Using computer technology to enhance science education

Cynthia Lynn Peterson
USING COMPUTER TECHNOLOGY TO ENHANCE SCIENCE EDUCATION

A Project
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Interdisciplinary Studies

by
Cynthia Lynn Peterson
June 2002
USING COMPUTER TECHNOLOGY TO
ENHANCE SCIENCE EDUCATION

A Project
Presented to the
Faculty of
California State University,
San Bernardino

by
Cynthia Lynn Peterson
June 2002

Approved by:

Dr. Bonnie J. Brunkhorst, First Reader

Dr. Sylvester Robertson, Second Reader
ABSTRACT

The objective of this project was to focus on science misconceptions and the use of computer technology as a tool to enhance science instruction. The purpose of this study was to determine if using computer technology as a tool for conceptual change would be an effective pedagogical strategy in replacing science misconceptions. The science concept focused on in this study was how the lungs are involved in the circulatory system.

The subjects used in this project were enrolled in seventh grade science classes. Two classes were given a traditional lesson and the other two classes were given a computer-aided lesson. Four questions were used as pre and post assessments. Student responses to the questions were analyzed for misconceptions: Data from twenty matched pairs of students and 31 non-matched students is included in the study.
ACKNOWLEDGMENTS

I would like to thank my mother, my daughter and Professors Bonnie and Herb Brunkhorst for their unwavering confidence in me.
DEDICATION

In memory of my mother, Carole Cassel
# TABLE OF CONTENTS

ABSTRACT ................................................................. iii

ACKNOWLEDGMENTS ......................................................... iv

LIST OF TABLES ............................................................ viii

LIST OF FIGURES ............................................................ ix

CHAPTER ONE: BACKGROUND

Purpose of the Project ................................................. 1

Context of the Problem ................................................ 1

Significance of the Project ........................................... 2

Assumptions ............................................................. 5

Limitations and Delimitations ....................................... 6

  Limitations ............................................................... 6

  Delimitations ........................................................... 7

Organization of the Thesis .......................................... 7

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction ............................................................. 9

Science Misconceptions ............................................ 9

Conceptual Change .................................................... 11

Prior Concepts .......................................................... 13

Three Levels in Learning ........................................... 14

  Image ................................................................. 14

  Schematization ...................................................... 16

  Theory Building ...................................................... 17

Using Computer Technology to Enhance Learning .............. 19
CHAPTER THREE: METHODOLOGY

Introduction ........................................................................ 24
Development ......................................................................... 24
Resources and Content Validation ........................................ 25
Design .................................................................................. 26
Population Served ............................................................... 30
Treatment ............................................................................ 31
Data Analysis Procedures ..................................................... 32
Summary .............................................................................. 32

CHAPTER FOUR: RESULTS AND DISCUSSION

Introduction ........................................................................ 33
Presentation of the Findings .................................................. 33
Pre Assessment Data ............................................................ 35
Post Assessment Data ........................................................... 36
Computer Aided Lesson/Matched Pairs ................................. 37
Question #1 ...................................................................... 37
Question #2 ...................................................................... 38
Question #3 ...................................................................... 38
Question #4 ...................................................................... 38
Traditional Lesson/Matched Pairs ......................................... 38
Question #1 ...................................................................... 38
Question #2 ...................................................................... 39
Question #3 ...................................................................... 39
Question #4 ...................................................................... 40
Discussion of the Findings................................. 40

Question #1................................................. 46

Question #2................................................. 48

Question #3................................................. 48

Question #4................................................. 49

Summary....................................................... 51

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

Introduction................................................... 53

Conclusions.................................................... 53

Recommendations............................................... 57

Summary....................................................... 60

APPENDIX A: INFORM CONSENT............................... 61

APPENDIX B: DEBRIEFING................................... 65

APPENDIX C: PARTICIPATION RECRUITMENT, PROJECT
DESCRIPTION, AND RISKS AND BENEFITS............... 68

APPENDIX D: PRE AND POST ASSESSMENT.................... 73

APPENDIX E: LESSON PLANS................................. 79

APPENDIX F: PRE AND POST TEST ACCURATE RESPONSES.... 90

APPENDIX G: WEBSITES.................................... 94

REFERENCES.................................................. 101
LIST OF TABLES

Table 1. Chart of Correct or Accurate Answers Pre and Post ........................................ 35

