind)

B. General Characteristics

1. Undergo metamorphosis as they develop
2. Most live in water when young and on land as adults
   Young - live in water and use gills to get O2
   Adults - live on land and use lungs, many develop legs and webbed feet
3. 3-chambered heart (1 receive O2 rich blood the other receive CO2 rich blood, mixes in 3rd chamber, disadvantage to our heart?)
4. Most exchange gases through their skin as well
5. ectothermic (frogs hibernate in fall and cold- use fat bodies for food, eat again in Spring estivate in hot/dry weather (inactive, bury into wet mud of drying lakes, doesn't last as long
6. Reproduction - spawning (no protective shell)
   (discuss lifecycle, larva is tadpole that loses tail and gills in weeks/months) (17453 eggs in pond- hatch in 12 days, 17454 - 17457 - tadpole stages)

** Numbers such as 17453 denote a laser disc frame used as visual aid

II Amphibians

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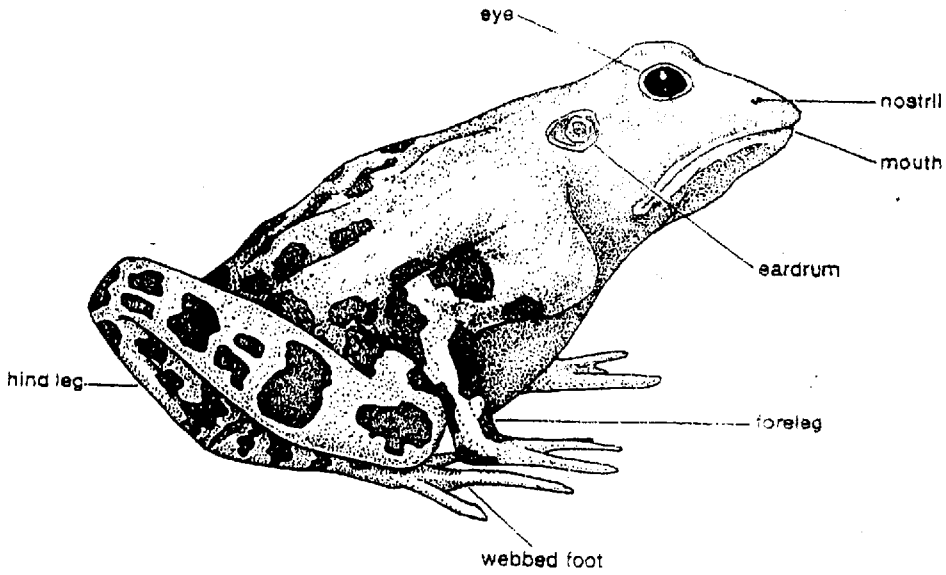


DIAGRAM A: EXTERNAL

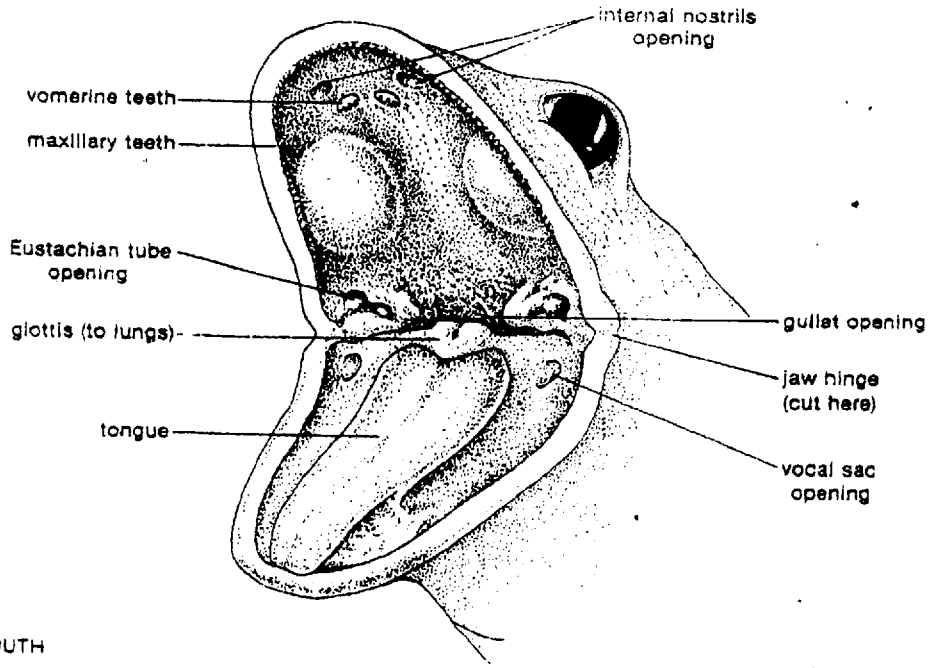
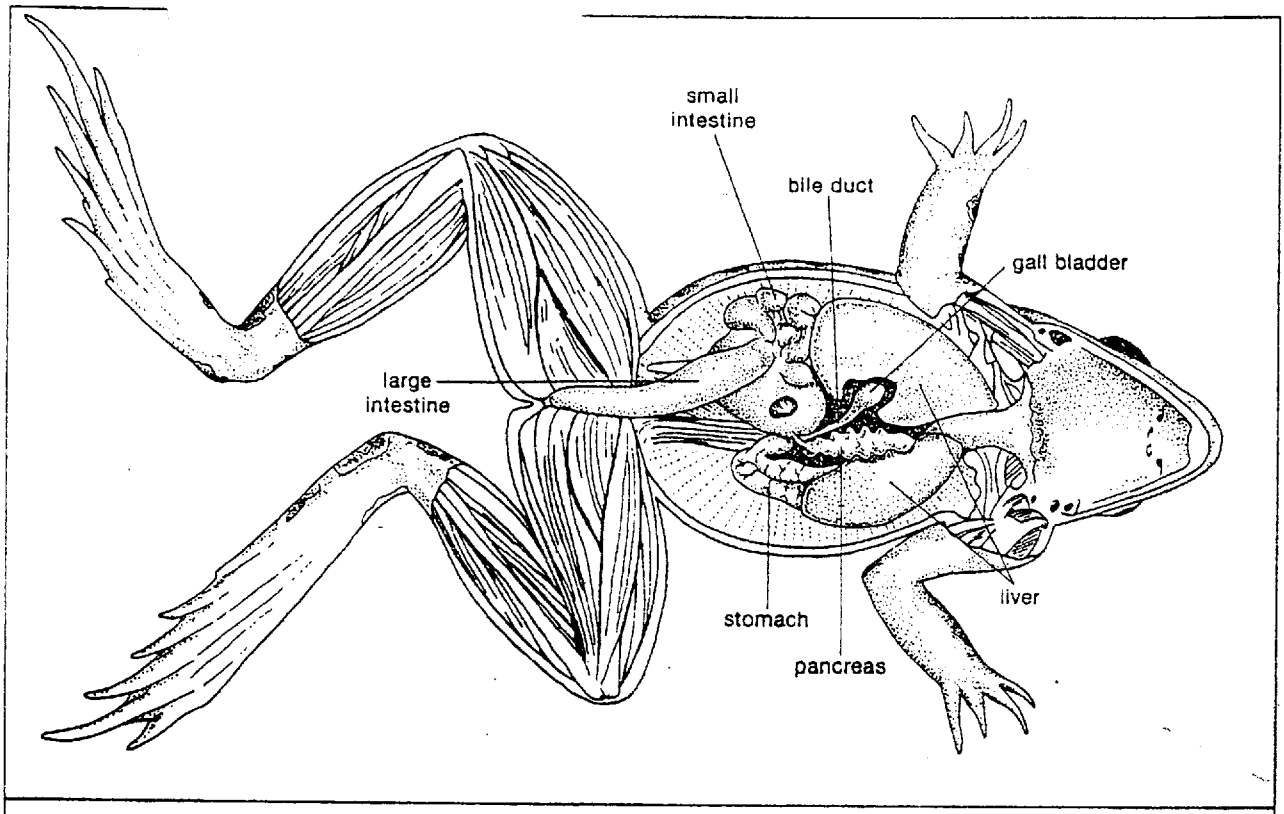
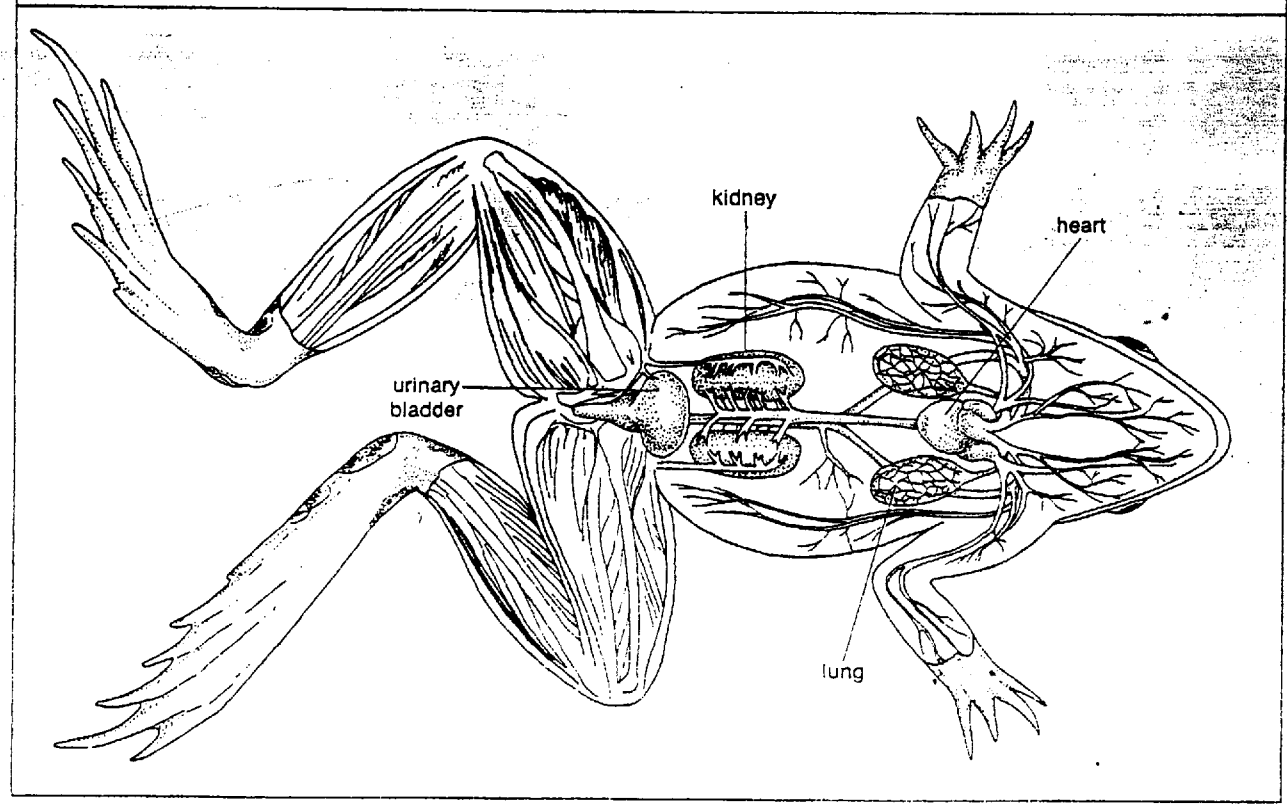


