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Integration of the BSCS 5E Instructional Method and Technology in an Anatomy and Physiology Lab

Tamilselvi Gopal
University of Southern Mississippi

The University of Southern Mississippi

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Tamilselvi Gopal

A Dissertation
Submitted to the Graduate Studies Office
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

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ABSTRACT

INTEGRATION OF THE BSCS 5E INSTRUCTIONAL METHOD AND TECHNOLOGY IN AN ANATOMY AND PHYSIOLOGY LAB

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This research provides an understanding of how the 5E instructional method combined with educational technology tools can be used in teaching undergraduate college level anatomy and physiology laboratory classes. The 5E instructional model is the exemplary instructional model in teaching biology for high school students. The phases in the 5E learning cycle are Engage, Explore, Explain, Elaborate, and Evaluate. In every step of the learning cycle, the researcher used appropriate technology tools to enhance the teaching and learning processes. The researcher used the Dynamic Instructional Design model to identify the appropriate technology tools for instruction. The topics selected for modification were 'The Heart' and 'The Vascular System.' The researcher chose these two topics based on results of the preliminary survey that the researcher conducted during summer 2008. The existing topics identified on the syllabus were followed but the teaching method was changed. In order to accomplish this, the researcher created a class Website and included tools including pronunciation, spelling, an Interactive Tool, and Web links. In addition, the researcher also created teacher resources for the Pronunciation Corner and Spelling Bee, so that any teacher can customize and use these tools for their classes. The results indicated that the students took advantage of the technology provided.

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TABLE OF CONTENTS

LIST OF TABLES

Table

LIST OF ILLUSTRATIONS

Figure

CHAPTER I

INTRODUCTION

Background

For the past four semesters the researcher has been teaching Anatomy and Physiology (BSC 250L) labs at the University of Southern Mississippi. This course is offered every semester for non-biology majors. The majority (~95%) of the students who take this course BSC 250L (Anatomy & Physiology lab) are community health, nursing, dance, exercise science, or coaching majors, for which the course is required. The one credit hour lab course meets once a week for two hours. In Spring 2009, there were about 21 students in each section. One hundred and sixty five students were enrolled and the researcher was teaching three sections of the eight. Usually, there are approximately 160 students enrolled in the lab every semester. These students also take the Anatomy and Physiology lecture course, but it is not necessary for them to take both lecture and lab in the same semester.

Anatomy and Physiology of human beings involve many scientific terms. The BSC 250 L Anatomy and Physiology lab requires students to understand the structure and function of human systems such as histology, integument, muscular, respiratory, circulatory (cardiovascular), and skeletal systems. The anatomy part of the course requires students to identify structures of the organs. The physiology part of the course requires students to answer questions based on the function of the organs and organ systems. For final grades, we (the instructors) assess students' learning in three different stages and they are finally converted into percentages.

The following are the three stages:

1. Anatomy lab practical (60%) – 2 Practicals
2. Physiology quizzes (30%) – 4 Quizzes
3. Journal entries (10%) – 30 Entries

This study was designed for the anatomy part of the lab. Each lab practical covers three lab exercises. Lab practical I included Histology, Integument System, and Skeletal System. Lab practical II included Muscular System, Respiratory System and Cardiovascular System exercises. The research was carried out during the Cardiovascular System part of the course which appeared in the second lab practical. The Cardiovascular System consisted of two sections: the Heart and the Vascular System. These two sections are usually taught in two lab periods. This study followed the existing syllabus and modified only the instructional method of the Cardiovascular System (See Appendix A). The distribution of points in Practical II follows:

1. Muscular System - 34%
2. Respiratory System - 16%
3. Cardiovascular System - 50% (Heart & Vascular System)

The 5E Instructional Model is based on an inquiry method which is used and recommended by the Biological Sciences Curriculum Study (BSCS). The BSCS 5E instruction emphasizes a guided inquiry approach. The learners in 5E instruction experience a 5E cycle that carefully structures their learning (Bybee et al., 2006a). The former BSCS Executive director, Rodger W. Bybee states that BSCS 5E Instructional Model meets the criteria for integrated instructional units as outlined in National Research Council (Bybee, 2006).

Science and Technology is one of the eight categories of Content Standards mentioned in the National Science Education Standards (NSES) (NRC, 1996). An article on the 'Pedagogy and technology integration' states that technological tools, theories about technology integration, and recent research findings are the key elements in technology integration. The author further added that technology used for teaching and learning should be an integral part of the instruction and it should not stand out in the instruction (Okojie, Olinzock, & Boulder, 2006).

The NSES emphasizes the importance of science teaching in the statement "effective teaching is the heart of science education" (NRC, 1996). Science instruction should provide a conducive environment for the learners to learn actively. In the present school setting, computers are moved from laboratories into classrooms and the Internet has become mandatory for teaching and learning (Gershner & Snider, 2001).There are many online and offline technologies that allow teachers to create interesting, and at the same time useful, teaching and learning environments in the classroom.

Considering the above facts, the researcher believed that technological tools would help achieve the goals of Anatomy and Physiology instruction. The researcher also thought that BSCS 5E learning cycle would provide a common ground to start building technology incorporated instructional tools. This research was implemented to determine the effect of changing the instructional method during the Cardiovascular System portiuon of the Anatomy and Physiology lab.

Statement of the Problem

In the anatomy part of the class, students need to identify and write the correct spelling of scientific terms. First of all, they should know how to read and pronounce

these terms. If a student knows how to pronounce scientific terms properly, the chances of getting the correct spelling are higher (Montvilo, 2009). Thus, pronunciation plays a vital role in learning anatomy and physiology content. In the article 'learning to read and learning to spell are one and the same, almost' the author (Ehri, 1997) concluded that reading practice sets up word-specific representations which further support spelling those words. The same author suggested that spelling instruction could help design learners to better understand the relationship between letters and sounds which would result in better reading (Ehri, 2000) . Conrad determined that transfer between reading and spelling occurs in both directions (Conrad, 2008).

Learners should be provided with opportunities in which they can interact as opposed to being treated as passive listeners. Cuthrell identified that instruction that incorporates more interactive technological strategies enhances student learning (Cuthrell, 2007). Park argues that an online interactive learning environment makes the learners interactive-participants. Being interactive participants, the learners are actively engaged in the learning process (J. Y. Park, 2008). He further added that in an interactive learning environment, the students are not identified as receivers but as participants; not as consumers but as producers; not as examinees but as examiners.

In the present instructional method, course instructors use charts, models, and mannequins in teaching the Cardiovascular System. The learners are treated as passive listeners. As described in the text (p.225), 'Teaching Science for Understanding,' "All the resources of the Internet are available to science teachers; the challenge is to find ways to use them wisely" (Mintzes, Wandersee, & Novak, 1998). The above statement was identified to be compelling in teaching biology to non-biology students, so the

researcher also wanted to include relevant and useful Web Resources in the Cardiovascular System tool so that diverse learners are benefited.

Purpose of the Study

An instructional method helps the teacher to transfer knowledge and skills to the students in order to achieve the objectives of the teaching-learning process. Technological tools are believed to help teachers construct the instructional method (Lei & Zhao, 2007). Selection of appropriate technological tools is essential for the desired knowledge transfer to take place (Duffy & Mcdonald, 2008). Teaching Anatomy and Physiology to non-biology students can be made more effective by incorporating technology tools into the present instructional method.

Students need to have meaningful learning which will help them in their future careers. In this study, a class Website was designed incorporated with Interactive Tools for the Cardiovascular System to facilitate new ways of teaching. This learner-centered Interactive Tool helps students to understand and appreciate the material they learn and ultimately helps them obtain better grades. Research conducted with Information and Communications Technology course students focused on effectiveness of Web-based resources from a student perspective concluded that students had positive feelings about the Web-based resources in their learning (Napthine, 2006). The students also pointed out that Web-based resources had the potential to support them even further. In the text How People Learn (Bransford, Brown, & Cocking, 1999) under 'Technology to Support Learning,' the effect of Interactive-technology in learning is described as follows:

> *The interactivity of these technology environments is a very important feature for learning. Interactivity makes it easy for students to revisit*

> *specific parts of the environments to explore them more fully, to test ideas, and to receive feedback. Noninteractive environments, like linear videotapes, are much less effective for creating contexts that students can explore and reexamine, both individually and collaboratively.*

John Dewey, a pragmatist educational philosopher emphasized 'learning by doing' in his learning theory (Dewey, 1916). As stated by Dewey, students learn the material through the consequence of direct experience when they interact with the learning material. Instructors can provide a variety of learning opportunities for students to maximize their learning. In the Anatomy and Physiology course, if students are given a chance to interactively hear and test the spelling of the scientific terms, practice and test the identification of the Heart and the Vascular System until they get them correct, and use relevant and useful Web-resources in one central place that would help them learn the material this may assist in their learning and retention of this information.. This study was designed to provide instruction through technology for this purpose.

Research Questions

This study investigated the following research questions in order to measure the effect of a modified instructional method in students' learning. The research questions are as follows:

1. What is the difference between the mean scores of the control and the experimental groups on the Cardiovascular System portion of the second lab practical?
2. What is the difference between the mean scores on the Cardiovascular System portion of the second lab practical that were taught by different teachers?

3. Is there any interaction between the group and the teachers on the Cardiovascular System portion of the second lab practical?

4. What is the difference between the mean scores of the control and the experimental groups on the Non-Cardiovascular System portion of the second lab practical?

5. What is the difference between the mean scores on the Non-Cardiovascular System portion of the second lab practical that were taught by different teachers?

6. Is there any interaction between the group and the teachers on the Non-Cardiovascular System portion of the second lab practical?

Program Evaluation

This study also obtained student feedback to assess the instructional method. The following question was raised to understand the effectiveness of the modified instructional method from the students' perspective.

1. How does student feedback help assess and improve the instructional method?

Hypotheses

In order to investigate the above research questions, following hypothesis were proposed.

Hypothesis (1): There will be a significant difference between the mean scores of the control and the experimental groups on the Cardiovascular System portion of the second lab practical.

Hypothesis (2): There will be a significant difference between the mean scores on the Cardiovascular System portion of the second lab practical that were taught by different teachers

Hypothesis (3): There will be a significant interaction between the groups and the teachers on the Cardiovascular System portion of the second lab practical.

Hypothesis (4): There will not be a significant difference between the mean scores of the control and the experimental groups on the Non-Cardiovascular System portion of the second lab practical

Hypothesis (5): There will be a significant difference between the mean scores on the Non-Cardiovascular System portion of the second lab practical that were taught by different teachers.

Hypothesis (6): There will not be a significant interaction between the group and the teachers on the Non-Cardiovascular System portion of the second lab practical.

Definition of the Terms

The following are the definitions of the words used:

1. Intervention - Teaching the Cardiovascular System to the BSC Anatomy and Physiology lab students using the class Website.
2. Performance - The points earned by the students for a total of hundred in the second lab practical test.
3. Technology tool - A class Website that had a pronunciation tool, a spelling tool, an Interactive Tool, and Web-resources.
4. Traditional method - Teaching the Cardiovascular System using a chart of the Vascular System, mannequin, and model of the Heart.
5. Modified instructional method - The instructional method that combines the 5E instructional method with technology tools such as Pronunciation Corner,

Spelling Bee, Interactive Tool, and Web Resources in a class Website to teach the Cardiovascular System.

6. Control group - The classes that received the traditional instructional method which used the chart, models and mannequins for the Cardiovascular System.
7. Experimental group - The classes that received modified instructional method which used the tools such as Pronunciation Corner, Spelling Bee, Interactive Tool, and Web Resources for the Cardiovascular System.

Objectives of the Modified Instructional Method Module

1. To teach anatomy and biology students in an effective way using the 5E learning cycle.
2. To help students understand the scientific content they learn in the lab class.
3. To incorporate the appropriate technology tools to maximize student learning.
4. To teach students how to pronounce and spell correctly the scientific terms of Cardiovascular System.
5. To help students practice and test the Heart and the Vascular System interactively.
6. To carefully select and present the Web-resources that are relevant and useful for the Cardiovascular System.
7. To create technology tools like customizable Pronunciation Corner and Spelling Bee for any subject teachers to use in the future.

Justification of the Study

There are three main reasons for the development of this study. Each reason is further elaborated upon. The justifications for conducting this study are:

1. Preliminary study

2. Non-biology majors
3. Lack of appropriate technology tools used in instruction of BSC 250L.

Preliminary Study

During summer 2008 Anatomy and Physiology lab instructors and students were surveyed for a preliminary study. The questionnaires are attached (See Appendix B, C). Fifty-five students from four sections taught by three different instructors returned the survey. The survey was conducted to identify which anatomy topics students found difficult to understand within the anatomy content. The questionnaire consisted of three questions for both instructors and students to answer. The questions for the instructors included how many years they had been teaching this Anatomy and Physiology lab course, which one topic they found easy to teach, and which one topic they found difficult to teach. The eight anatomy topics were listed for them to circle. The questions distributed to students included identification of degree major, one topic they found easy to understand, and one topic they found difficult to understand. Students were also given the list of eight anatomy topics from which to choose. Students were surveyed on the final day of their Anatomy and Physiology lab summer class. Instructors were surveyed during the last week of the class.

Out of fifty five students, three students did not read the question properly and circled all the topics; two students circled more than one easy topic. Similarly, three students circled no topic as difficult and four students circled more than one topic. These responses were not included in the analysis. Simple bar graphs and pie charts were developed to represent the topic that the students and instructors found easy and difficult to understand. A frequency table was formed to see how many students chose the same

topic to be difficult or easy (See Table 1). Frequencies were converted to percentages in order to normalize the data

Table 1

Response of Students to Easy and Difficult Topics in the Anatomy

	Percentage	
Topics	Easy	Difficult
Histology & Membranes	2	19
Integument	18	8
Human Axial Skeleton	12	6
Human Appendicular Skeleton	6	10
Musculature	39	6
Respiratory System	8	8
Human Heart	16	21
Vascular System	0	21

Among four classes, two classes were taught by the same instructor and the other two classes were taught by two different instructors. Among fifty five students 39% of the students found 'Musculature' as an easy topic; and none found the 'Vascular System' as an easy topic. In addition, 21% of the students found both the Human Heart and Vascular System as their difficult topics.

Based on the analysis, 21% of the students found the Heart and the Vascular System difficult topics to understand and 19% of the students found Histology & Membranes as their next most difficult topics. It also became evident that the instructors

also found the Human Heart and Vascular System (Circulatory System) difficult topics to teach (See Table 2). Considering the response of both students and instructors, it was decided to modify the present instructional method of teaching the Cardiovascular System.

Table 2

Response of Instructors to Easy and Difficult Topics in the Anatomy

Teaching Experience	Easy to Teach	Difficult to Teach
4 Years	Human Appendicular skeleton	Histology & Membranes
1 semester	Musculature	Human Heart
2 semesters	Human Heart	Vascular System

Non-biology Majors

Scientific terms are generally based on the structure or function of the organs and organ systems and are derived from Greek or Latin words. Students find it difficult to read and write scientific terms. They hear these terms only in the class and do not have the opportunity to hear the pronunciation frequently. Even if the students pay attention in class, they find it difficult to remember how to pronounce the scientific terms. Students do not have a chance to explore the learning material before or after the scheduled lab class. Moreover, the majority of students are non-biology majors, so they do not hear or see the same resources in any other class. Here it is proposed that the instruction could be modified in such a way that learners can *practice and test* the pronunciation and spelling of the scientific terms, and *identification and testing* of the Cardiovascular System

structures. It is also proposed that the modified instructional method could promote a deeper understanding by incorporating technology tools in teachings.

Lack of Appropriate Technology Tools Used in the Instruction of BSC 250L

Technology resources, especially Internet resources, have become an integral part of everyday life, and undoubtedly, the media influences the way students learn and teachers teach (Lowerison & Sclater, 2005). If tools of the pedagogical cycle are identified and selected properly, this will help promote and support effective instruction (Okojie et al., 2006). It was decided to incorporate technological tools into the instruction. The resources that were selected were believed to address the individual needs and different learning styles of the students. The instructional method that was developed included tools to enhance students' pronunciation and writing of the scientific terms on the Cardiovascular System.

Research Design

The design of this study required a comparison of the performance of the control group against the experimental group. Therefore, quantitative measures were used to determine if the intended learning had taken place. The performance in terms of the mean score in the second lab practical was compared between the control and experimental groups. The Instruction of the Cardiovascular System was modified in the experimental groups. The experimental group students received the modified instruction. The control group students received the traditional instruction. The effect of the program was also evaluated from the students' perspective. During the second lab practical experimental students were asked to fill out questionnaire. The responses to the questionnaire were coded to evaluate the effect.