Table 2. Chart of Matched Pairs Alternative Responses Pre and Post .............................. 40

Table 3. Chart of Non Matched Student Alternative Responses Pre and Post ..................... 43
LIST OF FIGURES

Figure 1. Computer Aided Lesson Matched Pairs Pre and Post Responses ......................... 37

Figure 2. Traditional Lesson Matched Pairs Pre and Post Responses ............................. 39

Figure 3. Computer Aided Lesson Non-matched Students Pre and Post Responses ............ 45

Figure 4. Traditional Lesson Non-matched Students Pre and Post Responses ..................... 46
CHAPTER ONE
BACKGROUND

Chapter One presents an overview of the project. The contexts of the problem are discussed followed by the purpose, significance of the project, and assumptions. Finally, the limitations and delimitations that apply to the project are reviewed.

Purpose of the Project

The purpose of the project was to determine if using computer technology as a tool for conceptual change would be an effective pedagogical strategy in replacing science misconceptions.

Context of the Problem

The hypothesis of this project is that a lesson which uses computers to engage students as active participants, would be a more effective pedagogical tool in facilitating replacement of misconceptions with more correct science concepts than a traditional lesson. The science concept focused on in this project was the circulatory system; specifically the path the blood takes from the heart to the lungs, to exchange oxygen and carbon dioxide, back to the heart, and then out to the body to deliver oxygen to
the body cells and pick up carbon dioxide to exchange in the lungs, before returning to the heart again.

Significance of the Project

Science misconceptions have been observed as far back as 1929 by Piaget, and in 1968 by Ausubel who described them as preconceptions (McElwee, 1991). "Research has established that students' alternative conceptions in science are very tenacious and that conventional instruction is notably ineffective in promoting conceptual change" (Tao & Gunstone, 1987, p. 39). Osborne and Squires have also stated that the last decade has provided an increase in the body of research addressing the way in which children learn science and the models of teaching employed by teachers (1987). This project focuses on a concept in the area of life science which can have many misconceptions associated with it. It also focuses on teaching methods that could be employed to facilitate conceptual change to correct or reduce misconceptions.

The life science concept of how the lungs are involved in the circulatory system was chosen based on previous observations that more than half of my students, even after teacher directed instruction, frequently were unable to replace misconceptions concerning how the heart
circulates the blood. Typically many students in seventh grade have a basic understanding of the fact that the lungs take in oxygen and give off carbon dioxide. They also have a basic understanding of the fact that some of the blood cells carry oxygen to all parts of the body. However, most of the seventh grade students have not yet made the connection of how the lungs are involved in the circulatory system. The misconceptions which arise, post instruction, show a lack of understanding concerning the fact that the heart must pump the blood to the lungs to exchange carbon dioxide (exhale) for oxygen (inhale), before the blood can return to the body.

Interviews of several middle school science teachers who have taught this same concept revealed that they were also frustrated with the knowledge that, even after traditional instruction, a significant number of students continue to hold onto misconceptions concerning how the heart circulates the blood. In post lesson reviews and tests, more than half of the students continue to state that the blood circulates from the heart to different parts of the body and back to the heart again, without mentioning that the blood also goes to the lungs to exchange carbon dioxide for oxygen.
Osborne and Squires state "The research emphasizes the need for children to be regarded as active and purposeful learners who engage in a dynamic process of construction and reconstruction of the personal concepts which they use to understand science" (1987, p. 373). This project compares the traditional lesson with a lesson which uses computers as a tool to facilitate conceptual change and replace misconceptions. My hypothesis is that a lesson which uses computers to engage students as active participants, would be a more effective pedagogical tool in facilitating replacement of misconceptions with more correct science concepts than a traditional lesson.