DIAGRAM B: MOUTH

Use with the Skill-Building Activity "The Anatomy of a Frog"
Chapter 11, pages 264–265.





Frog Anatomy

External Features

1)Eyes, 2) nostrils, 3)Tympanic membrane - circular structures behind each eye which are attached to a bone that sends vibrations to inner ear which then sends nerve impulses to brain, 4) fore limbs - for support of frog 5) Hind limbs - for locomotion 6) skin - mention poison of some and color protection and breathing

Mouth Features

1) Maxillary and vomerine teeth - help grasp prey
2) internal nostrils - internal passage for air to enter mouth cavity
3) gullet - opening into esophagus
4) glottis - opening of windpipe in pharynx
5) Eustachian tube - tube connecting mouth and inner ear, allows balancing of pressure between the two
6) tongue - hinged at front of mouth

Internal features

Digestive

1) esophagus 2) stomach - J-shaped 3) small intestines - further digests food with help of secretions from pancreas and liver (liver produces bile which breaks down fat) 4) Lg. intestines - undigested material is made into feces 5) Cloaca - muscular cavity that stores wastes until they are passed out anus

Respiratory

1) Lungs - small sacs on either side of heart
2) trachea - transports air to lungs

Circulatory

1) Heart - 3 chambers
2) arteries and veins
3) spleen - small reddish round body near back wall of abdomen, recycles old blood cells, and stores blood

Excretory

1) kidneys - regulate amt. of water in body , oval shaped and on either side of spine
2) bladder - holds urine until it is excreted

Frog Anatomy

External Features

dorsal skin- coloration allows for camouflage, secretes mucus which makes them hard to hold
tympanic membrane - external eardrum
eye - location of eyes allows for good peripheral vision, can have eyes above water while rest of body is below
nictitating membrane- transparent eyelid, attached to bottom of eye
nostril - location of nostrils allows breathing while rest of frog is below water
front leg - prop body up on land, help in swimming, they have 4 toes with soft tips
hind leg - muscular for jumping and swimming
ventral skin - milky white and blends in with sky when viewed from below,has many blood vessel which makes it a supplemental respiratory organ
webbed feet - five toes connected to flexible web membrane, webbing allows for a large surface a to make frog a powerful swimmer

Mouth

vomerine teeth - used to hold and crush prey
internal nostril - air enters mouth here
maxillary teeth - small, sharp teeth located only on the top to hold prey
eye socket - strong, muscular pads that help push food down gullet opening when frog swallows
Eustachian tube opening - connects middle ear with mouth, equalizes the water pressure
gullet opening - channel connecting mouth and stomach
vocal sac opening - located only in males, assists in mating call
glottis - passage between throat and lung
tongue - attached in front of frog mouth, whips out and wraps around prey