The Present Study

Changes were made changes in the teaching method of the Cardiovascular System to observe if the modified teaching method had any influence on students' test performance. In order to make changes in the teaching method, a class Website was developed with all the above mentioned features to teach the Cardiovascular System. It is important to have a good understanding of what possible technologies have been used in the recent past to design the modified instructional method. The next chapter reviews the related literature in the integration of science and technology in instruction.

CHAPTER II

LITERATURE REVIEW

Technology in Education

Scientifically literate people understand the interdependence of science, mathematics, and technology (AAAS, 1993). Science and Technology Standards in the NSES (p. 107) outlines the relationship between Science and Technology as "Science as inquiry is parallel to technology as design" (NRC, 1996). Students are getting hands-on and minds on experience in science through the medium of interactive computer-based environments, which in turn help acquire deeper understanding of science (Bransford et al., 1999).

Technology in education has gained importance due to dramatic changes that technological innovations have brought to all aspects of society (Erekson & Shumway, 2006). The educational system is responsible for providing technology-supported learning opportunities to help students cope with technology advancements. Implementing a technology-based curriculum provides opportunities for students to develop skills and knowledge necessary to live in a technology-driven society. Technology integrated instructional methods helps transfer knowledge and skills to students (Park, 2006). In order to understand how technology fits into the curriculum, educators have to become aware of all technologies available.

Educational technology offers a variety of technology tools to help students understand the learning material. Educational technology ensures quality education if tools are selected appropriately. Duffy and Mcdonald define educational technology as "the theory and practice of design, development, utilization, management and evaluation

of processes and resources for learning (Duffy & Mcdonald, p. 5)." The authors also added that educational technology could include any resource or process that promotes students' understanding. The selection of appropriate technology tools for teaching rests with the instructors. If the quality of technology used is not taken seriously, it may cause more harm than benefit. Computer use in school curriculum was believed to provide a favorable learningenvironment especially for girls. Luckson analyzed students' gender differences in learning using computers in secondary schools. He found that though there was a gender difference in anxiety in learning and usefulness of computers in learning, there were positive effects on learning with computers (Kaino, 2008).

Many researchers have argued that technology tools positively influencing students' achievement. For example, a research paper that evaluated the effectiveness of a seven-year, Technology Enhanced Secondary Science Instruction (TESSI), concluded that TESSI encouraged greater student enrollment, retained senior science electives, and prepared students for post-secondary education and the realities of an information-based workplace (Woodrow, Smith, & Pedretti, 2000). Therefore, integration of technology into biology is also believed to increase students' understanding of science concepts and help them apply what they learn to their real lives. Interactive technology environments are an important feature in student learning (Bransford et al., 1999).

Pronunciation and Spelling in Instruction

Learning a subject other than their major is difficult for students. Having to write the exact terms of a different subject is also difficult. Many research findings identified that reading, spelling, and writing are strongly related to each other. Moats (2005, p.12) says that "Even more than reading, writing is a mental juggling act that depends on

automatic deployment of basic skills such as handwriting, spelling, grammar, and pronunciation." No wonder the students of Anatomy and Physiology courses feel that it is difficult to spell and pronounce the scientific terms. The same author states that learning to spell facilitates students' writing and reading. In another article (Snow, Griffin, & Burns, 2005), the authors state that "Spelling and reading build and rely on the same mental representation of a word. Knowing the spelling of word makes the representation of it sturdy and accessible for fluent reading" (p. 86). A professor who teaches the fundamental concepts of biology (Montvilo, 2009) emphasizes the importance of spelling and reading in his course Website. He says that pronunciation and spelling do count in biology since a single misplaced letter could change the whole meaning. He further added that learning correct spelling and pronunciation requires attention and conscious effort.

Considering the above facts, it was proposed that instruction should include a place for the students to learn and practice scientific terms in a Drill and Practice tool. It was also proposed that an Interactive Tool be available for students to practice at any time. In this research, the researcher decided to provide tools for the students to practice the pronunciation and spelling on the Cardiovascular System Website. Though there are a number of pronunciation and spelling tools available on the Internet, teachers do not have a choice to make one with vocabulary of their own choice. With the development of this research, the researcher wanted to provide a tool for the teaching community that automatically generates the same type of output for Pronunciation Corner and Spelling Bee as the research used.

Web-based Instruction

Recently schools have been urged to move from the generation of using technology to the generation of thinking with technology (Gershner & Snider, 2001). Web-based instruction has become an integral part of biology and it is necessary for every biology teacher to know how to use the appropriate technology for instruction. Web-based resources are effective in supporting student learning and Web-based technologies are increasingly being used in schools to support teaching and learning (Napthine, 2006). One of the primary assets of Web-based instruction is its ability to adjust to individual learning preferences (Harris, Dwyer, & Leeming, 2003). A study found that student evaluations of Web-based political modules indicates that Web learning adds value to the teaching and learning process and helps to develop the necessary intellectual and personal transferable skills (Harris et al., 2003) . In his article 'The Interplay of Biology and Technology,' the author states (p. 10051) that "biologists now operate in a time when technology is not merely appreciated but acclaimed (Fields, 2001)." Engaging students in problem-solving activities will expose them to deeper insights into various conceptions of the natural world and will help them develop insight into professional practice of scientists (Stewart & Rudolph, 2001).

A study that explored the learning effect related to various learning styles in Web-based virtual science lab reported that students who used an online virtual lab scored better grades than who received traditional method. The authors further added that Web-based virtual learning environments are suitable for students with different learning styles (Sun, Lin, & Yu, 2008). The real advantage of using Web-based education is the advantage of immediate access to the additional information on a topic via Web-links to

other resources (Zahorian, Smart, Lakdawala, Leathrum, & Gonzalez, 2000). Many research findings in various disciplines support the fact that Internet-integrated instruction plays a significant role in motivating students to learn. Online instructional strategies are now available to teachers in order to develop programmed instruction. In the popular online reinforcement tool 'Drill-and-Practice,' activities are available for teachers to offer structured reinforcement of previously learned concepts to their students. This software is based on behaviorist theory which helps students' master basic skills. Virtual realities are also being increasingly used in elementary, middle schools, high schools and undergraduate level biology courses (McNeese, Herron, & Sulbaran, 2008; Sun et al., 2008). Students are attracted to learn when virtual realities are used in the class (Mickell & Danner, 2007). The Virtual Courseware was used to teach an activity on the *Genetics of Inheritance using Drosophila* (Desharnais, 2007) . They also recommended ten design principles to help develop a virtual courseware for any science teacher. They further added that Web-based simulations can be an effective and convenient way of incorporating more inquiry-based learning. An attempt was made to teach Speech Mechanism using computer-based, stereoscopic images while studying Human Anatomy (Perry, Kuehn, & Langlois, 2007).

Many teachers in colleges are trying to incorporate technology tools in their teaching. Blog space was used in an undergraduate mathematics and computer science courses (Glass & Spiegelman, 2007). A pilot study on the Health Education faculty usage of You Tube as a teaching resource assessed that You Tube was an effective teaching resource for enhancing their understanding of health education course material (Burke, Snyder, & Rager, 2009).There are findings that support computer assisted

instructions as improving student achievement. For instance, a report on 'The Impact of Education Technology on Student Achievement' concluded that computer-assisted instruction led to positive gains in achievement on researcher-constructed tests, standardized tests and national tests in fourth and eighth grade students (Schacter, 2007).

The above discussed research papers helped to develop ideas about the type of technology tools that have been used in various majors and in biology by other instructors. They motivated the researcher to focus on the incorporation of online-based instruction in the Anatomy and Physiology lab. Moreover, it was decided to provide online tools for the students to interact with the learning material outside the class and practice the learning material. The researcher also wanted to use resources on the Web for instruction. So, the Web Resources were compiled that are relevant and useful for students to understand the Cardiovascular System.

BSCS - 5E Instructional Model

The Biological Science Curriculum Study (BSCS) is a team involved in curriculum development. The BSCS Executive Summary (2006) states that since 1980s the BSCS curriculum follows the 5E Instructional Model. As explained by Johann Herbart, who laid the foundation for 5E model in the early 20th century, the best pedagogy allows students to discover relationships among their experiences and the teacher gives direct instruction and explains ideas that the student would not discover by himself. The teacher also provides opportunities for the student to demonstrate his/her understanding. Instruction should encourage students to discover principles by themselves (Bruner, 1947). According to Bruner's learning theory the curriculum should be organized in a spiral manner so that the student continually builds upon what they

already learned. In 1930s, Dewey's instructional model recommended the following phases: sense a perplexing situation, clarify the problem, formulate the hypothesis, test the hypothesis, revise the tests, and act on solutions. Such constructivist perspectives are the basis of the 5E Instructional Model (Bybee et al., 2006b).

The former director of BSCS, Rodger W. Bybee helped develop an instructional model based on the constructivist philosophy of learning called the 5E Instructional Model. Engage, Explore, Explain, Elaborate, and Evaluate are the 5E's that constitute the BSCS model (Barufaldi, 2002). The BSCS 5E Instructional Model is one of the most respected instructional tools for teaching high school biology and is based on inquiry-learning. This method encourages students to view biology as relevant and important to their lives.

The BSCS 5E model promotes a learning environment that provides opportunities to explore and investigate as a way to understand new concepts. BSCS produces textbooks and modules that emphasize collaborative learning to help students develop skills such as debate, discussion, writing, drawing, presenting thoughts, and social skills (Wolf, 2003). The following steps are involved in the BSCS 5E Instructional Model:

1. *Engage* - This phase of instruction engages students with questions and creates curiosity. This also helps the teacher assess students' prior knowledge about the content.
2. *Explore* - In this part, students are encouraged to work and explore the ideas without any direct instruction. Students gather data to make predictions. Teacher provides students time to work and give them directions if necessary.

3. *Explain* - At this stage of instruction, the teacher encourages learners to explain what they have learned and introduces new terms, ideas, and explanations.
4. *Elaborate* - In this phase, the teacher encourages learners to apply the new knowledge to investigate further and helps students practice the new knowledge.
5. *Evaluate* - The teacher observes students' performance and products to assess their understanding. Students are expected to apply their new knowledge and skills as they give presentations .

BSCS instruction is not only appropriate to teach high school biology students, but also to the introductory college level courses. The basic concept of the BSCS 5E instruction is to involve students in the learning process. The teacher asks questions or engages in activities to create curiosity about the topic among students; allow students to explore the material; provides students a chance to explain their understanding; encourages students to apply the new knowledge, and finally evaluates their understanding. On the one hand this type of cyclic events in instruction helps the teacher to refine his/her instruction, and on the other, helps the students to improve their understanding. Taken together, it was decided that the use of the BSCS 5E instructional method would be appropriate to design and develop the *class-Website integrated Cardiovascular System* instruction.

DID Model

Technology-integrated instruction in teaching biology plays a central role in providing opportunities for students to experience scientific methods and understand scientific concepts. The dynamic instructional design model (DID model) is a flexible system for designing instruction. The DID Model helps improve the quality of instruction

for both students and teachers. This design offers flexibility and allows adjustments for continuous improvement based on formative feedback in the planning stage of the instructional system (Duffy & Mcdonald, 2008). Each element of the process is designed to attain maximum effectiveness. The DID model was used to find the appropriate tool for teaching Anatomy and Physiology topic, the Cardiovascular System.The following are the elements involved in the DID model:

Know the Learner - The teacher should design instruction or adjust instruction based on knowing the learners' learning styles, developmental stage of the learner, and assessment of learners' skills. The teacher should make sure that the instructional plan meets the needs of the learners.

1. *State the Objectives* - The teacher should plan instructional objectives to target learners' performance and different levels of critical thinking. The teacher should make sure that the instruction teaches the content that the learners need to learn.
2. *Establish the Learning Environment* - The instructional plan should provide a positive learning environment for the learners. The teacher should make sure that the learning environment promotes student learning.
3. *Identify Teaching and Learning Strategies* - Instructional design should address all of the components of the pedagogical cycle and a variety of teaching methods to reach diverse learners. The teacher should ensure that the instruction is effective in meeting the objectives.
4. *Identify and Select Technologies* - The instruction should include technologies that are appropriate to the content and pedagogy. The instruction should also include a variety of technologies to cater to different learning styles. The teacher

should make sure that the selected technologies are supporting the teaching-learning process.

5. *Perform a Summative Evaluation* - The instructional design should include assessment techniques to measure the expected outcome. The teacher should ensure that the evaluation techniques are valid and reliable in measuring students' achievement.

The DID model helped the researcher to identify what technologies could be used in different phases of the learning cycle.

How BSCS 5E Model and DID Model Fit into Standards (NSES)

National Academy of Science developed the National Science Education Standards (NSES) in 1996. NSES sets goals and objectives for K12 science education and this is the most widely used science standard in the United States. In 1989, the Science for All Americans developed *Benchmarks for Science Literacy* to reform K12 science, mathematics, and technology education (AAAS, 1993). NSES and Benchmarks for Science Literacy emphasize scientific inquiry. Scientific inquiry is the ability to ask scientific questions. The NSES encourages teachers to plan and conduct investigations, use appropriate tools, techniques, and educational technologies, which would subject students' to think critically and logically (Trowbridge, Bybee, & Powell, 2003). The objectives of science teaching as described in NSES and Benchmarks emphasize students' performance. NSES also asserts that the ultimate goal of science education is to produce competent students with respect to knowing, comprehending, applying, analyzing, synthesizing and evaluating (NRC, 1996).

The DID model design emphasizes the critical components necessary to design effective instruction. The DID model emphasizes both formative and summative evaluation to ensure that every step of the instruction works efficiently. BSCS now correlates its curriculum development with the NSES and an inquiry approach is the basis for the 5E instructional design. The national field-tests of BSCS curriculum modules show significant evidence of student learning. This is a proven model in biology instruction (Bybee, 2006). BSCS 5E instruction and DID model share many characteristics as outlined in NSES. The DID model could help a teacher to pick the correct technology tools to design courses around the BSCS 5E instructions. So, with the help of the technology tools, it was decided to use the 5E instruction for the Cardiovascular System to achieve maximum performance.

Ways to Include Technology in the 5E Learning Cycle

Teaching biology using the 5E learning cycle can easily be achieved with the incorporation of technology in every step. The DID model can help educators achieve that objective.

Engage

A teacher can use images, video clips or animations to raise questions or problems to engage students in the learning task. The teacher's duty at this stage is to elicit interest and curiosity which could be initiated using several audio-visual technologies. The teacher can also assess students' previous knowledge. Audio media like audiocassettes, IPods, pod casts, and radio could also help stimulate interest among students. The digitizers could also be used to draw pictures on the graphic tablet and projected onto the

screen to create interest and promote stimulation and interactivity in learning the material.

Explore

At this stage, students explore objects, events or situations and the teacher encourages students' responses by giving positive comments or suggestions. In this manner, the teacher acts as a facilitator. Exploration activities allow students to interact and observe interactions that center around the learning task. Teachers could use scanners to convert hard copies of images into digital images developed by the students. Students could be given any type of handheld device to collect and record data that would later be saved into a database for further exploration. Digital cameras are another useful technology tool to help students gather and collect data to share. To teach an ecology lesson, for example, a digital camera would be an appropriate tool to capture images of various ecosystems that could later be uploaded to a Web page for peer feedback and assessment. Later, these images could be used for teaching the concepts in a classroom environment.

Explain

The teacher directs students' attention to specific aspects of the first two experiences (Engage and Explain of the 5E). The teacher encourages students to explain what they observed in their own words. The teacher accepts all reasonable answers and builds information from the students' responses. Thus, the informal language is converted to formal language at this stage. Teachers could use computers to help with the pronunciation of vocabulary terms, use electronic whiteboards to develop ideas from the responses given by students, and create concept maps on the computer to stimulate

discussions. For example, to teach the topic of respiration, a teacher could collect information from the students' responses to specific questions and write them on the digital whiteboard as part of a brainstorming activity. The discussion ensued from this activity could be saved into a digital file or printed as notes for students to review.

Elaborate

In this step, the teacher encourages students to apply the concepts and skills to new situations. In this case, students would use previously acquired knowledge to apply to the new situation. Then, students would draw reasonable conclusions from the data gathered. For the respiration example, lungs, skin, voice box, heart, oxygen, and carbon-dioxide are some of the keywords that are obtained from the students that could be elaborated upon using a concept mapping software to explain the relationships between various body parts and elements. This scenario could also be integrated into a video clip that is shown at the beginning of the class to stimulate discussion and elaboration. Thus, the teacher provides opportunities for students to practice their learning in new contexts. Another form of technology to help in this stage is using drill-and-practice-software to reinforce concepts learned and using simulation software to help students explore authentic situations.