The life science concept of how the lungs are involved in the circulatory system was chosen not only because of misconceptions that had been previously observed, but also because learning about the circulatory system of the human body is a requirement of the seventh grade California State Science Education Standards as published by the California Department of Education, Sacramento, California (Bruton & Ong, 2000). The "Structure and Function in Living Systems", Grade 7, Standard 5, page 24, of the California State Science Education Standards states:
The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. As a basis for understanding this concept: a) students know plants and animals have levels of organizations for structure and function, including cells, tissues, organs, organ systems, and the whole organism; b) students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system. (Bruton & Ong, 2000, p. 24)

Also cited is Grade 7, Standard 6, page 25, of the California State Science Education Standards, The Standards for Physical Principles in Living Systems, which states:

Physical principles underlie biological structures and functions. As a basis for understanding this concept: j) students know that contractions of the heart generate blood pressure and that heart valves prevent backflow of blood in the circulatory system. (Bruton & Ong, 2000, p. 25)

Assumptions

The following assumptions were made regarding the project:

1. Students have a basic understanding of how the circulatory system works; that the blood circulates from the heart to the different parts of the body, and back again to the heart.
2. Students have a basic understanding of how some blood cells help carry oxygen to all parts of the body.

3. Students have a basic understanding that carbon dioxide and oxygen gases are exchanged in the lungs.

4. Students have previous experience and a basic understanding of how to navigate to different computer web sites for information.

5. Students have previous experience working cooperatively in groups consisting of two to four.

Limitations and Delimitations

During the development of the project, a number of limitations and delimitations were noted. These limitations and delimitations are presented in the next section.

Limitations

The following limitations apply to the project:

1. Participation was limited due to the lack of facilities.

2. Individual interviews were not able to be completed due to timing of study.
3. The project was designed for seventh grade science classes at a school in Riverside County, Riverside, California.

Delimitations

The following delimitations apply to the project:

1. Flexible use of facilities at a school site would ensure the timely completion and greater involvement of students in this project.

2. Starting project earlier in the school year would insure time, if needed, to do individual interviews for additional research.

3. This project could be used in any elementary, high school, and community college, with modifications for age appropriate curriculum.

Organization of the Thesis

The thesis portion of the project was divided into five chapters. Chapter One provides an introduction to the context of the problem, purpose of the project, significance of the project, and limitations and delimitations for the project. Chapter Two consists of a review of relevant literature. Chapter Three documents the steps used in developing the project. Chapter Four presents the results and discussion from the project.
Chapter Five presents conclusions and recommendations for additional research and for instruction drawn from the development of the project. The Appendices follow Chapter Five. The Appendices for the project consists of: Appendix A Inform Consent; Appendix B Debriefing; Appendix C Participation Recruitment, Project Description, and Risks and Benefits; Appendix D Pre and Post Assessment; Appendix E Lesson Plans; Appendix F Pre and Post Test Accurate Responses; and Appendix G Websites. Finally, the references follow the Appendices.
CHAPTER TWO

REVIEW OF THE LITERATURE

Introduction

Chapter Two provides a discussion of the relevant literature. Specifically, how science misconceptions are an important part of learning science and what is needed for conceptual change of misconceptions; understanding how we learn, specifically Korthagena and Lagerwerf’s (1995) three levels in learning and how misconceptions sometimes become part of what we learn; and finally how computer technology might be used as a tool for conceptual change of science misconceptions and to enhance science learning.

Science Misconceptions

Much research has been done on students’ science misconceptions. Misconceptions have been known or realized as early as 1929 (Peaget & Ausubel, 1968). Children enter school with prior knowledge and concepts based on previous experiences. “They do this in order to make sense of the world they live in” (p. 139). They do not come as blank slates. “...Students enter school with a plethora of experiences, use this foundation to form personal theories (often erroneous) about the world, and rarely correct misconceptions even when new information is presented to
them” (Woods, 1994, p. 33). The challenge is to identify prior concepts which may be incorrect (misconceptions) and to design lessons and instruction which will help students replace misconceptions with correct concepts. However, “Conceptual change is often very difficult even when prior conceptions are explicitly considered” (Gil-Perez & Carrascosa, 1990, p. 533).