Digestive System

liver - divided into 3 sections or lobes, secretes bile to break up fat, monitors level of digested foo blood and stores excess products of digestion
urinary bladder- stores urine and excess water before excreted through cloaca
pancreas- secretes enzymes to aid in digestion, releases sodium bicarbonate to neutralize effects o stomach acid
gall bladder- stores and concentrates bile, sends bile to the small intestine
esophagus- tube from the mouth to the stomach, large to allow prey to be swallowed whole
stomach- performs chemical and mechanical digestion, chemical digestion occurs due to the gastri juice, twisting and churning of the stomach allows for mechanical digestion

small intestine- continues digestion, secretes amino acids, monosaccharides, glycerol, and fatty ac produced and these are absorbed into the circulatory system

large intestine- absorbs water and minerals, solidifies feces, feces passed to

Circulatory System

heart- has three chambers (rt.&lt. atria & ventricle), atria receive blood and ventricle pumps bloo to the lungs and rest of body

lungs- assisted by skin, can enlarge 3x their deflated size, don't have a diaphragm- use floor of mo to force air in and out of mouth

kidneys- filter blood and concentrate nitrogenous wastes, these wastes are mixed with blood and called urine, urine is temporarily stored in urinary bladder

spleen- reservoir for red blood cells, iron atoms are recovered reused

Reproductive System

cloaca- receives products from reproductive, excretory and digestive systems

fat bodies- fat is centralized rather than located throughout the body, under the skin, as it is in mammals, fat bodies are large by the end of summer, used by frog in winter

ovaries- contains thousands of tiny eggs, no two eggs are alike, each egg has a different genetic combination, eggs enlarge and burst through the thin walls of the ovaries into the digestive cavity

oviducts- receive eggs as they burst through ovaries, provide jellylike coat as they travel down oviducts, eggs pass out through cloaca

SKILL-BUILDING ACTIVITY

THE ANATOMY OF A FROG

PURPOSE: To *observe* the structure of a frog and gain skill in *using dissecting tools.*

MATERIALS:

preserved frog	probe
dissecting tray	dissecting pins
forceps	diagrams of frog structure
scissors	colored pencils

PROCEDURE:

A. Place the frog in the dissecting tray with its backside up. Use diagram A (supplied by your teacher) to locate the external features. Your teacher will give you the diagrams needed for this work. Check off each part as you identify it.

1. Describe the feel of the skin.
2. What sense organs are on the head?
3. Compare the size and structure of the forelegs, hind legs, and feet.
4. Why are the hind feet webbed?
5. Why is the upper surface darker colored than the lower surface?

B. Cut the jaws at the hinges so the mouth can be opened. See Fig. 11–12. Locate the structures shown in Diagram B. Check off each as you locate it.

6. How is the tongue attached to the floor of the mouth?
7. A frog's tongue is sticky. How does this help in food getting?
8. Which jaw holds the teeth? Teeth are not for chewing. What might they do?
9. Why is the glottis a muscular ring tha can be opened and closed?
10. Push the probe down the gullet Where does this tube lead?

C. With the frog on its back, pin the limb down as in Fig. 11–12. Grasp the skin a point 1 with the forceps. Lift the skin anc make a small cut. Insert the tip of the scissors and cut the skin along line 1. Dc not cut too deeply or you may damage internal organs. Cut along lines 2, 3, 4 and 5. Pin back the skin flaps. Observe the muscle layers beneath the skin.

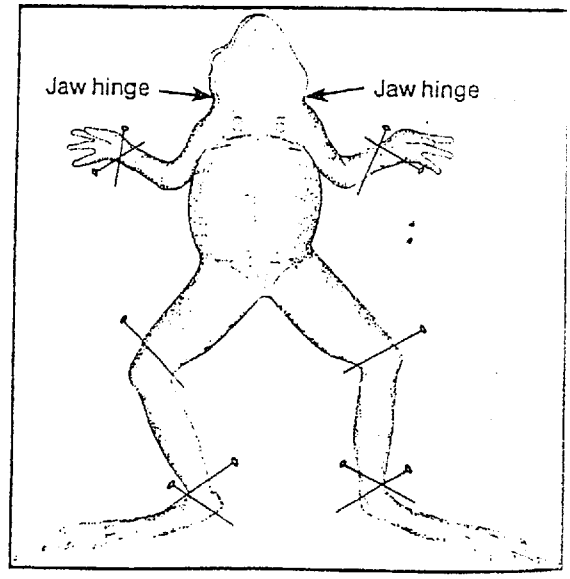


Fig. 11–12

11. Are blood vessels visible in the muscles or skin? What color are they?

D. Cut through the muscles in the same way. You will have to cut through the breastbone between the forelegs. Pin the flaps down as before.

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E. If the body cavity is filled with small, dark eggs, your frog is female.

12. What sex is your frog?

F. Use Diagram C to find the internal organs of the frog. Check off each part as you locate it.

13. What is the large, dark, three-part organ in the upper body cavity?

14. What is the green sac below it?

G. Cut out these organs. The heart should be visible in the upper chest area.

15. What is the shape of the heart?

16. How many chambers are there in this heart?

17. How many blood vessels entering or leaving the heart can you find?

H. Follow the blood vessels from the heart to the two small lungs. Lungs provide only part of the frog's oxygen needs.

18. How does the frog obtain the rest of the oxygen it needs?

I. Remove the heart. The digestive system is now visible. The small tube at the top leads from the gullet in the mouth to the large J-shaped organ.

19. What is the J-shaped organ called?

20. Cut this organ open. Had your frog eaten before it died?

J. Follow the small and large intestines from the stomach to the external body opening, the anus.

21. How are the stomach and intestines held in place in the body cavity?

K. Snip the tube at the top of the stomach and the bottom of the large intestine. Remove the entire digestive system.

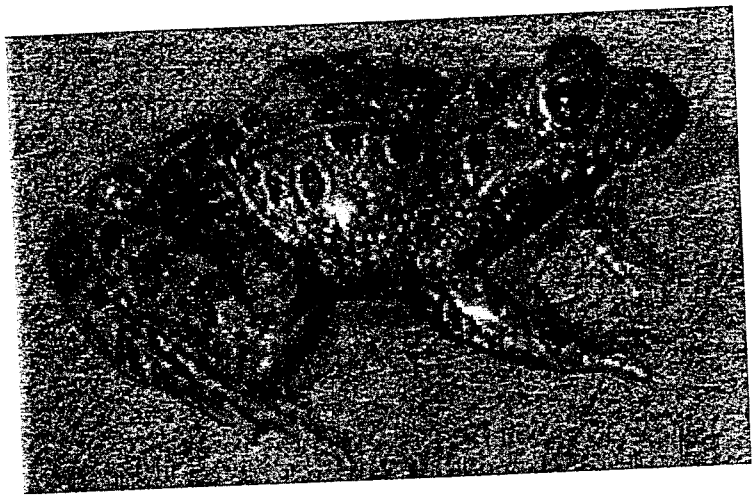
Fig. 11–13

L. Color the following structures on the diagram: the heart and blood vessels, light red; kidneys, dark red; liver, brown; gall bladder, green; lungs, blue; digestive system, yellow.

CONCLUSIONS:

1. How are a frog's hind legs adapted for its type of life?
2. How does the frog obtain oxygen?
3. How does the circulatory system of a frog differ from that of a fish?

BIOLAB•FROG



User's Manual

BL-01-5110-1

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CHAPTER ONE

Introduction

BioLab•Frog simulates an actual frog dissection on your computer screen. As you view and remove organs in *BioLab•Frog*, the software displays added information about each item. It also uses QuickTime movies and microscopic pictures to illustrate functions that are normally difficult to view or understand.

The program motivates reluctant students and introduces frog anatomy without requiring students to perform actual dissections. It also offers an inexpensive alternative to a traditional frog dissection lab.