Evaluate

In this step, the teacher assesses students' knowledge and skills that are associated with understanding of a new topic. The teacher provides opportunities for students to self-assess their learning in order to further improve their understanding. The students are required to demonstrate their understanding of a new concept in this stage. Students observe and answer questions posed by the teacher. They also self-evaluate and self-

monitor their performance. Teachers could use spreadsheets as a tool in this process as students create charts and graphs to show their performance in accomplishing the task (Okojie et al., 2006). Online tools and offline tools could also be used in evaluation. For example, the tool 'word-track' could also be used in evaluation which is one of the features of word document-editor that enables easy evaluation for the teacher to do and students' to understand as well.

Examples that Demonstrate the Use of 5E Instruction in Biology Classrooms

Researchers are trying to identify technologies that promote students' scientific understanding, activities, and practices that foster students' inquiry processes and methods. Developing various technological skills in order to meet the educational challenges that are facing present day students is imperative. These skills help them understand and accept changes as they occur. The following two examples demonstrate how technology can be integrated into 5E learning cycle in teaching biology classrooms:

1. An article described a way to incorporate 5E instruction in teaching human digestion and pH using pH sensor technology. The author explained the technologies that could be used in every step of the 5E instructional method to improve the teaching of the concept of pH. The author added that the educators should be aware of present technologies, so that they can understand and take advantage of the ways that it could facilitate the learning environment and experience (Kim, 2008).

2. Another article explained a high school class project on Ecology that used the 5E instructional method. As part of this project, students created and observed the mini-ecosystems in a 2-Liter bottle. The authors outlined the learning activities and purpose of every phase of the 5E cycle in the project. The authors concluded that the 5E model helps

the teacher to design inquiry experiences and thus motivate the students to learn ecology (Brown, Friedrichsen, & Mongler, 2008).

The review of related literature gave me a sense of how to develop a class Website with interactive drill and practice tools *the pronunciation,* and *the spelling tool.* Testing in Anatomy requires students to identify and write the correct spelling of the identified structure. There are no resources readily available to use for the Cardiovascular System instruction with the above mentioned features. So, a class Website was developed and used a class Website to teach the Cardiovascular System. Web Resources were collected and included on the class Website. In addition, a Teacher Resource Tool was developed for any subject teacher to use for the Spelling and Pronunciation.

Phases of 5E in Teaching the Cardiovascular System

Teaching of the Cardiovascular System took place in two phases. Each lab section lasts for two hours. The first consisted of the implementation of the first four phases of the BSCS 5E learning cycle. The last phase, evaluate was done only during the second lab practical. The detail of the instructional method in each phase is as follows.

Phase 1

Engage. At this phase, the instructors engaged students in watching video clips, images, and playing games from the class Website to introduce the topic the Heart. When the instructors introduced the Vascular System, images of the Vascular System were used to create interest about the topic. The instructors also asked oral questions to elicit curiosity. Simple questions were asked such as: How many chambers does a human heart have? Do you think all the living creatures have a four chambered heart? Do you know the purpose of the heart?. The students brainstormed about the topic, and this phase last

for around 25 minutes. The students got excited about the topic, and the teacher was able to assess their previous knowledge which helped he/ she to build upon further information.

Explore. At this stage, students should be allowed to explore the tools, specifically the class Website. But, due to lack of computers in the lab, the instructors themselves explored the tools and demonstrated them to the students via an instructional computer. The instructors used a computer connected with the Smart Board, Internet and data projector to demonstrate the class Website. This phase took around 45 minutes to introduce the Website and explore the tools. The students were also allowed to explore the Website during spring break, and the students contacted the researcher for clarifications through email. In this phase, the teachers also used the heart models, mannequins, and charts to show the structures, because those materials will be used in the test.

Explain. In this phase, students were allowed to explain their understanding on the topic, the Cardiovascular System. The teachers encouraged students to explain what they observed on the Website in their own words. Students in few sections attempted to explain their understanding but many of them were hesitant. The teachers built information from the students' responses. Informal language is converted to formal language at this stage. For instance, the wall between the chambers is called septum, and the covering layer of the Heart is called pericardium, red blood vessels are called arteries, blue blood vessels are called veins and many other new terms were introduced and explained in this stage. This phase lasted for about 15 minutes.

Elaborate. In this stage, the teacher elaborated upon the concept using examples from different areas such as exercise, health, dance, and nursing. The teacher encouraged students to apply the concepts and skills learned to new situations. The instructors used the Interactive Tools, animations, video on the Heart and the Vascular System from the class Website to reinforce the topic. Therefore the teacher acted as a facilitator to help students understand the material and extend their knowledge. This phase lasted for about 20 minutes.

Phase 2

Evaluate. In this step, the instructors assessed students' knowledge and skills about the Cardiovascular System in the second lab practical. Every section was tested with a different set of questions. The class Website was not used in this stage to assess students' knowledge but it helped the teacher to assess the usefulness of the tool by keeping track of the users of the Website. The detail about the tracking facility is further elaborated upon in the next chapter. The students of the experimental classes completed a survey and that helped the instructor to evaluate the effect of the modified instructional method.

The next chapter describes the steps involved in the design and development of the class Website, and how it was implemented in the class, and details about the participants.

CHAPTER III

RESEARCH METHODOLOGY

Participants

Undergraduates, including freshmen, sophomores, juniors, and seniors, who were enrolled for Spring 2009 Anatomy and Physiology BSC 250 lab were the participants of this study. The researcher obtained permission from the Biology Department Chair and the Lab Coordinator for Anatomy and Physiology lab classes to change the instructional method (See Appendix D, E). Two other instructors who taught Anatomy and Physiology also agreed to the implementation of the modified instruction. Number of sections taught by each instructor in the BSC 250 lab is presented in Table 3. The implementation of this research on the Spring 2009 Anatomy and Physiology laboratory students was approved by the Human Subjects Approval Committee (See Appendix F). The researcher taught three sections. Out of these three sections, the modified instructional method was used in two sections, thus serving as the experimental groups; the traditional method was used in one section and served as the control group. The sections of two other instructors (A, B) were also included in the study.

Table 3

Number of Sections Taught by Each Instructor in the Anatomy and Physiology Lab

	Number of Sections Taught	Control	Experimental
Researcher	3	1	2
Instructor A	3	2	1
Instructor B	2	1	1

Excluding the researcher's sections, out of five, one instructor taught (A) three sections and the other instructor (B) taught two sections. Out of the five sections the other two instructors taught, two sections served as the experimental groups and three sections served as the control groups. In total, out of eight, four sections served as experimental groups and four sections served as control groups. The following table (See Table 4) illustrates number of students that are involved in the control and the experimental group of the study.

Table 4

Number of Students in the Control and the Experimental Group

	Number of Students in the Control Group	Number of Students in the Experimental Group
Researcher	20	38
Instructor A	44	21
Instructor B	21	21
Total	85	80

There were 38 students in the experimental group of the researcher. In the other two experimental sections, one section taught by instructor A had 21 students and the other section taught by the instructor B had 21 students. In total, there were 80 students in the experimental group. Next, there were 20 students in the researcher's control group. In the other three control sections, one section taught by the instructor B had 21 students and two other sections taught by the instructor A had 44 students. In total, there were 85 students in the control group.

Procedure

The Cardiovascular System lab consists of two topics, the Heart and the Vascular System. The classes that received the modified instruction had access to a password-protected class Website. The class that received traditional instruction did not have access to the class Website. For traditional teaching, the instructors used models of the heart (small and large), mannequins, and charts of the Vascular System.

For the past few years, students have had access to course materials including the syllabus, model journals, anatomy booklets, journal criteria, and photos of lab models in the Biological Sciences-Lab Website. Most of the photos of lab models, charts, and mannequin are labeled. The heart had many parts labeled, but not all the veins and arteries were labeled for the Vascular System. Every semester, students were informed about this Website but they did not have a chance to explore it during the class. Those resources were not used in the classes for instructional purposes.

The researcher developed a class Website on the Cardiovascular System to implement the modified instruction. The class Website development was essential to the study. Therefore, this part of the chapter is explained under two sections as follows:

a. Development of the class Website (Instrumentation)

b. Implementation of the class Website to teach the Cardiovascular System

The development of each tool is further elaborated upon.

Brief Description about the Website Tool

The class Website was hosted at the University's Web account. The class Website included tools that the researcher deemed appropriate for teaching the Cardiovascular

System with the BSCS 5E Instructional Model. The features of the Cardiovascular System Website are:

1. *Pronunciation Corner-* This feature had the pronunciation and definition of the scientific terms from the Heart and the Vascular System. This feature also had downloadable audio files for the Heart and the Vascular System.
2. *Spelling Bee* - This feature had the vocabulary from the Heart and the Vascular System, both written and pronounced. The users could hear the pronunciation and type the word spelling for practice. This feature allowed the students to try multiple times.
3. *Interactive Tool* - This feature allowed the users to practice and test their identification of structures of the Heart and the Vascular System. Actual photographs of the heart, mannequin, and chart were used. This feature also allowed the users to test their identification, and spelling of the identification.
4. *Web Resources* - This feature had a collection of Websites on the Heart and the Vascular System including videos, images, games, interactives, animations, audios, and descriptives.
5. *Teacher Resources* - In this feature, teachers could create a Spelling Bee and Pronunciation Corner for any set of words. The steps to follow in the successful creation of the Spelling Bee and the Pronunciation Corner for teachers were provided. The teachers must have audio files for the set of words to create the Pronunciation Corner and Spelling Bee.

Description of the Cardiovascular System Website

Homepage

The class Website Homepage included the above described features. The Pronunciation Corner had links to the Heart, the Vascular System, and the Downloadable audio files. The Spelling Bee had links to the Heart and the Vascular System. The Interactive Tool had links to 'Take the Practice' and 'Take the Test' features. The Web Resources had links to The Heart and the Vascular System. The Teacher Resources had links to the Pronunciation Corner and Spelling Bee. The Website also had the contact email address. The Website was password-protected (See Appendix J). The experimental classes taught by three different instructors were provided with three different user IDs and passwords. The auto-complete form for user Ids, passwords, and answers was turned off. The class Website was optimized for the FireFox browser. The browser played the audio file if the plug-ins were enabled. The Java script in the browser needed to be enabled in order to play the audio file without getting prompted to download it and also to display interactively the names of the labeled parts under 'Practice the test' of the Interactive Tool (See Appendix J).

Pronunciation Corner

Collection of resources for the pronunciation corner. To build the Pronunciation Corner, the researcher collected the audio files of the scientific terms from the 'The Free Dictionary' Website. There were British and American pronunciations of the word. The researcher collected the American pronunciation of the word. The researcher saved the audio files and named the audio file with the same scientific word in order to avoid confusion. The audio files were collected in the WAV form. The researcher also collected

the definition of the terms from the same Website. Typically in the Free Dictionary Website, there was more than one definition for a word. This is because, in biology one word may have more than one meaning and the correct meaning depends upon the context. The researcher collected the definition that was suitable for the Cardiovascular System. There were 26 words for the Heart and 25 words for the Vascular System. In total, 51 scientific words, 51 audio files, and 51 definitions were used to build the Pronunciation Corner tool for the Cardiovascular System.

Construction of the pronunciation corner. In this stage, the collected words, definitions and audio files were used to develop the Web page. The programmer developed a template for the Pronunciation Corner as suggested by the researcher. Then, the researcher used Microsoft FrontPage, a Web authoring tool to build the Web pages. FrontPage (a HTML editor) provided a graphical interface to create and manage the Web pages. The developed Web pages were tested using a local Web server (Apache).

Description of the end product (pronunciation corner). When the users clicked on the Heart or the Vascular System on the Pronunciation Corner link of the home page, they were taken to a new page which resembled a flash card. If the new page was Heart, there were 26 words and if it was Vascular, there were 25 words. The words were listed alphabetically (See Appendix J). But, the user had the option to choose any word from the list to start hearing the pronunciation, as the words were hyperlinked. This page is linked with the home page.

When users clicked on any word from the list, they got the next page with the word at the top of the flash card, in the middle, a speaker icon to play the sound, definition of the word, number showing how many words remaining and the number of

the word the user was in, link to all pronunciation words, and link to the next flash card. From the second flash card onwards the user also had option to go to the previous or next card. So, all the flash cards had the correctly spelled term, the pronunciation of the term, and definition of the term in the Pronunciation Corner. When the user clicked on the Downloadable audio files link, a new window opened up that asked for destination folder to save the WinRAR file. The users could extract the ZIP file to get separate folders that had Heart and Vascular audio files.

Unique Features of the Pronunciation Corner Tool

1. The tool had contents that the students were required to know for this Anatomy and Physiology class. This Website was free from advertisements, which helped the learners stay focused during the learning process.
2. The content and design were conceived by the researcher based on the learning needs and objectives of this class. To develop the tools, the researcher obtained technical assistance from a computer professional in order to ensure that the final product looked professional.
3. This tool enabled the students to download audio files so that the students could store them in their Personal Digital Assistant (PDAs), laptops, personal computers, and cell phones to hear them at their convenience.
4. Anatomy and Physiology students did not have an existing tool of this kind for them to learn and practice for the test. This tool gave them a chance to hear all the terms of the Cardiovascular System in one central place.

Spelling Bee

Collection of resources for the spelling bee. To build the Spelling Bee, the researcher used the same audio files that were collected from 'The Free Dictionary' Website for the Pronunciation Corner. The Spelling Bee audio files were also required to be named with the corresponding scientific word. Before building the Website, the researcher had to formulate the spell-check rules to verify the user answer with the correct answer (See Appendix J).

In this stage, the words and the audio files were used to develop the Web page. The programmer developed a template for the Spelling Bee as suggested by the researcher. Then, the researcher used Microsoft FrontPage to build the Web pages. The developed Web pages were tested using a local Web server (Apache). The developed Web pages were transferred to the University Server using SSH-FTP client. While creating the Spelling Bee the researcher used PHP programming to provide the text field (to type the spelling) and compare the user input with the correct answer. Finally, all Web pages were tested.

Description of the end product (spelling bee). When the users clicked on the Heart or the Vascular System on the Spelling Bee link of the home page, they were taken to a new page that also resembled a flash card (Appendix J). In the new page was Heart, there were 26 words and if it was Vascular, there were 25 words. The same word list from the Pronunciation Corner was used to create the Spelling Bee. These words were also listed alphabetically. But, again the user had the option to choose any word from the list to start. If the user clicked on any word, the next page appeared had the heading (Heart or Vascular) at the top of the flash card, in the middle, a speaker icon to play the sound of

the word, number showing how many words remained and the number of the word the user was in, a text field to type the spelling, a submit button to submit the answer, a small description of how to use the flash card, a link to All Spelling, and links to previous and next page. The user could click the speaker icon to hear the pronunciation of the chosen word, type the spelling in the text field, and submit it. If the answer was correct, the next page said 'Good, it was correct'; if it was wrong, the next page said 'Sorry, that was wrong' and there was an option to try again; if there was only one spelling wrong the next page said 'that was misspelled' and there was an option to try again, if the user had typed some extra letters apart from the correct answer, the next page said 'Good, but you typed something extra'.When the user typed an answer and submitted it, the next page always showed what answer the user had typed along with the comments. But when the user submitted some extra letters along with the answers, the next page showed the answer the user typed and the correct spelling of the word. This feature was believed to encourage the students to try again and again till they got the correct spelling by providing them with clear directions.

Unique Features of the Spelling Bee Tool

1. The Spelling Bee was customized for this class. Students did not normally have a tool of this kind to test their spelling of the words that they had to learn for this class.
2. There are a number of Spelling Bees available on the Internet, but in those Spelling Bees, students get random words. They have no control over the terms. This tool includes a set of words specifically for the Cardiovascular System of

this course. Using this tool, students save time and energy. This course is worth one credit and students are not willing to spend too much time searching for help.

3. This tool was user-friendly. It lets the user type in either in upper-case letter or lower-case letters or in combination of both. Students are allowed to try as many times as possible to practice and prepare for the test.