Misconceptions do not only affect children. When studies were done involving children, college students, and adults (teachers), the percentage of wrong answers remained almost constant in all groups (Gil-Perez & Carrascosa, 1990). Both children and adults develop scientific concepts as a result of trying to make sense of the world we live in. Learning in science “...often requires realignment in thinking and constructing new ideas that may conflict with earlier ideas” (Fellows, 1994, p. 986). Piaget, in 1950, described these changes as accommodations. Learners find that when they are presented with new concepts, their old way of thinking does not fit with the new information they are receiving. They then must somehow adjust and create new connections to make sense of the new information. This is referred to as conceptual change. However, helping students to adjust and create new connections is not an easy process (1994).
Conceptual Change

Conceptual change is difficult to accomplish. Conceptual change requires radical changes in thinking where students' core concepts, principles and theories are often challenged. Students must substitute their old ideas with newly constructed ways of thinking based on new information. Students rarely accomplish conceptual change (Fellows, 1994). One explanation for the persistence is that while students are exposed to new concepts, students take in the new information by memorizing facts and terminology without changing their prior concepts. Often this is done by the student for the purpose of being able to repeat the facts and terminology back to the teacher for a grade. The new information was only useful to the student in order to accomplish what was needed at the time. The teacher may assume the student has learned the new concept if he or she performed well for an assignment or test. However without changing prior concepts, students find they are unable to use these new facts and terminology to explain, describe, or make predictions of real-world phenomena. They find the new concepts useless and return to their original or prior concepts which often involve misconceptions.
Another explanation for the persistence is that the student does not find the new information important, or interesting, or useful. The student does not see the information as a help to making sense of the world around him or her (Peaget & Ausubel, 1968). The student must be motivated to want to learn the new information in order to even start the process of conceptual change.

Van Hiele also developed a theory that accounted for some of the reluctance to give up prior conceptions. The theory is based on communication problems that sometimes occur in a classroom setting between teachers and their students. Van Hiele suggests that there are three levels in communication: The Intuitive Level (base or zero level); the First Level, which is a network of relations (or structure); and the Second Level where one examines the internal structure of the First Level (as cited in Korthagen & Lagerwerf, 1995). Problems in communication occur if, for example, a teacher is communicating a concept at the First or Second Level, and the student is still on the Intuitive Level. Because the student is still at the base or zero level, he or she will not understand the concept the teacher is trying to convey. The student will reject the new information or concept as useless and
return to old ways of thinking including any prior misconceptions

Prior Concepts

Forming prior concepts, including misconceptions, seem a natural function in the way we learn. We form concepts in order to make sense of our world around us. Hosts of classroom trials have shown the Learning Cycle, originally proposed by R. Karplus of the University of California at Berkeley, is very effective in providing a means of removing students' nonscientific preconceptions (as cited in Gang, 1995). The Learning Cycle is designed as a three-phase approach for student involvement in physics lessons. This approach has been documented to enhance students' effectiveness in learning. The Learning Cycle uses a real-world task approach for students to form new images or concepts from real world experiences. The Learning Cycle works well if the teacher has the training, resources, and time needed to accomplish this. However, the availability of resources, time constraints, and the teacher's own limited creativity make it difficult to carry this off for every lesson (Liggitt-Fox, 1997). To also expect a teacher to be able to identify every individual student's misconceptions in just the areas of
science would be nearly impossible. It would take all a teacher's time and effort to do so. Prior conceptions, including misconceptions, will always exist as a natural part of our learning about the world around us. It therefore might be more effective to look at how we learn in order to understand how prior conceptions, including misconceptions, are formed if we want to help students replace them. Students must be helped to understand the basis for their preconceptions and these preconceptions must be then tested against the real world (Woods, 1994).