Some features of *BioLab•Frog*:

- It covers six frog systems.
- It reinforces learning with a review quiz after presenting each system.
- It provides a comprehensive review with the **Frog Test**.
- It gives comprehensive pre-lab information on the structure, function and location of frog parts.
- It clarifies unanswered questions that arise during dissections.
- The minilabs provide interactive, in-depth lab experience in the physiology of amphibians.

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CHAPTER TWO

Using the BioLab

BioLab•Frog is a self-paced tutorial that simulates an actual frog dissection. It includes these primary components:

- **Modules and reviews** for each of the six systems of the frog dissection that you can navigate in a traditional sequence or in any order you choose.
- The **Frog Test**, which comprehensively measures your knowledge of frog anatomy and physiology.
- Four **minilabs**, with which you can gather your own data about frog anatomy and physiology and draw conclusions.

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Instructional Level

BioLab•Frog is designed to be used by students in middle school through high school. Any student studying amphibian anatomy or physiology will benefit from this program. The main audience for *BioLab•Frog* is the high school biology student. Both lower and higher level students will increase their understanding of the different amphibian organ systems presented in this program.

Instructional Objectives

After completing *BioLab•Frog*, students will be able to:

- Identify and locate all major frog organs and bones.
- List the functions of each major frog organ.
- Group organs into the appropriate organ system.
- Complete a typical lab write-up, including the use and interpretation of graphs.

What's Included

These items are included with *BioLab•Frog*:

- Program CD.
- Teacher's Guide.
- Quick Reference CD Insert.

Teaching With BioLab•Frog

Teachers can use *BioLab•Frog* in their classrooms to help students learn more about frog anatomy and physiology.

Pierian Spring courseware takes students beyond memorization. After students demonstrate that they have learned specific information, they have ample opportunities to use the informa-

tion in problem-solving activities that challenge their ability to analyze and draw conclusions.

BioLab•Frog includes a database that works behind the scenes to record the names and results of all of your students as they complete activities during the dissection.

About Your Host

Bob Doltar, the creator of the *BioLab* series of software products, has taught high school biology and other science courses since 1977. He currently teaches biology at Grant High School in Portland, Oregon. He also served as the Science Department Chairman at Grant High School in Portland for four years.

Visiting the Learning Oasis

Pierian Spring Software provides a website called *Pierian Spring's Learning Oasis* that further extends the *BioLab* learning process. If you have Internet access, please visit **http://www.pierian.com**.

The Learning Oasis contains these resources:

- Links to other websites containing educational content.
- Educational tools and other material that you can download.
- Opportunities to communicate with other teachers and students.
- Information about Pierian Spring Software and our training, ordering and support programs.

Logging In

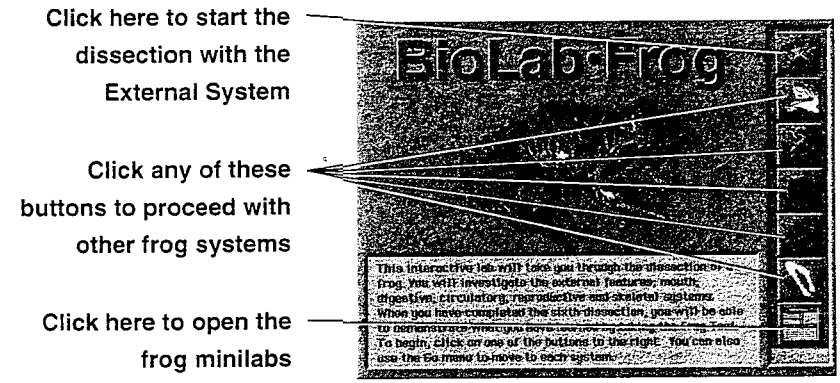
When you start *BioLab•Frog*, the software automatically prompts you to enter your first and last names. This ensures that all of your results on the module quizzes and Frog Test get accurately saved.

If someone else was using the BioLab before you, log in before you begin navigating the modules:

1. Select **New User** from the File menu.
2. Type your first and last name.
3. Click **OK.**

Navigating Through the Frog

When you enter *BioLab•Frog*, the program displays a panel of tools that you can click to select the frog system that you want to study:

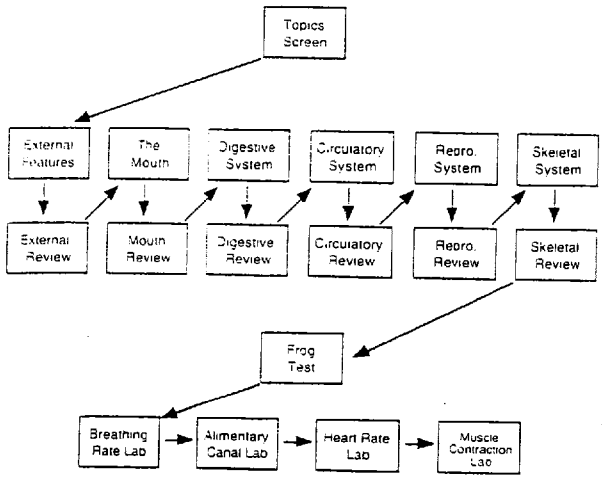


The sections of the frog dissection include:

External	The frog's skin, limbs and sense organs.
Mouth	A closer look at the special adaptations of the frog's mouth.
Digestive System	The internal organs that contribute to digestion.

Respiratory System	The internal organs that contribute to breathing and circulation.
Reproductive System	The frog's sexual organs and systems.
Skeletal System	A frog Bone Yard.
Frog Labs	Four interactive minilabs in which you investigate the frog's respiration, digestion, circulation and muscular capacity.

The following diagram illustrates the typical path you would follow as you proceed through *BioLab•Frog*:



TO COMPLETE THE GUIDED DISSECTION

1. Click the **External** button on the topics screen.
2. Complete the module by clicking the specified parts of the frog. When you finish, the program displays an alert that gives you the option to continue.
3. If you are ready for the External quiz, click **Continue**. If you want to review the function of any frog part, click it on the screen, then click **Continue** when you are ready for the quiz.

4. Complete the quiz as directed by the software.
5. Click **Repeat** to take the quiz over, or click **Next** to continue to another module in the dissection. Some modules ask you to click specified parts of the frog, while others ask you to drag specified organs to and from their proper locations in the frog's body.
6. When you complete all six modules, *BioLab•Frog* gives you the option to complete a comprehensive test covering the entire dissection, or to review other modules before continuing into the Frog Test.

USING THE GO MENU

You can complete whichever of the modules you want in whatever order you prefer.

As an alternative to clicking the icons, you can select each of these modules from the Go menu to proceed directly to the associated section.

When you have completed a module and its quiz, a √ appears next to that module's name in the Go menu.

After completing a dissection module, you can use the Go menu to review the system before taking the Frog Test. However, you must dissect all six systems before you can access the Frog Test from the Go menu.

Getting Help

You can view online help for any screen by selecting **Help** from the Apple menu. The help system describes each menu item and allows you to practice using the mouse to move organs to their proper locations.

Quitting BioLab•Frog

You can select **Quit** from the **File** menu to exit *BioLab•Frog*. The software saves your scores from each module quiz and automatically retrieves the information the next time you use *BioLab•Frog*.