Interactive Tool

Collection of resources for the interactive tool. To build the Interactive Tool, the researcher first took digital photographs of models of the heart, a mannequin, and chart of the Vascular System. The photos were transferred to the computer. Then they were sorted out into the Heart and the Vascular System. There were 134 photographs for the Heart and 108 for the Vascular System (See Appendix J). Eleven good pictures for the Heart and 15 pictures for the Vascular System were selected for labeling. Next, every picture was labeled in two different forms, using PowerPoint (See Appendix J). In the lab manual, the names of the structures are listed and every structure was also given a number. First, every picture was labeled with the corresponding numbers as it appeared on the lab manual so as to avoid confusion. Second, the structures were labeled with both names and their corresponding numbers. Next, the title of every picture was typed and saved. The labeled pictures and the titles were converted into PNG images. The images of the Heart and the Vascular System were saved in the image folder.

Construction of the interactive tool. In this stage, the PNG images above created were used to develop the Web page. The PNG images were imported to MS FrontPage to create the image-maps. The 'Take the Practice' section was designed in such a way that upon mouse-over on the numbers of the PNG image, it displayed the names. Next, using

the template developed by the programmer (See Figure 1), the researcher built Web pages for this feature (See Appendix J). In FrontPage, the researcher provided text fields with respect to the number of labels on an image using PHP codes. The Web pages were tested using local Web server (Apache server using XAMPP). Then, the Web pages were transferred to the University Web server using SSH-FTP client. All final Web pages were tested in different browsers such as Firefox, Internet Explorer, Chrome and Safari. All the tools were also tested in different Operating Systems like Windows, Windows XP, Windows Vista, Mac and Linux for its lay out, content, and compatibility.

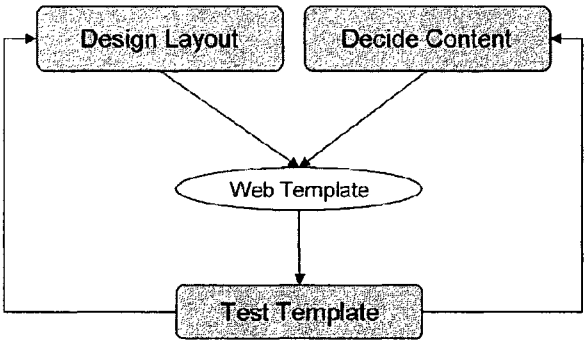


Figure 1. A Concept Map Showing the Steps Involved in the Development of a Template

Description of the end product (the interactive tool). From the home page clicking on the "Take the Test" or "Take the Practice" took the users to list of topics to practice (See Appendix J) or a list of topics to be tested on. From here, when users clicked on a particular topic for practicing, they were taken to a page where the image had Number Labels and a Title for the corresponding topic. Upon mouse-over, it displayed the name, and in the same page there was a link to Take the Test, Next Image, Previous Image, and List all Practices. When a topic was clicked in the 'Take the Test' list, the users were taken to a page where the image had Number Labels and a Title. Upon mouse-over, it did

not display the name. There were text fields for the users to enter the answer. The number of text fields and the number of labels corresponded to each other. At the bottom of the text field, there were two buttons named: Submit and Reset. The same page had links to List all Tests, Next Test, Previous Test, List all Practices, Home page, and Practice. When users submitted their answers, they were taken to a page where it had the number and name labeled image. This page displayed the answer the user typed. If the answer was correct, it said 'You got it right' and it did not display the answer. If the answer was wrong, it said 'You got it wrong', and it also displayed what the user had typed. This feature helped the learners to compare their answers with the correct answer on the image. If the answer had some extra letters along with the correct answer, it said 'You typed something extra', and it also displayed that the user had typed. This feature also helped the user to see what letter they had typed extra. If the answer had one or two spelling mistakes, it said 'You misspelled it', and it also displayed what answer the user had typed. This feature was also helpful for the user to compare his/her misspelled answer with the correct answer on the image. In order to make out the differences from one to another, the answers were displayed in different colors for different responses. The researcher believed that this feature helped the students to try again and again until and till they got the correct answers with the help of clear directions. This page had links to Practice this, Home page, and List all Practices.

Unique features of the interactive tool.

1. Currently, students can not learn all the structures from the current Biological Sciences lab Website. This expanded tool was helpful for the students to learn all the parts in one place.

2. Students learned this difficult topic easily by interacting with this tool. The students also had the option to test themselves. Thereby, students could practice and test in the same place and verify if they understood the identification as well as the spelling. Using this tool, slow learners could have sufficient time to practice the material.
3. Though there are thousands of arteries and veins in human body, Anatomy and Physiology students were required to learn names of certain arteries and veins. This tool used the actual photographs and the same numbers as used in the lab manual of the heart models, mannequin and chart, in order to avoid confusion.
4. In this tool, upper-case letters, lower-case letters and combinations of both were recognized and accepted when the students typed in their answers.

Web Resource

Collection of resources for the web resources. To build the Web resource tool, the researcher searched the Internet and collected 52 Websites on the Heart and the Vascular System. Next, the most useful and interesting Websites were selected upon careful examination of the whole content. Fourteen Websites for the Heart and 11 for the Vascular System were selected. The researcher wrote a small description of the content of every selected Website. In the next stage, the resources were categorized into audios, videos, images, games, interactives, animations, and descriptives. The list of Websites with their description for the Heart and the Vascular System were saved in a word document.

Construction of web resource. In this stage, the Web Resources were used to create Web pages. The template developed by the programmer was used to create the

Web Resources- Webpage. While developing the Web page, the researcher used the list of descriptions to hyperlink with the actual Website address (URL). As before, the Web pages were developed using MS FrontPage. The Web pages were tested in the local server (Apache server using XAMPP) before transferring them to the University server (using SSH-FTP client). Final Web pages were tested.

Description of the tool. When the users clicked on the Heart or the Vascular System on the Web Resources of the Homepage, they were taken to the respective Web resource page. The resources were provided under different sub-headings. The sub-headings under the Heart were videos, images, games, interactives, and animations (See Appendix J). The sub-headings under the Vascular System were videos, images, audios, interactives, and descriptives. The descriptions were provided to give the user an idea about what to expect in the link. The descriptions were hyperlinked. When the users clicked on the description, the links opened up in a new page. The Heart and the Vascular System Web resource pages were linked with each other, and they also had links to the Homepage. Available information indicated that different students learn differently, and this Web resource would be helpful for students with different learning styles.

Unique features of this tool.

1. This tool could save time and energy for students, since relevant and useful Web Resources were carefully selected and listed in one place. The Internet is like an ocean and students would be lost if they did not know how to refine their searches. This tool helped students to stay focused on the task.
2. Because this feature had options like videos, animations, interactives, games, audios and images for the learners to choose from in one central place, students

were believed to be motivated to use the resources that best suited their learning style and pace.

Teacher Resource

Collection of resources for the teacher resource. The Teacher Resources included the Pronunciation Corner and the Spelling Bee. In order to create the Teacher Resource, the researcher formulated the spell-check rules. Already collected audio files and definitions for the Heart and the Vascular System were used by the programmer to build and check the Teacher Resource. The programmer built the Teacher Resource, and the researcher defined the rules, checked the input and output, and suggested some ideas to improve the tool (See Figure 2).

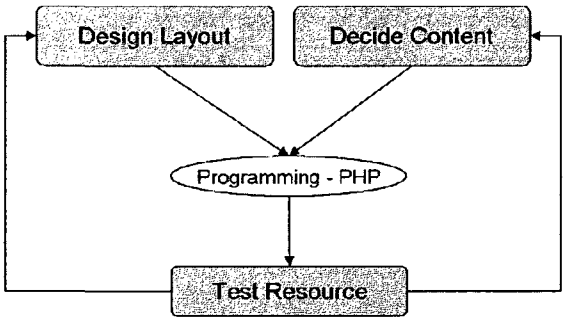


Figure 2. A Concept Map Showing the Steps Involved in the Construction of Teacher Resource

Description of the tool. This tool is designed for teachers to create a Pronunciation Corner (PC) and Spelling Bee (SB) for a set of words. In order to create them, teachers are required to have audio files for the set of words they select. When users click on the 'Pronunciation Corner and Spelling Bee' link on the Homepage, they are taken to the next page (See Appendix J). At the top of the page, it says 'Create Pronunciation Corner

and Spelling Bee' and below that there is a text field for the user to enter the number of words. If the users do not enter the number of words and click 'Next', it does not take them to the next page. This is because the number of words that the user had entered in the first page must correspond with the number of text fields that appears in the second page.

A maximum of 27 words are allowed to create the Pronunciation Corner and the Spelling Bee in order to maintain the 'Flash Card-Look' to Pronunication Corner and Spelling Bee. In the middle of the page a statement of 'Read the following DOWNLOAD instructions before you proceed' is flashing to capture users' attention to read the instructions before they proceed. The instructions specify the number of characters allowed for the course title, and subject topic. The instructions also guide the teachers in how to name the audio files (with an example), where to save them, and how to link the Pronunciation Corner and the Spelling Bee to the homepage. Once the teacher enters the numbers of words and clicks next, the program creates the next page with text fields for the teachers to enter the words and the definitions. In the same page, the teachers can type the course title, subject topic, path to the index/homepage file, and the words and definitions in their respective text fields (See Appendix J). Teachers also have the option to choose background colors from the color-palette for the digital Flash Card.

Unique feature of the teacher resource tool.

1. There are no customizable Spelling Bees available for the teachers to use, and this tool will help any subject area teachers to create their own Spelling Bee for specific class use.

2. This tool has clear instructions for teachers to follow in order to create a Pronunciation Corner and Spelling Bee.
3. The Spelling Bee and Pronunciation Corner that were created with this tool did not have distractions such as advertisements. The output looked professional.
4. Because this tool was available online, any teacher could create their own Spelling Bee in minutes and use it in the class for teaching.

Implementation of the Class Website to Teach the Cardiovascular System

For the topics of the first lab practical, all the students were taught in the same way. The intervention was implemented only for the second lab practical. The intervention was implemented for the experimental group (80 students), and not implemented for the control group (85 students). The control group received traditional instruction for the Cardiovascular System. The class Website was used to teach the Cardiovascular System for the experimental group.

The experimental group was taught by three different instructors. One instructor had been teaching Anatomy and Physiology lab for the past four and a half years, the researcher had been teaching for the past 4 semesters, and another instructor was teaching this course for the first time. The researcher demonstrated the class Website to the other two instructors during the first week of March (See Figure3). The Cardiovascular System consisted of the Heart and the Vascular System. The Heart was taught during the second week of March, using the class Website for the experimental group, and using heart models and mannequins for the control group. Students in the experimental group were given User IDs and Passwords to access the Website. The students had one week to explore the Website. During the fourth week of March, the Vascular System was taught

using the class Website for the experimental group, and using chart and mannequins for the control group.

During the last week of March, the Anatomy and Physiology Students had their second lab practical. The second lab practical accounted for 100 points of student grades. There were 50 questions and a bonus question worth 2 points. All eight sections used a common structure of an answer key. The answer key is attached for reference (See Appendix G). There was a little change in the answer key for the experimental group. Question 45 for the control group had a question on the chart or the heart. For Question 45, students in the experimental group had to submit the 'Website-Use-Acknowledgement Form' at the time of second lab practical to receive two points. The bonus question for the control group was the instructor's choice. But, the experimental group students were asked to fill out a questionnaire (See Appendix H) to receive two points. The students were informed about the grading system. The four experimental and the four control groups second lab practical were graded by the respective instructors. The scores were recorded.

Follow Up

1. The researcher provided a contact email address on the Homepage. The students in the experimental group were informed about the email address. All the students in the experimental group were asked to email their questions, comments or concerns to the email address. The researcher maintained the email account and answered the questions. Just three students from eight sections used this contact mail to communicate with the researcher.

2. The class Website usage was followed up using a STATCOUNTER facility. The researcher created an account in the STATCOUNTER to monitor who, when, how, and how long a user used the Website. STATCOUNTER was a Web tracker (www.statcounter.com). The researcher linked the home page to this Website.

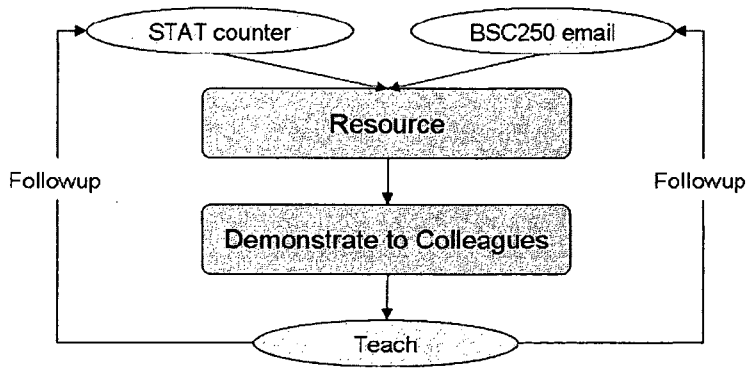


Figure 3. A Concept Map Showing the Steps Involved in the Implementation of the Modified Instruction

This site provided the Web-statistics about the user. The researcher blocked her computer cookies, so that the STATCOUNTER did not count her frequent visit to the class Website. There were many other features such as visit length, returning visit, browsers, came from, and country of visit helped the researcher to keep track of the users. The researcher created two STATCOUNTER accounts for the BSC 250 Lab. Because, the first account named 'BSC 250L' reached 500 hits on March 31, 2009, and the researcher created another account (BSC 250L2) to keep track of the visitors. The BSC 250L2 reached 270 hits till April 2, 2009. Interestingly, there were no hits after April second. This is because, by March 31st, four out of eight classes had taken their second lab practical and the next four labs had finished their practical on April 2nd. In total, there

were 770 hits for the class Website until April 2nd, 500 hits by March 31st and 270 hits from March 31 to April 2. The summary of the visitors showed that there were 770 page loads. Out of which, 339 of them were unique visitors, and 115 of them were returning visitors for the Cardiovascular System Website (See Appendix J).

Program Evaluation

During the second lab practical, students of the experimental classes were asked to give their feedbacks about the new instructional method. Students were awarded 2 points for filling out the Survey. The consent form was orally read by the respective instructors in their experimental sections (See Appendix I). Students were asked to provide their Student Ids on the questionnaire to allow for print awarding. The researcher wanted to see if the class Website had also been used by the control group students. So, the students of control classes were also asked two questions. The following are the two questions:

1. Did you know that there was a "Heart and Vascular System" Website used to teach few other sections of BSC 250L?
2. Did you get a chance to use that Website?

The experimental group students were asked seven questions. These questions were intended to understand how the new instructional method helped them learn or not helped during the Anatomy and Physiology lab. The response to the questionnaire was used for 'Program Evaluation.' The next chapter talks about the analysis of the data.

CHAPTER IV

RESULTS OF DATA ANALYSIS

The grades in the second lab practical for the control and experimental groups were recorded and analyzed. For both the control and experimental group, the second lab practical was worth 100 points and there was a bonus question worth 2 points. So, each score represented the grade out of 100. The first lab practical score was also used in the analysis. The data was analyzed using ANCOVA, because the second lab practical score was analyzed using the first lab practical score as a covariate (Field, 2005). The SPSS (Statistical Package for the Social Sciences Version 16, April 2008) was used for data analysis. To investigate the research questions, 2*3 Factorial ANCOVA was used. This is because, *the groups* had two levels such as control and experimental; the instructors *teaching experience* had three levels such as 4 years, 4 semesters, and first time.

First, scores of the control and experimental group on the first lab practical was compared to see if the groups are significantly different from each other. Independent samples t test was used to analyze. Descriptive statistics explains us that students of the control group had higher mean score (M= 66.12) than the experimental group (M= 57.99) on the first lab practical (See Table 5). The results (See Table 6) indicate that there was a significant difference between the mean scores of the control and experimental groups on the first lab test, $t(163) = 2.218$, $p = 0.028$ (two tailed). This implies that the control and experimental groups are already different in their learning. The analysis of the independent samples t test suggests us that the groups are already different in their learning; therefore to reduce within-group error variance, we should include the first lab test as a covariate for the analysis of the second lab test.

Table 5

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
First lab Practical	Control	85	66.12	23.289	2.526
	Experiment	80	57.99	23.786	2.659

Table 6

Independent Samples t Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
First lab Practical	Equal variances assumed	.501	.480	2.218	163	.028	8.130	3.666	.892	15.368
	Equal variances not assumed			2.217	161.9	.028	8.130	3.668	.887	15.373

In order to determine whether students' use of Website had a significant effect on their performance on the cardiovascular system portion of the second lab test, a 2*3 Factorial ANCOVA was used. Score in the cardiovascular portion of the second lab test was the dependent variable and first lab test was the covariate. An alpha level of 0.05 was used.

Research question 1: What is the difference between the mean scores of control and experimental groups on the Cardiovascular System portion of the second lab practical?