Three Levels in Learning

In an article on learning, Korthagen and Lagerwerf (1995) describe three main levels in learning. These levels are: image formation, schematization, and theory building, which are Van Heile's theory taken to a broader field with emphasis on the relationships between the cognitive and the affective aspects of the learning process. Each level represents three fundamentally different phases in the process of understanding a subject or concept.

Image

The first level in learning, described by Korthagen and Lagerwerf, is image formation. Images play an
important role in how we experience the world around us. We use visual images and images that come from our other senses such as touch, hearing, smell, and taste. We also use emotions we experience to shape our images and to add meaning to the world around us. "Image formation is the process by which one forms an image of a concept or phenomenon by experiencing it" (Korthagen & Lagerwerf, 1995, p. 1016). Images are connected to reality because they are formed in our reality and they satisfy a need.

“One characteristic of images is that they are formed in situations in which the person has some kind of need or concern” (Korthagen & Lagerwerf, 1995, p. 1015). Our feelings at the moment and what is primarily important to us make images important. One example of this is the image of boiling water for a cup of tea. We might associate the drinking of the tea to relaxation. This is because we have used our senses of smell and taste, as well as our emotions surrounding where and how we drink a usual cup of tea. The knowing and understanding of how water boils becomes less important. The drinking of the tea satisfies our need and is the more important part of the image at the moment. We might form misconceptions about how water boils because it does not satisfy a need at that moment. Therefore, initial images we form are considered “bare in
comparison with the varied and colorful reality of the everyday world” (Korthagen & Lagerwerf, 1995, p. 1015).

**Schematization**

To learn more about an image, we must learn all about it; all the common and not so common aspects and all those aspects that belong to related topics. This is the second level which is called schematization. We form images which are both bare and wrapped up in reality of everyday life. Sometimes we are faced with new situations where a question, or a problem, or simple curiosity may cause us to look for more information about the image we have formed. “During schematization, all sorts of new concepts present themselves” (Korthagen & Lagerwerf, 1995, p. 1018). It is important at this level that students are allowed to talk about what they are doing. Terminology or language becomes important at this level. Students need to use the correct terminology that fits the concept or situation. Laboratory situations are also needed as real life situations are often difficult to observe directly. “Schematization is based on a need for more clarity” (p 1019). Once the image forms and more and more elements gradually become distinguished and named, connections are made between those elements. “Ultimately, schematization enables students to explain and justify what they are
doing, and to verify their results" (p. 1019).
Schematization is where students may start to question their own prior concepts because these prior concepts do not answer questions or solve problems which have now become important to them.

Theory Building

The third level is a natural progression from the first and second levels. The article describes this transition as going from image formation to schematization, to theory building. Theory building is making logic out of the schematization. "During schematization, images are described in words and pictures" (Korthagen & Lagerwerf, 1995, p. 1020). Logical arguments cannot be expressed in pictures. In theory building everything must be put into words, which easily results in all sorts of uncertainties. The transition between the theory building level and schematization is important. Incorrect logical connections or misconceptions are sometimes made because the structures in the schematization were insufficiently developed (1995).

In many situations, it is not always necessary or desirable to go from schemata to theory. However, "the final goal of the learning process should be to ensure that students are able to apply their knowledge"
This can be accomplished by going beyond the theory level to incorporate level reduction. The students' theory which was just developed (third level) must now be subjected to a variety of situations until their schematization functions as if it were images (first level), thus the name level reduction. Level reduction is similar to a student solving a mathematical problem in which the student can automatically recognize parts of the problem while being able to concentrate on forming new schematization to solve the rest of the mathematical problem.