CHAPTER THREE

Dissecting the Frog

This section of the manual describes how to complete the virtual dissection lab in *BioLab•Frog*. It includes information about using screens in *BioLab•Frog* to complete these tasks:

- Identifying external frog organs and characteristics using the External and Mouth screens.
- Identifying internal frog organs and systems using the Digestive, Respiratory and Reproductive System screens.
- Identifying parts of the frog skeleton using the Skeleton screen and its Bone Yard.
- Completing the four minilabs: **Breathing Rate**, **Alimentary Canal**, **Heart Rate** and **Muscle Contraction**.

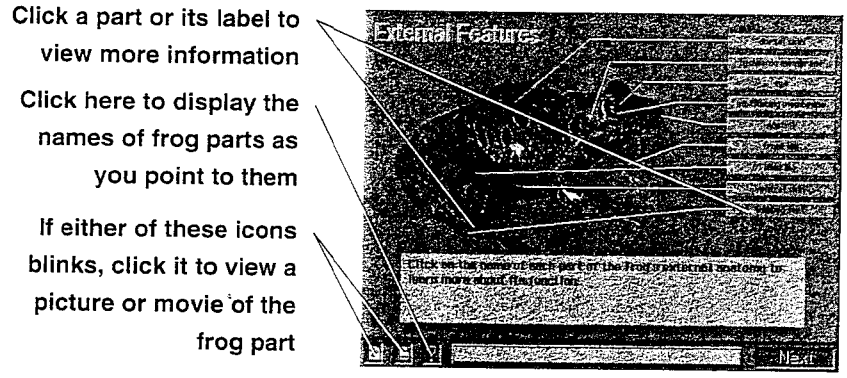
External Features and Mouth System

In the first two modules of *BioLab•Frog*, the software displays parts of the frog with labels. You can either click the part on the frog's body, or you can click its label to view information about the part's function.

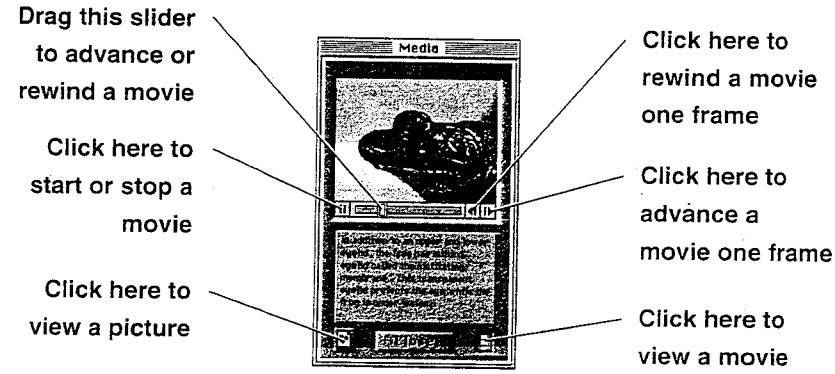
After you click all of the frog parts, you can choose to take the quiz for the module, or spend more time reviewing parts of the system.

During the quiz, *BioLab•Frog* describes a part so that you can click the associated label or location on the frog's body.

Once you complete the quiz, *BioLab•Frog* prompts you to repeat the quiz or continue to the next screen of the dissection.



If you click either of the media buttons, a media window appears with which you can view enlarged pictures or videos of the indicated organ or part.



Digestive, Circulatory and Reproductive Systems

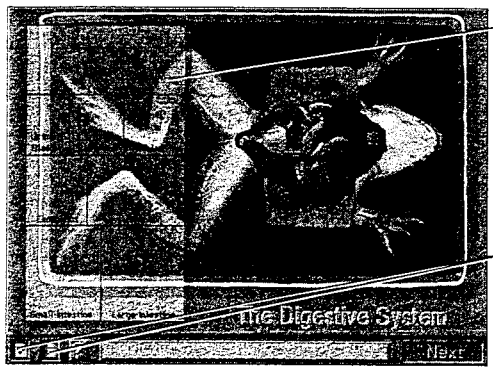
The subsequent three modules of *BioLab•Frog* display internal organs of the frog.

As you drag organs from the frog body to correct locations on the dissection tray, *BioLab•Frog* displays more information about the function of the organ.

After you successfully transfer all of the system's organs to the tray, you can choose to take the quiz for the module, or spend more time reviewing parts of the system.

During the quiz, *BioLab•Frog* describes a part so that you can drag the associated organ back to its correct location in the frog's body.

Once you complete the quiz, *BioLab•Frog* prompts you to repeat the quiz or continue to the next screen of the dissection.



Drag each organ to the correct location on this dissection tray. Some organs might have more than one part

If either of these icons blinks, click it to view a picture or movie of the frog part

Skeletal System

The Skeleton module concludes the dissection of the frog.

It displays frog bones in the Bone Yard that you must drag to the corresponding locations on the frog skeleton chart. Once you fit a bone into the correct location, *BioLab•Frog* displays the name of the bone.

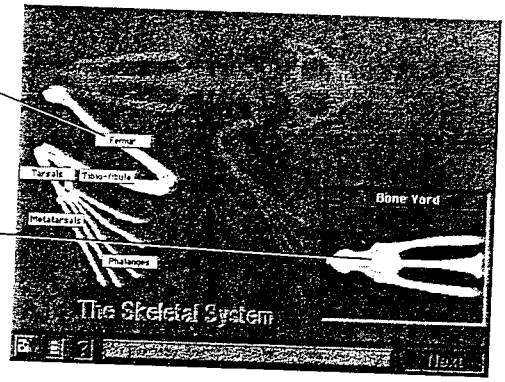
Once you complete the skeleton, you can choose to take the quiz for the module, or spend more time reviewing the bones.

During the quiz, *BioLab•Frog* displays the names of each of the bones. Drag each name from the Bone Yard to the label that points to the correct bone in the skeleton.

Once you complete the quiz, *BioLab•Frog* prompts you to repeat the quiz, continue to any screen of the dissection, or, if all parts of the dissection have been completed, continue to the Frog Test.

When you correctly place a bone, a label with its name appears

Drag bones from here to their correct location in the frog skeleton



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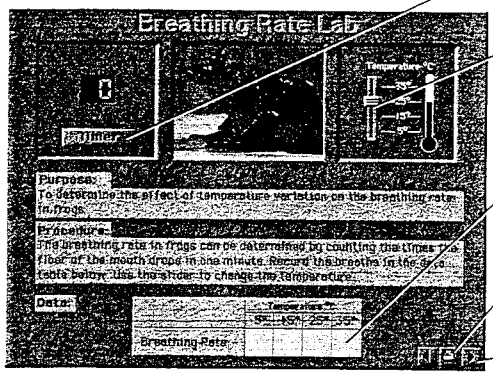
The Frog Minilabs

You can complete four frog minilabs that allow you to observe anatomical and physiological characteristics of frogs and draw conclusions based on the data you gather.