The results in Table 7, indicate that there was a significant difference between the mean scores of the control and the experimental groups on the Cardiovascular System portion of the second lab practical $F(1, 158) = 23.154$, $P < 0.001$, $\omega = 0.2$. The effect size is between small and medium.

Table 7

Tests of Between-Subjects Effects

Dependent Variable:Cardio

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12207.495[a]	6	2034.582	20.735	.000
Intercept	4556.026	1	4556.026	46.431	.000
FirstlabPractical	8895.384	1	8895.384	90.654	.000
Group	2272.514	1	2272.514	23.159	.000
Instructors	395.063	2	197.532	2.013	.137
Group* Instructors	627.003	2	313.502	3.195	.044
Error	15503.718	158	98.125		
Total	223930.000	165			
Corrected Total	27711.212	164			

a. R Squared = .441 (Adjusted R Squared = .419)

Marginal means for Group (See Table 8) explains us that the control group had less mean (M=30.66) than the experiment group (M=38.59) when controlled for the first lab test. In otherwords, the experimental group performed better than the control group. This implies that the Website use helped the experimental group perform better than the control group. Levene's test (See Table 9) reveals us that the error variance was not significant for the Cardio data and thus we did not violate the assumption of homogeneity of variance.

Table 8

Marginal Means of Groups

Estimates				
Dependent Variable: Cardio				
			95% Confidence Interval	
Group	Mean	Std. Error	Lower Bound	Upper Bound
Control	30.66	1.153	28.387	32.943
Experiment	38.59	1.159	36.298	40.877

a. Covariates appearing in the model are evaluated at the following values: First lab Practical = 62.18.

2. What is the difference between the mean scores on the Cardiovascular System portion of the second lab practical that were taught by different teachers?

Table 7 explains us that there was not a significant difference between the mean scores on the Cardiovascular portion of the second lab practical that were taught by different instructors, $F(2, 158) = 2.013$, $p = 0.137$. Marginal Means for the instructors

(See Table 10) indicate that Instructor B and researcher had almost (M=35.72, M=35.75 respectively) same mean score comparatively than instructor A (M=32.40).

Table 9

Levene's Test of Equality of Error Variances

Dependent Variable: Cardio

F	df1	df2	Sig.
1.306	5	159	.264

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + FirstlabPractical + Group + Instructors + Group * Instructors

Table 10

Marginal Means of Instructors for Cardio

Estimates

Dependent Variable: Cardio

Instructors	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Instructor B	35.72	1.531	32.701	38.748
Instructor A	32.40	1.314	29.806	34.997
Researcher	35.75	1.369	33.048	38.455

a. Covariates appearing in the model are evaluated at the following values: First lab Practical = 62.18.

3. Is there any interaction between the group and the instructors on the Cardiovascular System portion of the second lab practical?

Table 7 explains us that there was a significant interaction between the groups and the instructors on the Cardiovascular System portion of the second lab practical, $F(2, 158) = 3.195$, $p = 0.04$, $\omega = 0.09$. The effect size is very small. It is clear from the significant value that the instructors and the groups significantly influence the performance of the students on the cardiovascular portion of the second lab practical. Marginal means (See Table 11) show that experimental group of all three instructors had higher means scores (M=36.85, M=36.88, M=42.03 respectively) than the control group (M=34.60, M=27.92, M=29.48 respectively). The significant interaction is due to variation among the differences between means, which means Instructor B's students' did not benefit as much as the other two instructors's students do. This is because; Instructor B's control class already had a comparatively high mean score than the other two instructors control classes. A graph on the estimated marginal means (See Figure 4) also supports the above statement.

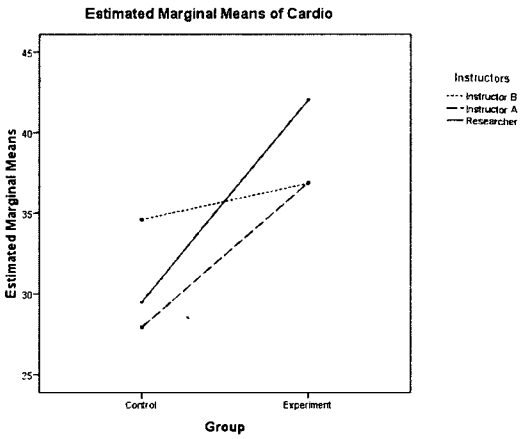


Figure 4. Interaction of Group and Instructors on Performance of the Cardiovascular portion of the Second Lab Test

Table 11

Marginal Means of Interaction for Cardio

Group * Instructors					
Dependent Variable:Cardio					
				95% Confidence Interval	
Group	Instructors	Mean	Std. Error	Lower Bound	Upper Bound
Control	Instructor B	34.60	2.174	30.306	38.892
	Instructor A	27.92	1.498	24.961	30.878
	Researcher	29.48	2.216	25.099	33.852
Experiment	Instructor B	36.85	2.162	32.580	41.122
	Instructor A	36.88	2.171	32.597	41.171
	Researcher	42.03	1.614	38.840	45.215

a. Covariates appearing in the model are evaluated at the following values: First lab Practical = 62.18.

4. What is the difference between the mean scores of the control and the experimental groups on the Non-Cardiovascular System portion of the second lab practical?

Table 12 shows us that there was a significant difference between the mean scores of the control and the experimental groups on the Non-Cardiovascular System portion of the second lab practical, $F(1,158) = 6.318$, $p = 0.013$, $\omega = 0.1$. The effect size is small. This implies that the control and the experimental groups are different in their learning, although they are taught using the same traditional method for the Non-Cardio portion of the second lab practical. Table 13 shows the Marginal Means of the groups for the Non-

Cardio portion. The control group had a higher mean score (M=35.83) than the experimental group (M=31.43) on the Non-Cardio portion of the second lab practical.

Table 12

Tests of Between-Subjects Effectsfor Non-Cardio

Dependent Variable: Non-Cardio

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12950.248[a]	6	2158.375	19.423	.000
Intercept	3203.319	1	3203.319	28.826	.000
First lab Practical	10244.465	1	10244.465	92.189	.000
Group	701.584	1	701.584	6.314	.013
Instructors	481.507	2	240.753	2.167	.118
Group * Instructors	347.529	2	173.764	1.564	.213
Error	17557.655	158	111.124		
Total	225281.000	165			
Corrected Total	30507.903	164			

a. R Squared = .424 (Adjusted R Squared = .403)

5. What is the difference between the mean scores on the Non-Cardiovascular System portion of the second lab practical that were taught by different instructors?

Table 12 also explains that there was no significant difference between the mean scores on the Non-Cardiovascular System portion of the second lab practical that were taught by different instructors, $F(2, 158) = 2.167$, $p = .118$. This implies that

performance of the students on Non-Cardio portion of the second lab practical was not significantly influenced by the instructors, though they had different levels of experience. Table 14 explains the Marginal Means of the instructors for the Non-Cardio portion. Students of all three instructors had almost same mean scores (M=31.14, M=34.07, M=35.67 respectively) on the Non-Cardio portion of the second lab practical.

Table 13

Marginal Means of Groups for Non- Cardio

Estimates

Dependent Variable: Non- Cardio

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	35.83	1.227	33.403	38.251
Experiment	31.43	1.234	28.989	33.862

a. Covariates appearing in the model are evaluated at the following values: First lab Practical = 62.18.

6. Is there any interaction between the group and the teachers on the Non-Cardiovascular System portion of the second lab practical?

Table 12 also indicates that there was no significant interaction between Group and instructors, F (2, 158) = 1.564, p = 0.213. This implies that the performance of students on the Non-Cardio portion of the second lab practical was not significantly influenced by the group and instructors. Table 15 explains that the performance of the control group students (M = 34.15, M = 37.54, M = 35.78 respectively) is higher than the

experimental group students (M = 28.13, M = 30.59, M = 35.55 respectively) irrespective of which instructor taught them.

Table 14

Marginal Means of Instructors for Non-Cardio

Estimates				
Dependent Variable: Non Cardio				
			95% Confidence Interval	
Instructors	Mean	Std. Error	Lower Bound	Upper Bound
Instructor B	31.14	1.629	27.925	34.360
Instructor A	34.07	1.399	31.306	36.831
Researcher	35.67	1.457	32.791	38.545

a. Covariates appearing in the model are evaluated at the following values: First lab Practical = 62.18.

Levene's test (See Table 16) shows us that the error variance was not significant for the Non-Cardio data, and thus we did not violate the assumption of homogeneity of variances.

Table 15

Marginal Means of Interaction for Non-Cardio

Group * Instructors					
Dependent Variable: Non-Cardio					
				95% Confidence Interval	
Group	Instructors	Mean	Std. Error	Lower Bound	Upper Bound
Control	Instructor B	34.15	2.313	29.587	38.723
	Instructor A	37.54	1.594	34.395	40.691
	Researcher	35.78	2.358	31.126	40.441
Experiment	Instructor B	28.13	2.301	23.585	32.675
	Instructor A	30.59	2.310	26.031	35.156
	Researcher	35.55	1.717	32.160	38.944

a. Covariates appearing in the model are evaluated at the following values: First lab Practical = 62.18.

Table 16

Levene's Test of Equality of Error Variances forNon-Cardio

Dependent Variable: Non- Cardio			
F	df1	df2	Sig.
1.414	5	159	.222

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Hypotheses Testing

Hypothesis 1: There will be a significant difference between the mean scores of the control and the experimental groups on the Cardiovascular System portion of the second lab practical.

It was found using factorial ANCOVA that there was a significant difference between the mean scores of the control and the experimental groups on the Cardiovascular System portion of the second lab practical $F(1, 158) = 23.154$, $P<0.0001$. The experimental group had a higher mean score than the control group. So, the results supported Hypothesis 1.

Hypothesis 2: There will be a significant difference between the mean scores on the Cardiovascular System portion of the second lab practical that were taught by different teachers.

From the analysis, it was found that there was not a significant difference between the mean scores on the Cardiovascular portion of the second lab practical that were taught by different instructors, $F (2, 158) = 2.013$, $p = 0.137$. So, the results did not support Hypothesis 2.

Hypothesis 3: There will be a significant interaction between the groups and the teachers on the Cardiovascular System portion of the second lab practical.

It became clear from the analysis that there was a significant interaction between the groups and the instructors on the Cardiovascular System portion of the second lab practical, $F(2, 158) = 3.195$, $p = 0.04$. The experimental group had a higher mean score than the control group of all three instructors. But, the interaction was to due to variation

among the differences between Instructor B's group and Instructor A's and Researcher's group. So, the results supported Hypothsis 3.

Hypothesis 4: There will not be a significant difference between the mean scores of the control and the experimental groups on the Non-Cardiovascular System portion of the second lab practical.

It was found from the analysis that there was a significant difference between the mean scores of the control and the experimental groups on the Non-Cardiovascular System portion of the second lab practical, $F(1,158) = 6.318$, $p = 0.013$. The control group had a higher mean score than the experiemental group on the Non-Cardio portion of the second lab practical. So, the results did not support Hypothesis 4.

Hypothesis 5: There will be a significant difference between the mean scores on the Non-Cardiovascular System portion of the second lab practical that were taught by different teachers.

It was found from the analysis that there was no significant difference between the mean scores on Non-Cardiovascular System portion of the second lab practical that were taught by different instructors, $F(2, 158) = 2.167$, $p = 0.118$. Students of all three instructors had almost same mean scores. So, the results did not support Hypothesis 5.

Hypothesis 6: There will not be a significant interaction between the group and the instructors on the Non-Cardiovascular System portion of the second lab practical.

It was found from the analysis that there was no significant interaction between Group and instructors on the Non-Cardio portion of the second lab test, $F(2, 158) = 1.564$, $p = 0.213$. Though the control group students mean score was higher than the

experimental group students, it was not a significant difference. So, the results supported Hypothesis 6.

Program Evaluation

The researcher used the feedback received from the experimental students on the second lab practical to evaluate the method of instruction that they received for the Cardiovascular System. The questionnaire had seven questions. The response to the first five questions was recorded using a frequency table and a graph was plotted to see the results visually. For the first five questions students had circled what that applied. For the last 2 questions, Figure 5 represents the response.

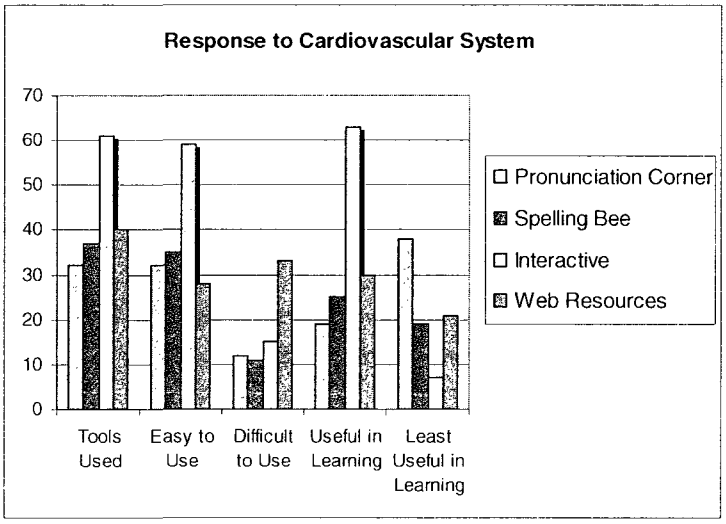


Figure 5. Response of Students about the Use of Cardiovascular System Website

The results show that 32% of students used Pronunciation Corner (PC), 37% of the students used Spelling Bee (SB), 61% of them used Interactive Tool (IT), and 40% of them used Web Resources (WR). About 32% of the students felt that the PC was easy to use, 35% of them felt that SB was easy to use, 59% of them felt that IT was easy to use, and about 28% of them felt that WR was easy to use. For the next question, students

answered that 12% of them felt that PR was difficult to use, 11% of them felt that SB was difficult to use, 15% of them felt that IT was difficult to use, and 33% of them felt that WR was difficult to use. When the students were asked about what tool(s) they found useful in learning the material, 19% of them answered that PC was useful in learning the material, 25% of them answered that SB was useful, 63% of them found that IT was useful, and 30% of them found WR were useful in learning the material. For question five, students responded that 38% of them found PC was least useful in learning the material, 19% of them found that SB was least useful, 7% of them found that IT was least useful, and 21 of them found that WR was least useful in learning the material.

For question 6, students were asked what aspect of the Website needed to be improved and their suggestions for improvement. The responses were coded and depicted in the pie chart (See Figure 6). The response revealed us that 55% of the students reported that the Website needed no improvement and they liked the way it worked as is. About 15% of them answered that Web Resources needed some improvement, 13% of them answered that Pronunciation Corner needed some improvement, and 10% of them answered that Spelling Bee needed some improvement.

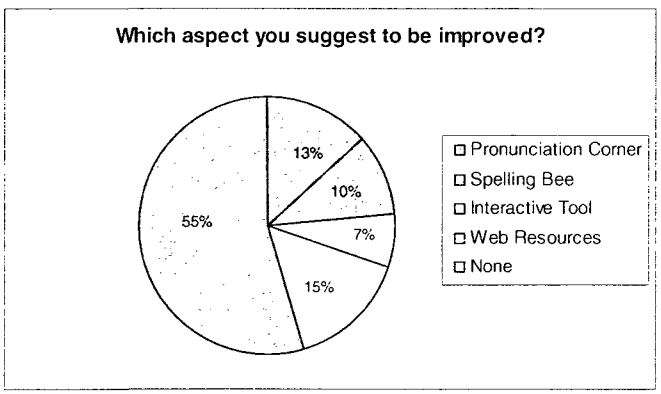


Figure 6. Suggested Improvements for the Class Website

For the improvement of the Pronunciation Corner students had suggested the addition of difficult words. For the improvement of the Spelling Bee, they again suggested the addition of difficult terms (Eg. Superior mesenteric artery instead of mesentery and artery). For the improvement of the Interactive Tool, most of the students suggested having all the models, charts, and mannequins labeled for all the Systems, especially the Muscular System. For the improvement of the Web Resources, most of the students suggested the addition of video clips.

For the last question, students were asked about the main difference between the topics that were taught using the traditional method compared to Web-based tools provided for the Cardiovascular System. About 76% of the students found the Web-based tools were better than the traditional method, 11% of them found that both the methods were same, 8% of had mixed opinions, and 5% of them found traditional method was better for learning. The students found that the Web-based tools helped them interact with the material, learn the material, reinforce the material, and practice for the test (See Figure 7).

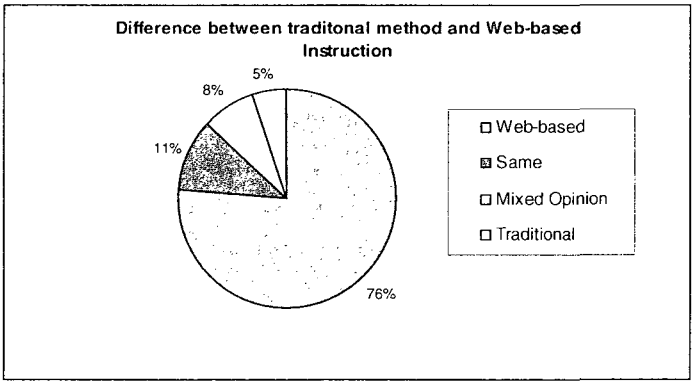


Figure 7. Difference between Traditional and Web-based instruction

The following are the responses from students that were supportive of the traditional method and had mixed feelings about the methods. "The charts are clearer in person than on the Website, overall there was not much difference," "same," "none," "You could not actually touch the thing," "the mannequins are used for the practical so, I felt more secure using them," "There really wasn't a difference," "It was pretty much the same," "Web based were more in depth, actually more complicated than necessary," "They did not look the same sometimes and little bit confusing."

Following are the samples of the responses that were supportive of the Web-based tools. "You were able to interact on the Website which made it a lot easier to learn. I wish there was something online for the muscular system," "The Web-based tools help reinforce the materials taught in the class. They were very helpful and you actually learned by using them over and over again," "I like the pictures that were taken because they were the exact ones," "The Web-based tools were a better teaching method because I had easy access to them online. I did not learn all of my muscles because I didn't have access to models that were in the classroom," "The Website allowed me to practice the structures without showing me the answers. It was better to prepare for the test. It allowed me to learn the structures using pictures and visuals instead of words," "the Web based tools helped me learn a lot easier," "The Web based tools allowed for a much quicker learning and testing system. It was easy to work through the tests to see what you needed to work on the most," "the Web allowed us to learn as opposed to memorize."

In this research there were two hypotheses tested.

CHAPTER V

DISCUSSIONS AND CONCLUSIONS

Introduction

Improvements in computer related peripherals are changing the way students learn. These days, many college level courses integrate online tools such as blogs, You-tube videos, and animations into instruction. The students are motivated to learn when they are presented with technology integrated lessons. Meaningful learning takes place when the students are interested in the topic they are learning. A multitude of online tool attracts students, creates interest in learning new material, and engages them in learning, thus provides different learning environments. Having such a wealth of information on the Internet college level courses need revisions of the present instructional method to achieve high standards. This study was aimed at investigating the difference in performance of students in a class Website integrated lab for the Cardiovascular System portion of the second lab test with a traditional method used class performance. The modified method provided a chance for non-biology major students to repeatedly hear the scientific term pronunciations, interact with the learning material, test their knowledge, and view all relevant resources at one central place. The researcher believed that these features would increase experimental students' performance on the cardiovascular portion of the second lab test.

Discussions and Conclusions

Technology has shifted from tools, machines, and products to systems, problem solving, and interfacing in science and mathematics (Park, 2006). Instructional technology helps educators accomplish the objectives of the teaching-learning process

(Okojie et al., 2006). Lecturing is not an effective teaching tool for promoting conceptual understanding (Knight & Wood, 2005). Especially for this lab, students need to understand the blood flow in the circulatory system in order to trace the blood circulation in the heart. It would be easy for the students to learn the anatomical structures if they understand the concept of blood circulation. Cardiovascular System Website integrated lesson was believed to capture students' attention and promote understanding. Moreover, the preliminary study revealed the fact that the instruction of Cardiovascular System needed some changes.

It was proposed earlier that *blogs* would also be a part of the class Website in order to communicate between the researcher and the user. Later, it was realized that if the blogs were just part of the Website and would not account for their grading, the students might not be interested in participating. Moreover, it would be confusing for some students if they had to participate or not in the blog to get full credit. Therefore, instead of a blog, a contact email address was provided to communicate, as this would be more obvious that this feature is to communicate.

From the results of the preliminary study, it became clear that none of the students found the Vascular System as their easy topic; they also identified Heart as their next difficult topic. So, the researcher decided that although the histology and membranes was their third difficult topic, Heart and Vascular System could be combined easily rather than combining any other two topics to change the teaching method. A class Website was incorporated with traditional teaching, and students of experimental class used it in preparing for the test. Because this tool was available online, they had an opportunity to visit as many time as possible to hear the scientific terms, test their ability to learn these

terms, and interact with the learning material. The results of the STATCOUNTER account revealed us that experimental students frequently visited the Website to learn. In addition, significant difference in performance between control and experimental groups on the Cardiovascular System portion of their second lab test made evident that the experimental students took advantage of the technology tools provided. Students' feedback supported that most of them liked Web-based tools integrated in the teaching of the Cardiovascular System.

Independent samples t test results suggested that students of both groups were different in their learning. In fact, the control group had higher mean score than the experimental group on the first lab test. But still, the experimental group performed better than the control group on the Cardiovascular portion of the second lab test. However, the control group performed better than the experimental group on the Non-Cardiovascular portion of the second lab test. This suggests that while this one single part (Cardiovascular System) of the lab practical was improved in the experimental group overall learning and retention of the materials was similar across tests. The result also brings up the point that the significant difference in performance between control and experimental on the Cardiovascular portion could also be due to the *Novelty Effect* because, this is the first time the Anatomy and Physiology students were taught using an online tool. Therefore, this type of technology integration may or may not produce the same result and excitement among students in the future.

The three instructors who taught this lab had different levels of experience in teaching. Instructor A was teaching the lab for the first time, Instructor B had been teaching for four years, and the researcher had been teaching for four semesters. This

study showed us that there was no significant difference between the mean scores on the Cardiovascular portion of the second lab test (irrespective of groups) that were taught by different instructors. The results also suggest us that there was no significant difference between the mean scores on Non-Cardiovascular System portion of the second lab practical (irrespective of groups) that were taught by different instructors. So, it becomes evident that there was no teachers' bias in the implementation of this project.

This study showed us that there was a significant interaction between the Groups and Instructors on the Cardiovascular System portion of the second lab practical. The experimental group had a higher mean score than the control group of all three instructors except for the fact that Instructor B's students did not benefit as much as the other two instructors. It was also found from the interaction analysis that there was no significant interaction between Group and Instructors on the Non-Cardio portion of the second test.

College students have the chance to meet frequently, discuss what happens in their classes, what tests they have and how to prepare for the test etc, so precautions were taken to control the spread of information from the experimental group to the controls (passwords given in class, etc.). But, somehow, students from control sections got the information that there is a Website on the Cardiovascular System used to teach some sections. About twelve students from the control group marked that they knew there was a Website used to teach other sections of the lab but only six of them marked that they used it. So, there is a possibility that a small number of students from the control group used the Website possibly influencing their grades. The words in the Pronunciation Corner and Spelling Bee did not have full scientific terms and had only part of the word for the students to learn and practice. This could also be a reason why many students

suggested improving the Spelling Bee and the Pronunciation Corner. Future studies should take this into account while developing a class Website of this kind.

The STATCOUNTER account tracked user's time of visits, length visit, frequency of visit, browser used, tools used etc, Looking at the STATCOUNTER results, it is interesting to see that maximum number of users and maximum number of stay on the Website was on the day before the test. Unfortunately, the second set of experimental students had their practical on April 2nd, and could not access the Website properly on the day before their test because the University Web-Server was not working properly. As the Website had images and voice files, the computer did not work the way it should work for them. Some students brought this issue up in their survey. This could be a reason why experimental groups who had their test on Thursday (April 2nd) had comparatively less mean scores. This represents one possible downside to using Web-based materials in teaching and study.

Various factors such as teacher related factors and learner related factors influence the teaching and learning process. Factors such as time of a day, the class room atmosphere, attitude of the teachers and students, students' behavior, the method of teaching, and the method of grading all influence performance. This study could have had any of these factors in the control and/or the experimental groups influencing performance.

To conclude, teachers should be able to decide which topics need computers and related peripherals to assist in their instruction. As suggested in a study that examined students' use of technology for learning relative to traditional method of learning, some students used more technology integrated method while others used traditional method

and both were able to maximize their performance given that they attended class and used the multimedia presentation and discussion (Kashyap, 2006). So, technological tools cannot completely replace the traditional teaching method to ensure high performance. They both have their own advantages and disadvantages. Therefore, it would be better to teach Anatomy and Physiology labs using traditional methods with technology integrated methods, to achieve the learning objectives.

Limitations of the Study

Though there were many advantages in the implementation of the study, one should also be aware of the following limitations:

1. The effect of 5E is minimized because the modified instruction was not implemented for the whole course only for one section of the course. Future work that includes modified instruction to the whole course could be beneficial to student understanding and retention.
2. The technology tools that were designed and developed for this class may only be useful for teaching this class but not for other classes. Although where appropriate this teaching method should be applied in the future.
3. Teachers themselves will not be able to develop the tools of this type unless they have the knowledge of software programs. However, with increasing access to persons knowledgeable in software programs this limitation may be overcome in the future.
4. The technology tools used here are Web-based and will require students to have access to the Internet in order to use them. With the recent expansion of personal computers this limitation may also be overcome soon.

5. The teachers who would like to use the teacher resources should have their own audio files to create the Pronunciation Corner and the Spelling Bee.

Recommendations

The following are the recommendations for future researchers in this field of study.

1. This study modified only the teaching method of the Heart and the Vascular System. Using the class Website template, future research could be built on the rest of the topics. The Muscular System is the next topic that is in the students' wish list to further elaborate upon.
2. This study involved only 80 students in the experimental group and 85 students in the control group. It would be better to expand the study to a larger group of students to make more accurate generalizations.
3. The results of the STATCOUNTER could be used to analyze the study habits of the Anatomy and Physiology lab students. Technology habits such as the preference of Web browser, how students get to what they browse, how they enter and leave the Website and many other factors could be studied.
4. Revision of the study would include student interviews, class observations to understand students' attitude towards technology use in the classrooms, and use of full scientific terms in the Pronunciation Corner and Spelling Bee tools.

APPENDIX A

ANATOMY AND PHYSIOLOGY BSC 250 LAB SYLLABUS

Syllabus
The University of Southern Mississippi
BSC 250 Anatomy and Physiology Lab
Spring 2009

Week	Exercise
1 Jan 12-16	Exercise #1: Histology, Exercise #2: The Integument, Exercise #3: Anatomical Orientation
2 Jan 19-23	MLK, NO LABS THIS WEEK
3 Jan 26-30	Exercise #3: Skeletal Terminology & Axial Skeleton
4 Feb 2-6	Exercise #3: Appendicular Skeleton
5 Feb 9-13	First Lab Practical
6 Feb 16-20	Exercise #4: The Muscular System 1ST PART OF JOURNAL DUE---15 ENTRIES
7 Feb 23-27	Mardi Gras, NO LABS THIS WEEK
8 Mar 2-6	Exercise #5: Muscle Physiology
9 Mar 9-13	Exercise #8: The Cardiovascular System - The Heart
10 Mar 16-20	Spring Break
11 Mar 23-27	Exercise #6: The Respiratory System Exercise #8: The Cardiovascular System - Vascular System
12 Mar 30-Apr 3	Second Lab Practical
13 Apr 6-10	Exercise #7: Respiratory Physiology
14 Apr 13-17	Exercise #10: Electrocardiogram & Peripheral Pressure, Exercise #11: Cardiovascular Physiology 2nd PART OF JOURNAL DUE---15 ENTRIES
15 Apr 20-24	Exercise #9: Anatomy of the blood

APPENDIX B

A PRELIMINARY SURVEY – INSTRUCTORS

Survey
The University of Southern Mississippi
Summer 2008

Participants: Anatomy and Physiology Instructors

Aim: To assess the difficulty level of the topics covered in BSC 250L Anatomy for a preliminary research study.

1. How many years have you been teaching (or) taught the Anatomy and Physiology lab? (BSC 250)

2. Please circle one of the following topics that you found easy to teach....
A. Histology and Membranes
B. Integument
C. Human Axial skeleton
D. Human Appendicular skeleton
E. Musculature
F. Respiratory system
G. Human heart
H. Vascular system

3. Please circle one of the following topics that you found hard to teach....
A. Histology and Membranes
B. Integument
C. Human Axial skeleton
D. Human Appendicular skeleton
E. Musculature
F. Respiratory system
G. Human heart
H. Vascular system

APPENDIX C

A PRELIMINARY SURVEY – STUDENTS

Survey
The University of Southern Mississippi
Summer 2008

Participants: Anatomy and Physiology Students (Summer 2008)

Aim: To assess the difficulty level of the topics covered in BSC 250L Anatomy for a preliminary research study.

1. Your Degree major is in .....

2. Please circle one of the following topics that you found easy to understand when your instructor taught in the class.

A. Histology and Membranes
B. Integument
C. Human Axial skeleton
D. Human Appendicular skeleton
E. Musculature
F. Respiratory system
G. Human heart
H. Vascular system

3. Please circle one of the following topics that you found hard to understand when your instructor taught in the class.

A. Histology and Membranes
B. Integument
C. Human Axial skeleton
D. Human Appendicular skeleton
E. Musculature
F. Respiratory system
G. Human heart
H. Vascular system

APPENDIX D

PERMISSION LETTER FROM THE BIOLOGY DEPARTMENT CHAIR

Permission letter from the BSC Department Chair

January 26, 2009

Dear Dr. Moore,

I am a Biology Education graduate student, and Dr. Sherry Herron is my mentor. Drs. Jawor, Blickenstaff, Mohn, and Hartsell are members of my committee. I have been teaching Anatomy and Physiology (BSC 250L) labs for the past three semesters. My committee has approved my prospectus for research to be conducted this semester (Spring 2009). My research will focus on teaching A&P students with the 5E learning cycle and incorporating web-based tools without altering the content of the syllabus. The 5E instructional method is the exemplary instructional method used and suggested by the Biological Science Curriculum Study (BSCS). I wish to incorporate this teaching method for two lab periods. I would need three classes to do this study. Among the three classes I teach, I would use one class as the control, and other two classes as the experimental group. I also would like to use other A&P lab classes that are taught by other instructors to serve as experimental and control classes in order to better assess the modified instructional method and remove teacher bias. I would like to use one class from Jill Maroo's class and one class from Kris Pitcher's class to serve as experimental group and two classes from Kris Pitcher and one class from Jill Maroo's class to serve as control group.

I am seeking your permission to do this study and would greatly appreciate it if I could teach three classes. I will definitely see to it that I follow the existing syllabus and only change the instructional method. I will analyze the data in the same semester and if the new instructional method works well, I would be happy to disseminate this research to the entire lab class. I greatly appreciate your help in this regard.

Thank you,

Tamilselvi Gopal
Graduate Student, CSME

Dr. Sherry Herron
Director, CSME

Dr. Frank Moore
Chair, Department of Biological Sciences

Approved

APPENDIX E

PERMISSION LETTER FROM THE LAB COORDINATOR

Permission Letter

January 26th, 2009

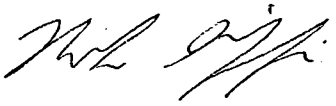
From
Nick Griffis
Anatomy & Physiology lab coordinator
The University of Southern Mississippi
Ph: (601) 266- 4932
john.griffis@usm.edu

To
The Administrator
Institutional Review Board
Human Subjects Protection Review Committee
The University of Southern Mississippi

Sub: Permission to conduct study in BSC 250L anatomy and physiology class

The Anatomy and Physiology (BSC 250L) teaching assistant Tamilselvi Gopal has informed me about the research she would like to conduct during Spring 2009. She also informed me that she will follow the existing syllabus and will change only the instructional method. I would like to permit her to do the study.