BREATHING RATE



Click here to start and stop the timer

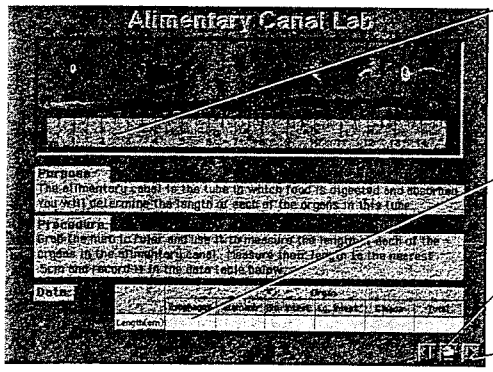
Drag this slider to set the temperature of the frog's environment

Type your findings in these fields

Click here to print the lab data

Click here to graph and analyze your data

ALIMENTARY CANAL



Drag the ruler around the screen to help you measure the length of each of the organs

Type your findings in these fields

Click here to print the lab data

Click here to graph and analyze your data

HEART RATE

Click here to pick up the indicated substance

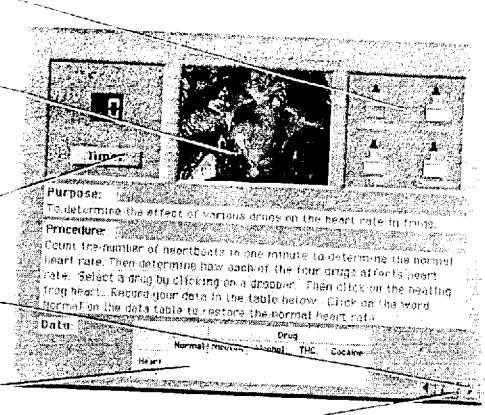
Click the eyedropper here to deposit a substance

Click here to start and stop the timer

Click here to graph and analyze your data

Record your findings in these fields

Click here to print your lab data



MUSCLE CONTRACTION

Drag this slider to set the shock intensity

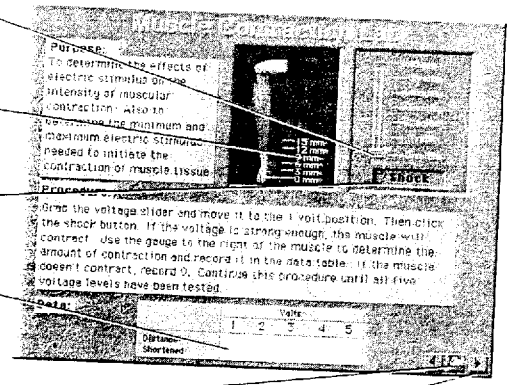
Observe the contraction on this scale

Click here to shock the frog limb

Enter your findings in these fields

Click here to print your lab data

Click here to graph and analyze your data



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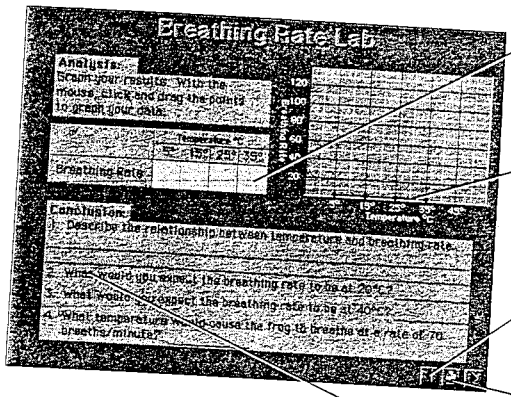
COMPLETING THE MINILAB REPORTS

Each minilab includes a report screen with which you can graph and analyze the data you gathered during the lab.



The data you gathered on the previous screen appears here

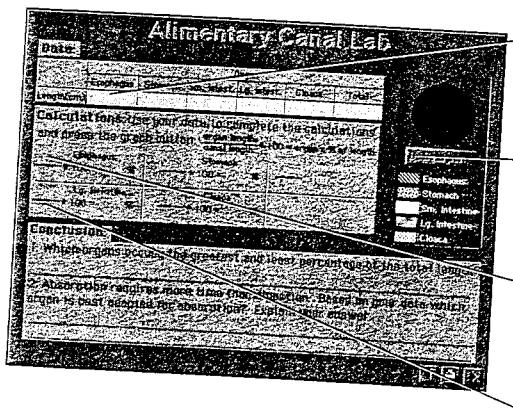
Drag these sliders to graph the correct data values

Click here to return to the previous screen

Click here to print your report

Complete your analysis by answering these questions

You must complete some additional calculations before you can graph data gathered during the Alimentary Canal minilab.



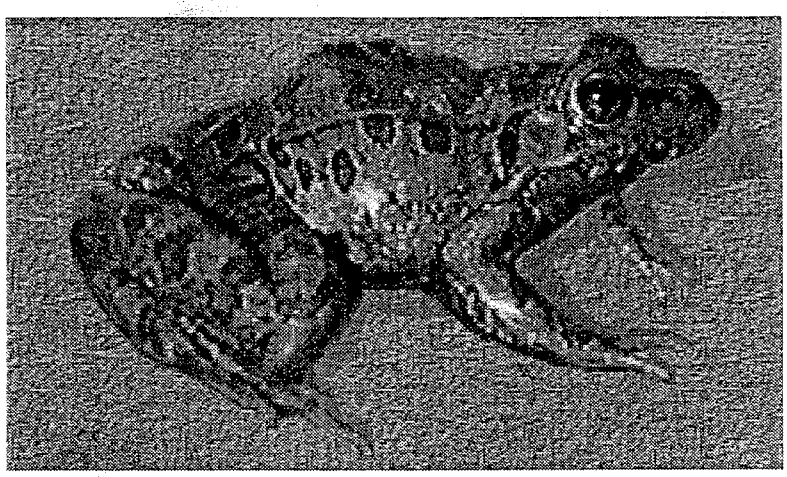
The data you gathered on the previous page appears here

Click here after you enter all of the values in the calculation fields

Enter the measured length of each organ above the divisor lines

Enter the total length of the digestive tract below the divisor lines

BioLab•Frog



Activities

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BL-01-5123-1

Breathing Rate

Name: _____

Date: _____ Period: _____

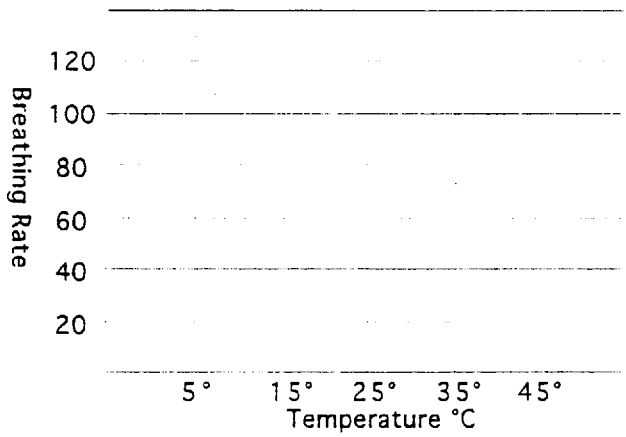
Purpose:
To determine the effect of temperature variation on the breathing rate in frogs.

Procedure:
The breathing rate in frogs can be determined by counting the times the floor of the mouth drops in a minute. Record the breaths in the data table below. Use the slider to change the temperature.

Data:

	Temperature °C			
	5°	15°	25°	35°
Breathing Rate				

Analysis:
Graph your results.



Conclusion:

1. Describe the relationship between temperature and breathing rate.

_____

_____

2. What would you expect the breathing rate to be at 20°C? _____
3. What would you expect the breathing rate to be at 40°C? _____
4. What temperature would cause the frog to breathe at a rate of 70 breaths/minute? _____

Alimentary Canal

Name: _____

Date: _____ Period:

Purpose:
The alimentary canal is the tube in which food is digested and absorbed. You will determine the length of each of the organs in this tube.

Procedure:
Grab the metric ruler and use it to measure the length of each of the organs in the alimentary canal. Measure their length to the nearest centimeter and record it in the data table below.