(Nick Griffis)



APPENDIX F

IRB APPROVAL

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **29020902**
PROJECT TITLE: **Integration of the 5E Learning Cycle and Technology in Teaching Anatomy and Physiology Lab**
PROPOSED PROJECT DATES: **02/10/09 to 12/30/09**
PROJECT TYPE: **Dissertation or Thesis**
PRINCIPAL INVESTIGATORS: **Tamilselv Gopal**
COLLEGE/DIVISION: **College of Science & Technolgoy**
DEPARTMENT: **C.S.M.E.**
FUNDING AGENCY: **N/A**
HSPRC COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF APPROVAL: **02/12/09 to 02/11/10**

Lawrence A. Hosman

Lawrence A. Hosman, Ph.D.
HSPRC Chair

2-16-09
Date

APPENDIX G

SECOND LAB TEST ANSWER KEY

BSC 250L SECOND LAB PRACTICAL - ANSWER KEY

Points : 50 * 2 = 100

PRINT ALL ANSWERS

NAME:_____

SECTION:_____

1. Muscles - Chest Plate / Half Head	26. Large Heart
2. Muscles - Half Head / Big Eye Model	27. Small Heart
3. Muscles - Chest Plate / Half Head	28. Small Heart
4. Muscles - Chest Plate / Half Head	29. Blue Vessel - Mannequin
5. Muscles - Mannequin	30. Red Vessel - Mannequin
6. Muscles - Mannequin	31. Muscles - Mannequin
7. Muscles - Mannequin	32. Muscles - Mannequin
8. Muscles - Mannequin	33. Definition
9. Respiratory System - Mannequin	34. Definition
10. Respiratory System - Mannequin	35. Your Choice - No Mannequin
11. Respiratory System - Half Head	36. Your Choice - No Mannequin
12. Respiratory System - Half Head	37. See Back- Deoxygenated-Blue
13. Respiratory System - Half Head / Mannequin	38. See Back - Oxygenated in Red
14. Respiratory System - Half Head / Mannequin	39. Red Vessels - Chart
15. Respiratory System - Half Head / Mannequin	40. Red Vessels - Chart
16. Respiratory System - Half Head / Mannequin	41. Red Vessels - Chart
17. Large Heart	42. BlueVessels - Chart
18. Large Heart	43. Blue Vessels - Chart
19. Small Heart	44. Lymph Node - Mannequin
20. Small Heart	45. Your Choice - No Mannequin
21. Large Heart	46. Muscles - Chart
22. Large Heart	47. Muscles - Chart
23. Small Heart	48. Muscles - Chart
24. Small Heart	49. Muscles - Chart
25. Large Heart	50. Muscles - Chart

Bonus: Your Choice

APPENDIX H

A QUESTIONNAIRE ON THE CARDIOVASCULAR SYSTEM

(2 points) **Student Id:** _____

Please Circle all that applies

1. What are the tools you ***used*** in the 'Heart and Vascular System Website'?
    a. Pronunciation Corner
    b. Spelling Bee
    c. Interactive
    d. Web Resources

2. Which tool(s) on the 'Cardiovascular System Website' did you find ***easy*** to use?
    a. Pronunciation Corner
    b. Spelling Bee
    c. Interactive
    d. Web Resources

3. Which tool(s) on the 'Cardiovascular System Website' did you find ***difficult*** to use?
    a. Pronunciation Corner
    b. Spelling Bee
    c. Interactive
    d. Web Resources

4. What are the tool(s) did you find ***useful*** in learning the material?
    a. Pronunciation Corner
    b. Spelling Bee
    c. Interactive
    d. Web Resources

5. What are the tool(s) did you find ***least useful*** in learning the material?
    a. Pronunciation Corner
    b. Spelling Bee
    c. Interactive
    d. Web Resources

6. Which aspect of the Website used for the Cardiovascular System would you ***suggest*** can be ***improved?*** How?

7. In your opinion, what was the ***main difference*** between the topics that were taught using charts, models, and mannequins ***compared*** to the Web-based tools provided for the Cardiovascular System?

APPENDIX I

ORAL CONSENT

THE UNIVERSITY OF SOUTHERN MISSISSIPPI
AUTHORIZATION TO PARTICIPATE IN THE RESEARCH PROJECT

You are requested to participate in the research project "Integration of the 5E learning cycle and technology in teaching anatomy and physiology lab". This study is for the dissertation purpose of the researcher for her doctoral degree in biology education. Participation in this survey is completely voluntary, and your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may withdraw at any time without penalty or prejudice and there are no risks to you.

You are asked to complete a short questionnaire, only taking about 5 minutes to complete. Your participation is greatly appreciated and your responses considered essential for feedback regarding my work. You are asked to provide your student ID on the questionnaire in order for credit to be properly awarded. Your scores on the lab practicals will also be used for this study. All analysis and publications of the data will be presented as combined data so that the identity of individual students is not possible. Therefore, the study maintains subject confidentiality.

Questions concerning the research, at anytime during or after the project, should be directed to Tamilselvi Gopal, #5087 CSME, USM. Contact number is (601) 266-4739. This project and this consent form have been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive # 5047, Hattiesburg, MS 39406-001, (601) 266-6820.

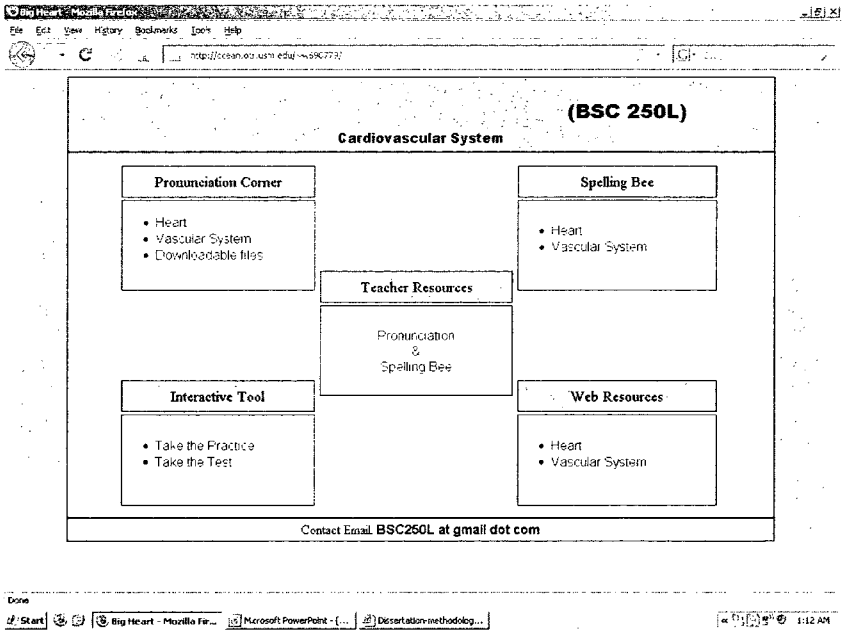
A copy of this form will be given to the participants, if requested.

_____ _____

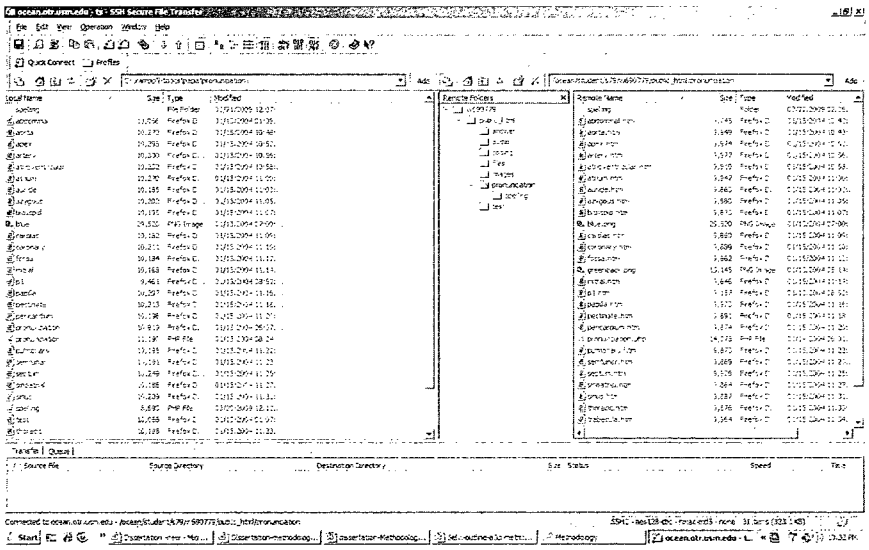
Signature of person explaining the study Date

APPENDIX J

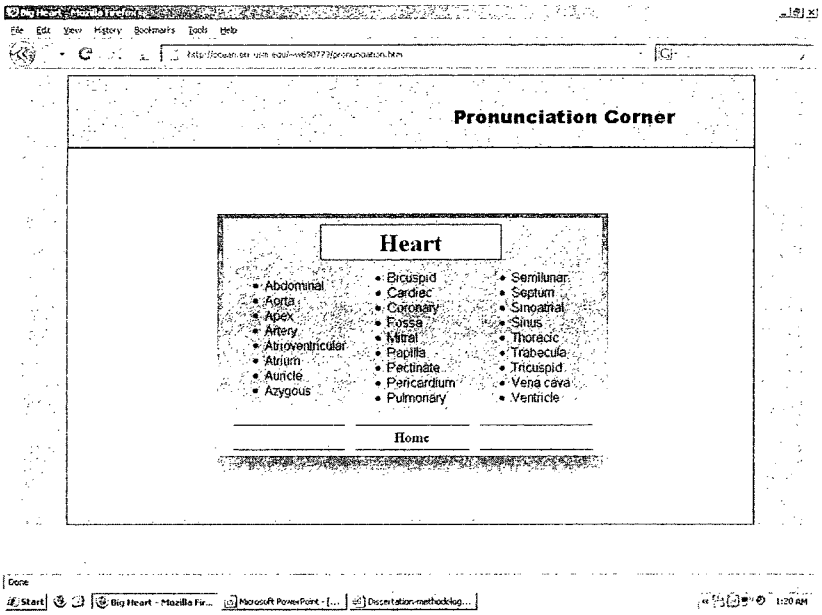
SCREENSHOTS FROM THE CARDIOVASCULAR SYSTEM WEBSITE



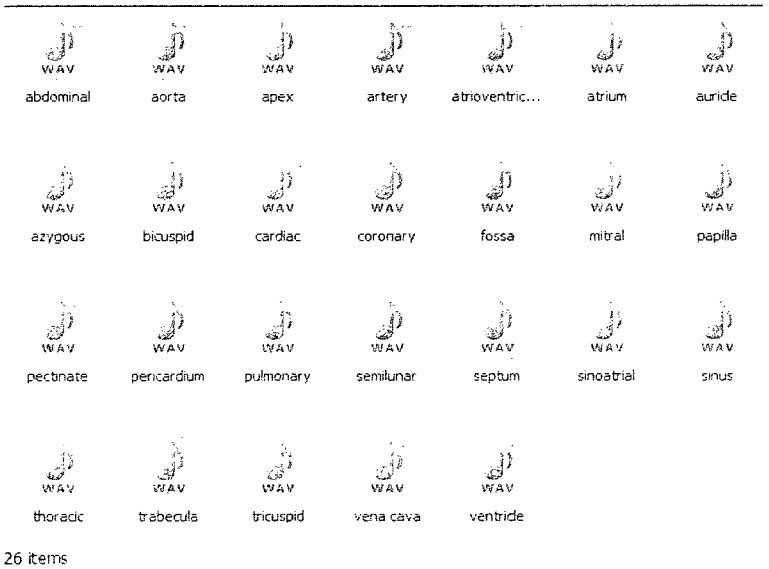
A Screenshot Showing the Homepage of the class Website



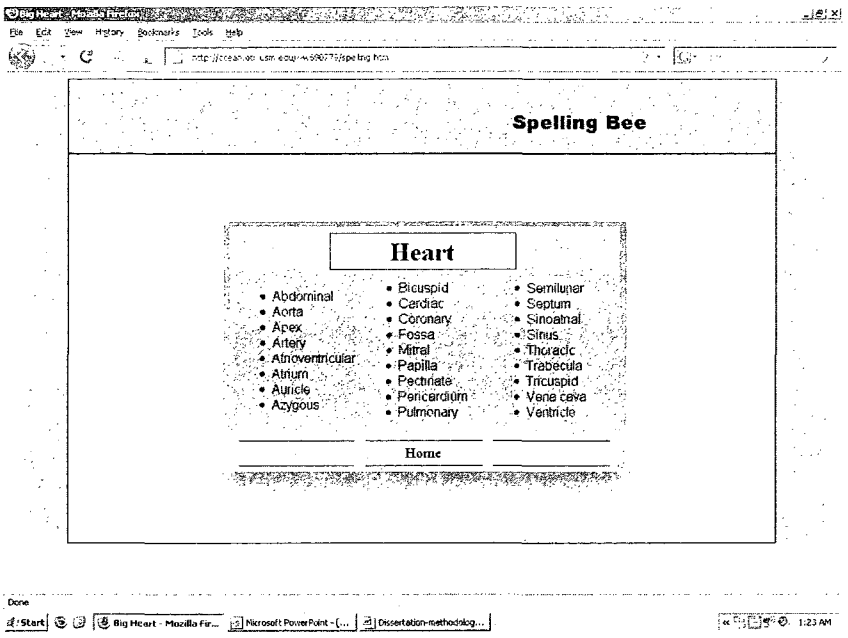
A Screenshot showing the transfer of between the local server and University Server using SSH-FTP client



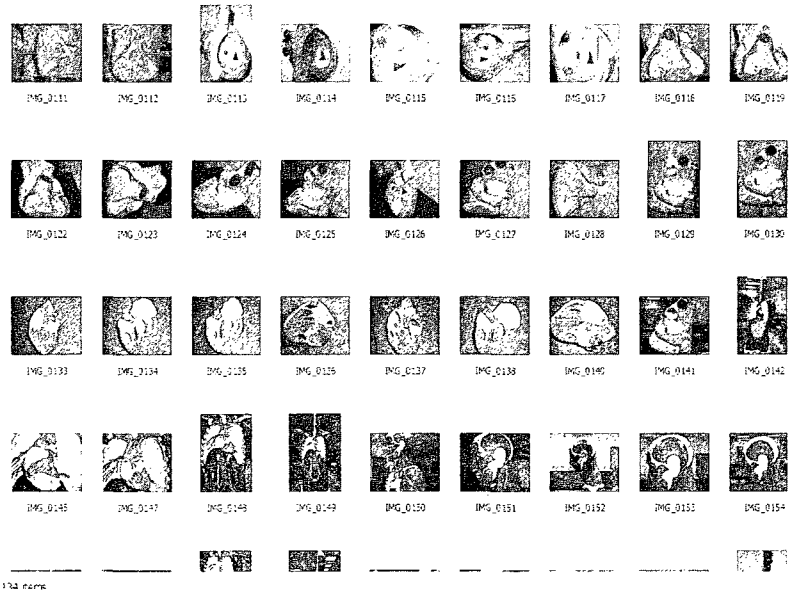
A Screenshot showing the list of words in the Pronunciation Corner



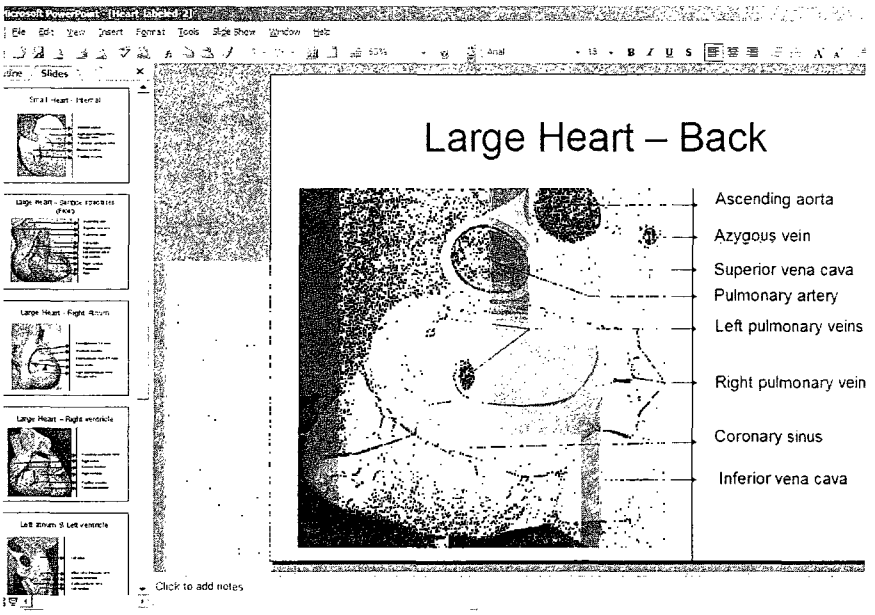
List of audio files used for the Spelling Bee and Pronunciation Corner