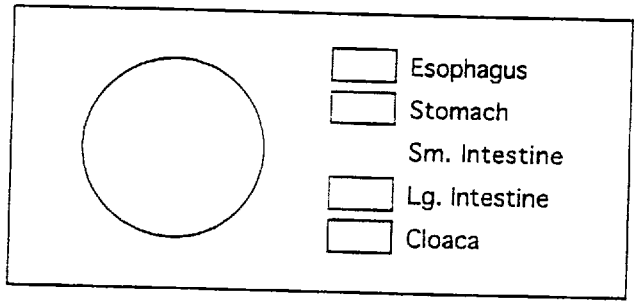
Data:

	Organ					
	Esophagus	Stomach	Sm. intest.	Lg. intest.	Cloaca	Total
Length(cm)						

Calculations: Use your data to complete the calculations.

$$\frac{\text{organ length}}{\text{total length}} * 100 = \text{organ's \% of length}$$

Esophagus _____ * 100 = %	Stomach _____ * 100 = %	Sm. Intestine _____ * 100 = %
Lg. Intestine _____ * 100 = %	Cloaca _____ * 100 = %	



Conclusion:

1. Which organs occupy the greatest and least percentage of the total length?

_____

2. Absorption requires more time than digestion. Based on your data, which organ is best adapted for absorption? Explain your answer.

_____

_____

Heart Rate

Name: _____

Date: _____ Period: _____

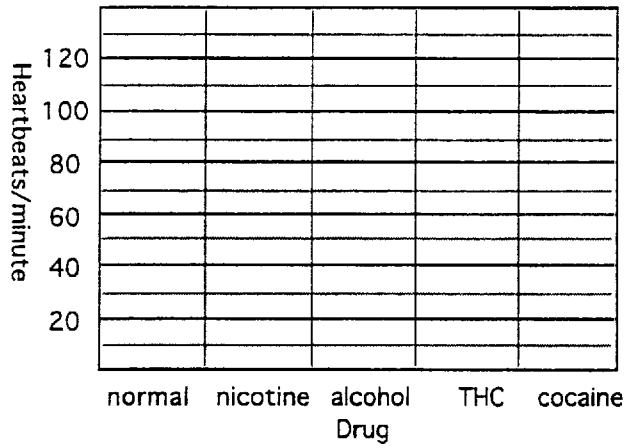
Purpose:
To determine the effect of various drugs on the heart rate in frogs.

Procedure:
Count the number of heartbeats in one minute to determine the normal heart rate. Then determine how each of the four drugs affects heart rate. Select a drug by clicking on a dropper. Then click on the beating frog heart. Record your data in the table below.

Data:

		Drug			
	Normal	Nicotine	Alcohol	THC	Cocaine
Heart rate					

Analysis:
Graph your results by making a bar graph.



Conclusion:

1. How did the different drugs affect the frog's heart rate?

_____

_____

2. A stimulant is a drug that increases physiological activity, such as heart rate. Which drugs would be considered stimulants?

_____

3. A depressant is a drug that decreases physiological activity, such as heart rate. Which drug would be considered a depressant?

_____

Muscle Contraction

Name: _____

Date: _____ Period: _____

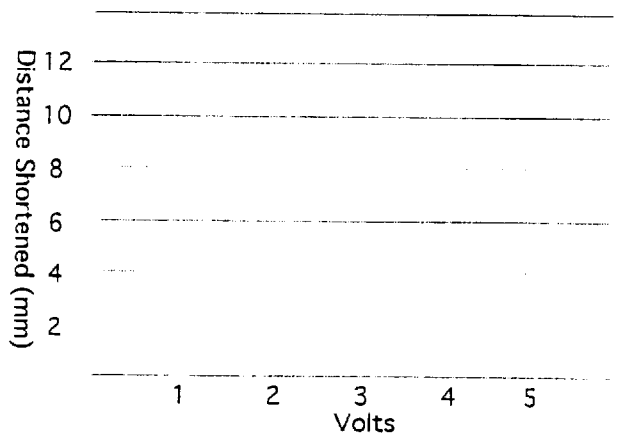
Purpose:
To determine the effects of electric stimulus on the intensity of muscular contraction. Also to determine the minimum and maximum electric stimulus needed to initiate the contraction of muscle tissue.

Procedure:
Grab the voltage slider and move it to the 1 volt position and click the shock button. If the voltage is strong enough, the muscle will contract. Use the gauge to the right of the muscle to determine the amount of contraction and record it in the data table. If the muscle doesn't contract, record 0. Continue this procedure until all five voltage levels have been tested.

Data:

	Volts				
	1	2	3	4	5
Distance Shortened					

Analysis:
Graph your results.



Conclusion:

1. What is the minimum voltage needed to stimulate a muscle? _____
2. At what voltage is the maximum contraction reached? _____
3. Describe the relationship between voltage and muscle contraction.

_____

_____

_____

4. What would you expect the distance shortened to be at 6 volts? _____

BIOLAB

FROG

Version 3.1 Supplement

Introduction

BioLab•Frog is now more powerful, versatile, and easier to use than ever before! Pierian Spring is very excited to present BioLab•Frog version 3.1, which can be used on both Windows and Macintosh computers.

This supplement will give you information on the features and program changes incorporated into BioLab•Frog 3.1. It is supplementary to the information presented in the User Manual, Read Me and Quick Reference CD-Insert. Please read this supplement for the latest information on the following features and topics:

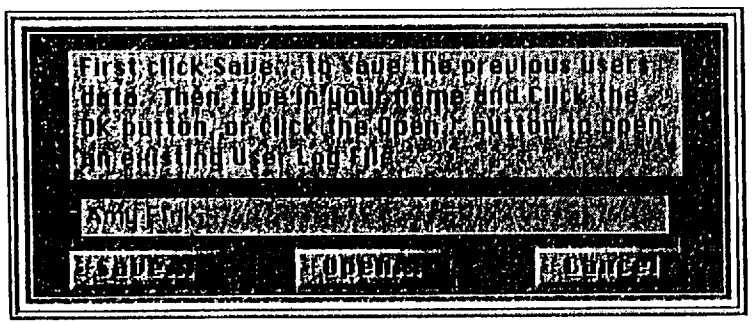
- **Logging In**
- **User Logs**
- **Data Log**
- **Preferences**
- **Navigation**
- **Program Help**
- **Tests and Activities**
- **Mini Lab Printing**
- **Circulatory System**
- **Quitting**

Logging In

When you launch BioLab•Frog, the program will prompt you to log in with your name. Simply type your name in the field and click OK. New users can also log in from within BioLab•Frog.

To log in as a New User from within BioLab•Frog:

1. Use the pop-up menu (the arrow icon) in the lower right corner of the screen to go to the Topics page.
2. Click the New User button.
3. Press Save... and enter a file name and location for the previous user's User Log. This will ensure that whoever was using the program before you has their data saved. Press Save.
4. Type in your name and click OK to log in.



If you have used BioLab•Frog 3.1 before and saved a User Log, you can open the saved log instead of logging in as a new user. To learn about the User Logs and how you can make BioLab•Frog remember what you have already completed when you return to the program, please read the information under User Logs.

User Logs

BioLab•Frog can remember what dissections each user has completed and what information has been entered in the Mini Labs. This information is stored in individual User Logs which each user can save and open each time he uses BioLab•Frog. When you quit BioLab•Frog or when another user attempts to log in, you will be prompted to save a User Log. This log saves the information you entered in the Mini Labs and remembers what dissections you have completed. To save your User Log when you quit BioLab•Frog or when a new user logs in, simply type a file name and choose a location where you would like to save your log. When you use BioLab•Frog again, you can re-open the saved User Log. This will reconfigure the pop-up menu to show what dissections you have completed and it will restore your data in the Mini Labs.

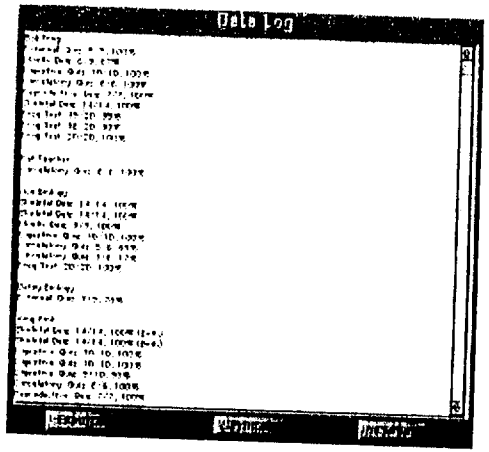
To open a saved User Log:

1. Launch BioLab•Frog or, to open a User Log from within the program, press the New User button on the Topics screen.
2. Press Open....
3. Locate your saved User Log and press Open.

This will open your User Log and allow the program to remember what you did the last time you used BioLab•Frog.

We recommend that teachers using BioLab•Frog in the classroom designate a specific folder or location where they would like students to save their User Logs. Within this folder, logs can be further organized into separate class folders or alphabetically divided folders. In addition, have students save their User Logs with their own name as a file name. With many students using the program, User Logs can accumulate and become difficult to find. Having a pre-arranged system for what to name the logs and where to save them will alleviate this problem and make saving and opening User Logs easier for the students.

Data Log



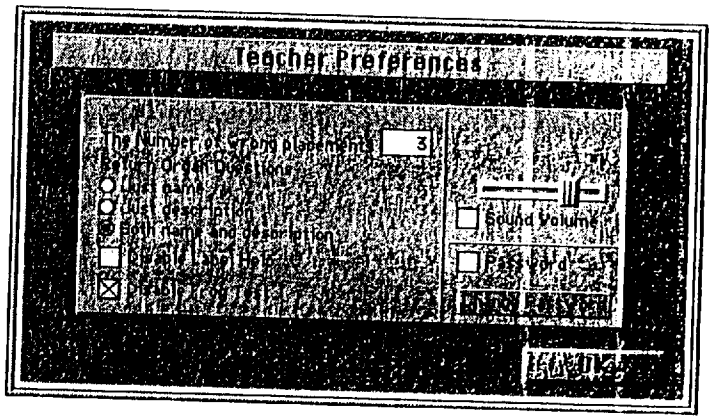
The Data Log stores the names and scores of each student who uses BioLab•Frog. To access the Data Log, click the Data Log button on the Topics page. The Data Log can be printed and exported to make reviewing and editing easier. To print the Data Log, simply open the Data Log, press the Print... button and then press Print from the print dialog. You can export the Data Log as a text file which you can open using other applications. To export the Data Log, open the Data Log, press the Export... button, designate a name and location for the file and press Save. Exporting the Data Log will allow you to clear scores from it when the Data Log becomes too large and ensure that all data is saved. The exported files can be viewed and edited by most word processing programs.

To Export and Clear the Data Log:

1. From the Topics page, press the Data Log button.
2. Press Export....
3. Designate a name and location for the text file and press Save.
4. Highlight names and scores you wish to delete from within the program Data Log and press the delete key.

This will keep the Data Log in the program clear of old scores so that it is easier to use within the program. You can open the saved text file from other applications to view or edit the scores. To close the Data Log and return to the Topics page, click the Close button.

Preferences

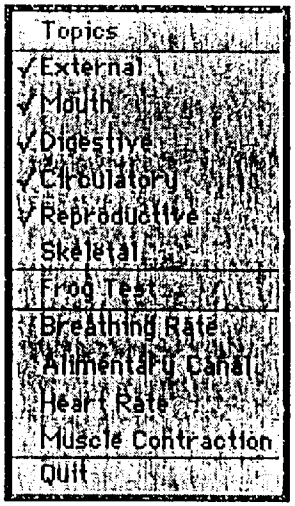


The Preferences allow you to customize BioLab•Frog for use in your classroom. Preferences can be accessed by clicking the Preferences button on the Topics screen. The Teacher Preferences allow you to set the number of incorrect organ placements accepted in the quizzes, designate the type of question used in the quiz, disable the Label Help, disable the Frog Test, adjust the program volume, and set a password which is needed to open the Preferences or the Data Log. The black backdrop is always present in BioLab•Frog. This keeps users from accessing the computer desktop.

To require a password to open the Preferences or the Data Log, open the Preferences from the Topics screen and put a check in the Password box. The default password is Frog. You should change the password to one of your choosing. To change the password, open the Preferences and press the Change Password button. Type in the old password and then enter your new password twice. This sets the password required to open the Data Log and Preferences to the new password you entered. If you are unable to remember your password, call Customer Support for assistance.

To ensure that students complete all six systems before advancing to the Frog Test, put a check in the Disable Frog Test box. To allow users to access the Frog Test at any point, remove this check.

Navigation



You can navigate through BioLab•Frog in whatever order you choose by using the pop-up menu. This menu is available by clicking the down arrow in the lower right corner of the program screen. From this menu you can navigate to the Topics Page, any Dissection, any Mini Lab, or the Frog Test. You can also quit BioLab•Frog from this menu.

Program Help

Help for BioLab•Frog is available in the User Manual, this supplement, the Quick Reference CD-Insert and the Read Me. The Read Me provides information on installing and launching BioLab•Frog on Macintosh and Windows computers.

Additional Teaching Materials

Tests and activities accompany BioLab•Frog and are available from the Documentation folder on your CD-ROM. The tests and activity pages can be opened and printed from there.

Mini Lab Printing

Blank print-outs of all four Mini Labs are available from the Documentation folder on your CD-ROM. These files can be opened and printed from there.

Circulatory System

The Circulatory System covers both circulatory and respiratory organs of the Frog. This dissection can be accessed by clicking the Circulatory button on the Topics page or by choosing Circulatory from the pop-up menu.

Quitting

You can quit BioLab•Frog by clicking the Quit button on the Topics page or by choosing Quit from the pop-up menu in the lower right corner of the screen. Using Command-Q on the Macintosh and Alt-F4 on Windows will also quit the program. When you quit, you will be prompted to save your User Log.

Customer Support

If you have any problems using this CD, contact Pierian Spring Software for technical support at:

Pierian Spring Software
5200 SW Macadam Ave.
Portland, OR 97201

Tel: (503) 222-2044
(800) 472-8578
Fax: (503) 222-0771
E-Mail: support@pierian.com

To learn more about Pierian Spring Software, visit our World Wide Web site at:
http://www.pierian.com

Vita

Colleen A Fitzgerald

Born: 2/23/68

255 Piermont Rd
Cresskill, NJ 07626

Bachelor of Science Degree - Elementary Education & Biology
The College of New Jersey (f/k/a/ Trenton State College)

Master of Arts - Subject Matter Teaching
Rowan University

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