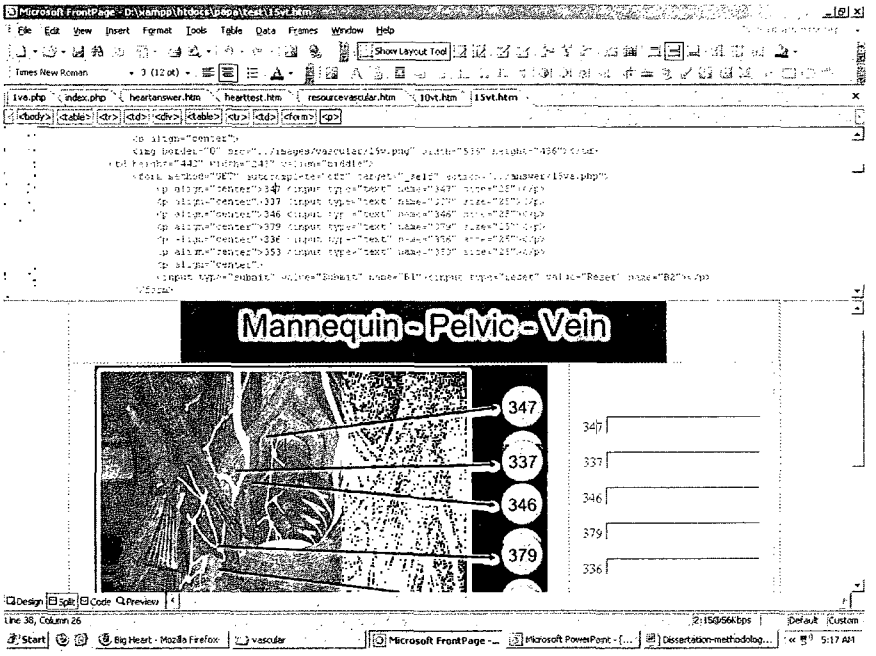
A Screenshot showing the list of words in the Spelling Bee



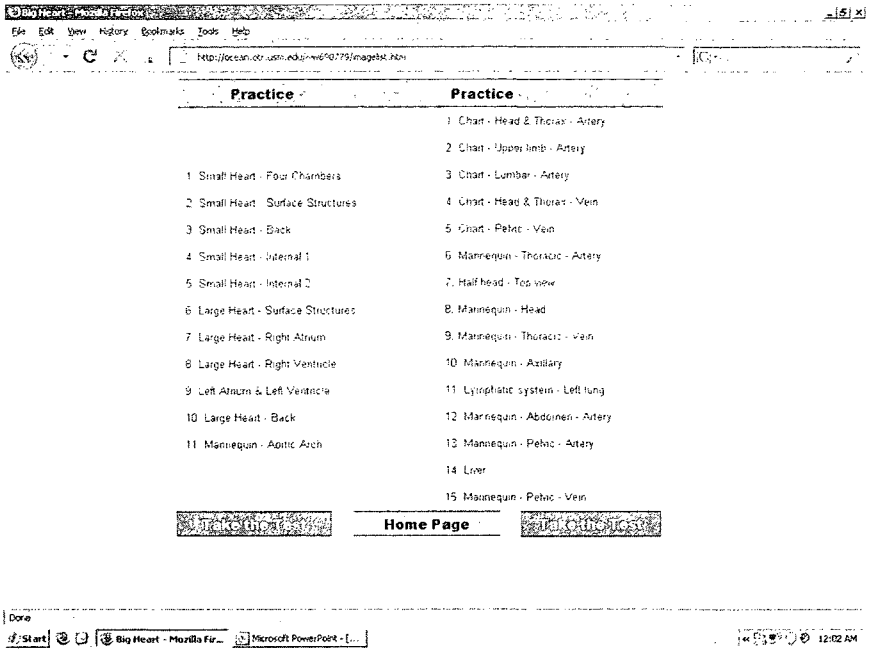
A Screenshot showing the small icons of the photographs taken for the Heart



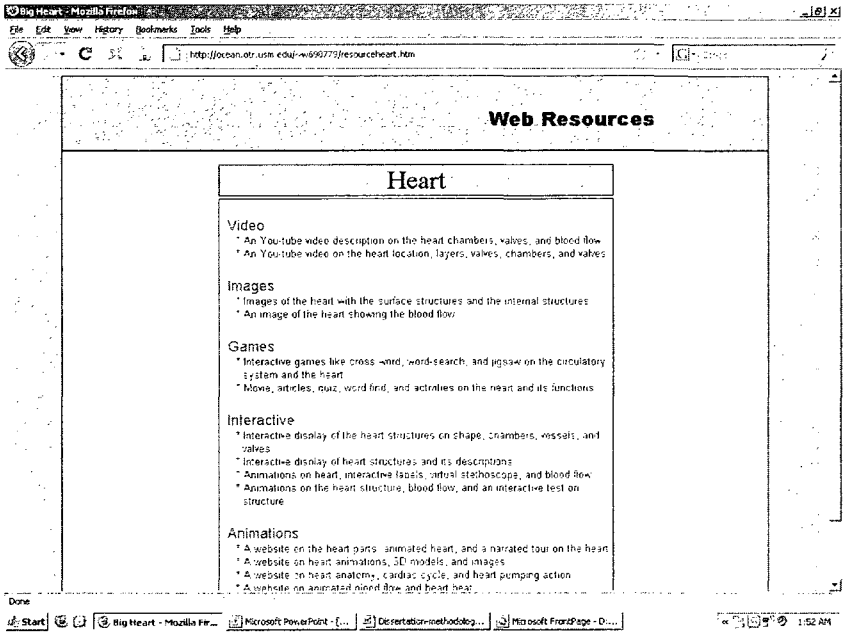
A Screenshot showing the labeled photograph in the PowerPoint



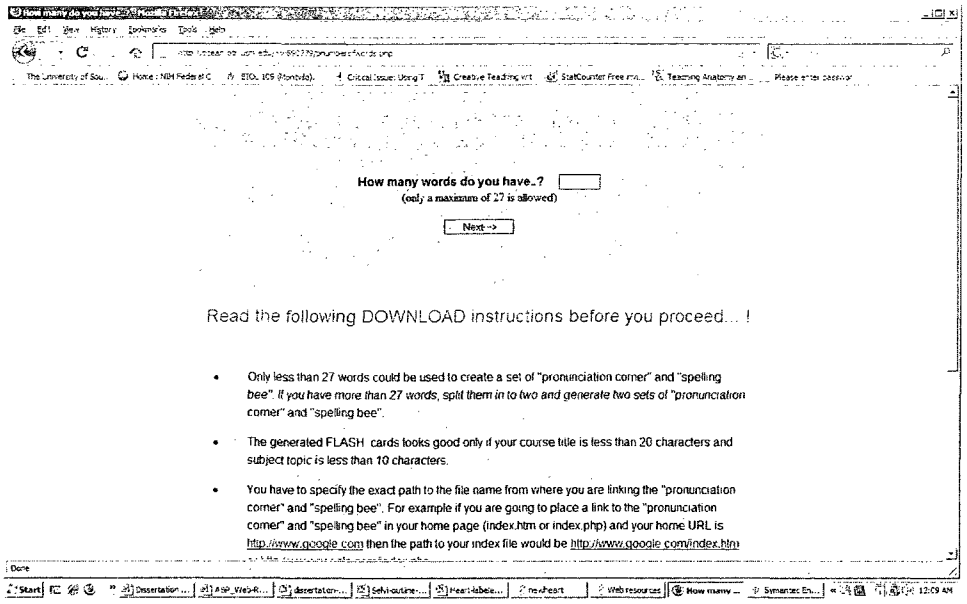
A Screenshot showing the construction of a Webpage using the FrontPage



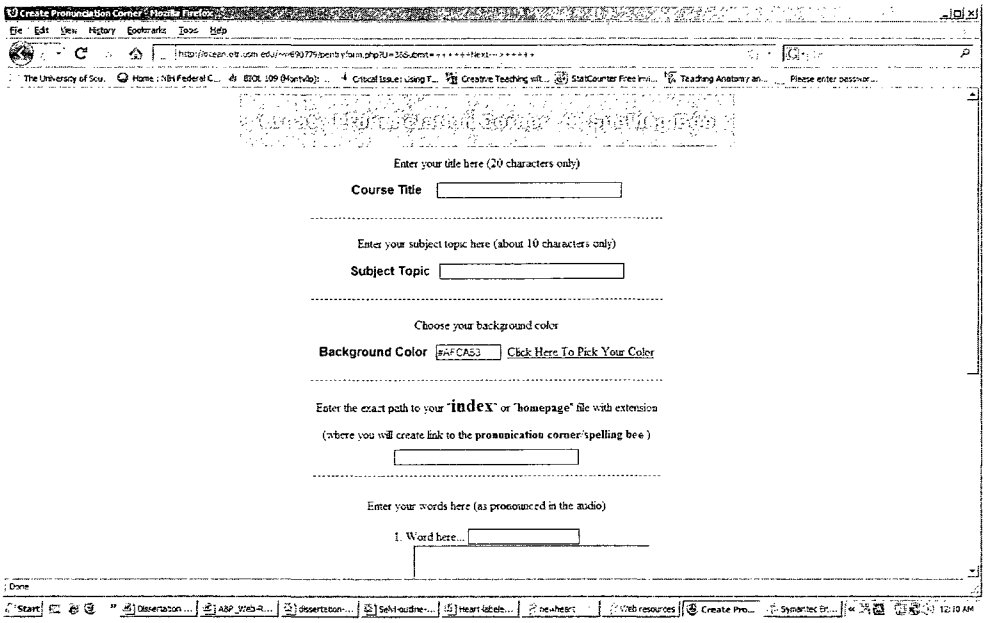
A Screenshot showing the first page of Take the Practice



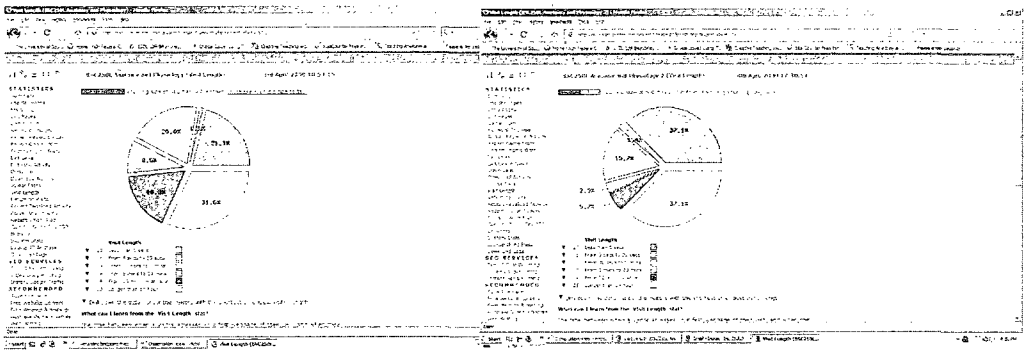
A Screenshot showing the Heart Web Resources page in the Firefox



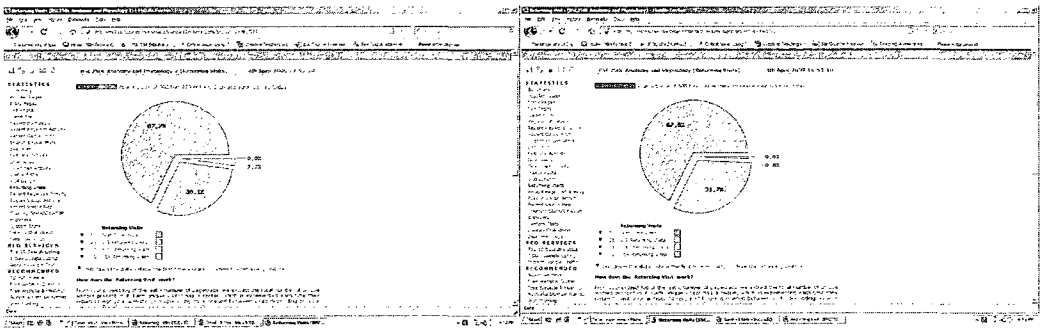
A Screenshot showing the first page of the Teacher Resource



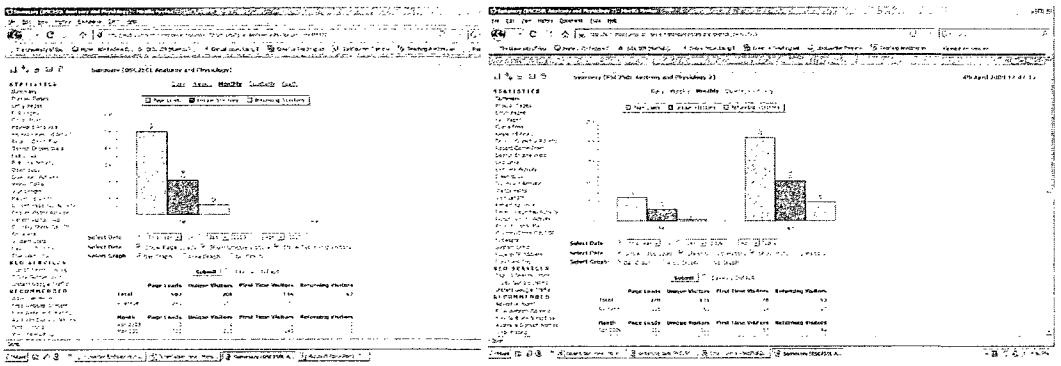
A Screenshot showing the second page of the Teacher Resource



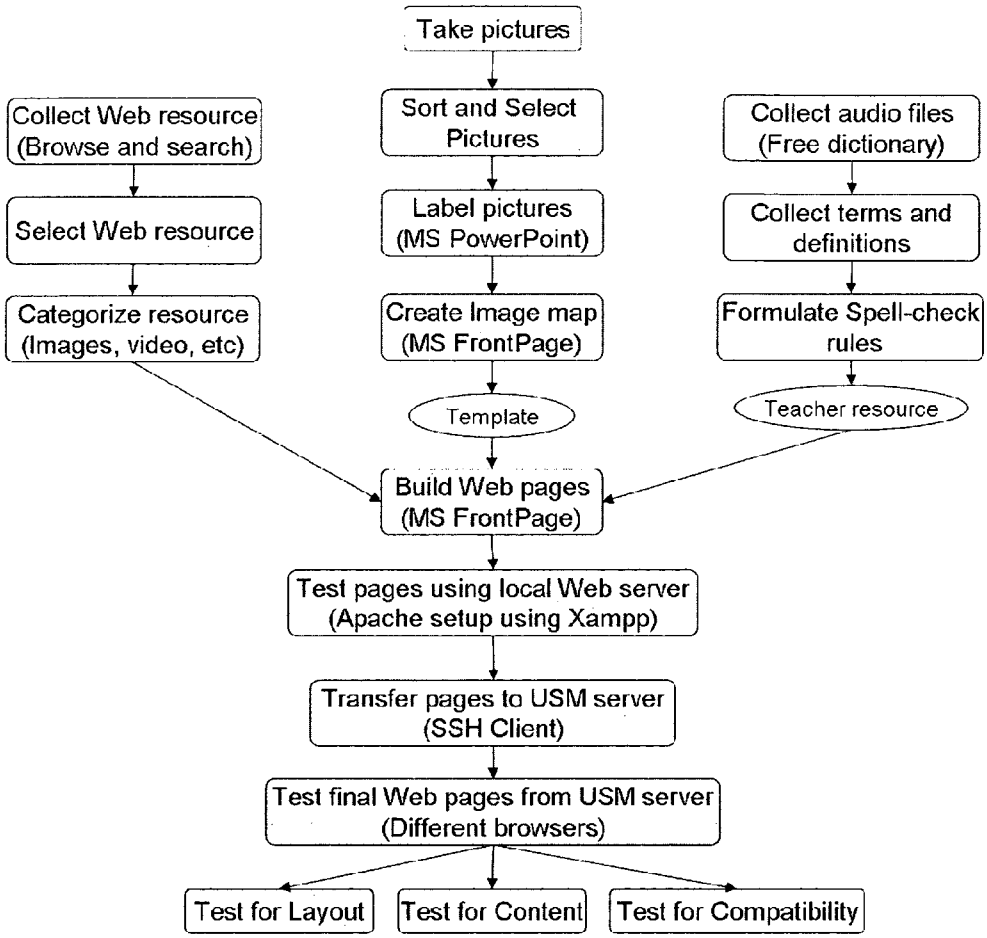
A Screenshot showing the Visit Length of the Cardiovascular System Website visitors from BSC 250L and BSC 250L accounts



A Screenshot showing the Returning Visits of the Cardiovascular System



A Screenshot showing the Summary of the page loads, unique visitors, and returning visitors of the Cardiovascular System Website from BSC 250L and BSC 250L2 accounts



A concept map showing the steps involved in the development of the Cardiovascular Website

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