"The theory of levels in learning helps us to realize that often misconceptions are not rooted in incorrect schematization, but in hasty and inadequate image formation, on the basis of which schematization then takes place" (Korthagen & Lagerwerf, 1995, p. 1034). Misconceptions can be replaced with correct concepts if certain conditions are met: 1) other experiences must be gained in situations where the student is familiar in order to lead them to question existing inadequate images; 2) the student can then focus attention on the characteristics which are important for the desired schematization; 3) reflection of those characteristics
will help the learners develop a new schematization themselves. If a misconception arises and the teacher happens to intervene with a hasty correct schematization, the teacher may hinder rather than promote the formation of adequate concepts.

Using Computer Technology to Enhance Learning

Image building and schematization are an important part of the learning process. Often science lessons start with experiments that are far removed from the students’ everyday life experiences and thus far from their existing images. A gap created between students’ existing images and the contents of the science lesson would promote the development of misconceptions. Concepts are built correctly or incorrectly in this process.

Research often emphasizes that students need to be active and purposeful learners engaged in construction and reconstruction of their personal concepts which they use to understand science (Osborne & Squires, 1987). This works well for concepts that have a hands-on activity that can be used for exploration. It does not work as well for lessons involving situations that cannot be duplicated easily in the classroom. As stated earlier, the real-world task approach works best for students to form new images
from real world experiences, but availability of resources, time constraints, and the teacher’s own limited creativity make it difficult to carry this off for every lesson (Liggitt-Fox, 1997). However computers can easily bring real world situations to the students. This would enhance student learning in science and it may help students to accomplish conceptual changes.

Computer Assisted Learning or using the computer as a learning tool has distinct advantages. There are four categories of learning experiences that can be provided by Computer Assisted Learning or CAL. These are: 1) Instructional, 2) Revelatory, 3) Conjectural, and 4) Emancipatory (Osborne & Squires, 1987). The first category, Instructional, provides valuable reinforcement and practice for basic skills. Instructional also provides immediate feedback for the students who need additional practice or help, and can be done while the teacher is busy with other students or projects.

The second category, Revelatory, provides simulations giving the student valuable opportunity to explore a model of an object that is not available in the classroom setting. The function is to “reveal” how something works and allow the student to develop an understanding of the system or model. This can give students an opportunity to
for real world experiences. Computers used in the Revelatory category can be used to test hypotheses, or can be used to evaluate conceptions by providing a conflict between predicted behaviors and their outcomes. This could give students feedback on the new images they are in the process of developing.

The third category, Conjectural, allows for experimentation so students can build on their experiences in their everyday interactions with the world. Conjectural gives immediate feedback to move away from misconceptions towards a deeper scientific understanding. Here their prior concepts would be challenged as they try things they think will work. This would also work well if it is done as a partner or group activity. It would provide the needed feedback of being able to talk through the experiment while using the necessary vocabulary or terms. An important part of the schematization level of learning (Korthagen & Lagerwerf, 1995). As students move through the experiment to higher levels of understanding, they will find the need to replace any misconceptions with the new concepts in order to make the experiment work correctly. Conjectural provides a structure for students' schematization and helps students accomplish conceptual changes.
Emanicipatory, the fourth and last category, is designed to extend and enhance the capabilities of the user. In science education, software used for data analysis and plot graphs are probably the most common examples. Just as word processor software has transformed many adults in the way they write, because they are less afraid of errors and the laboriousness of endless redrafts, the data analysis and plot graph software allows students to produce printed results of high quality, which in turn raises their self esteem, motivation and confidence (Osborne & Squires, 1987). This would effectively transition the student from the schematization level into the theory building level of learning.

The use of computers as a learning tool has other advantages as well. Computers also allow different entry points for learning. An important instructional strategy often used by teachers is to facilitate students' individual learning needs. Students, for example, who are visual learners and have strong spatial abilities, may require spatial entry points for learning. Drawing software or use of pictures and animation would engage these students while a regular traditional lesson might not. Students who are strong in linguistic abilities may require a verbal entry point for their learning, such as
use of word processing software. Using both in a lesson gives students concrete connections between imagery and verbal articulation (Reissman, 1993). These connections are an important part of Korthagen and Lagerwerf's three levels of learning.

Summary

The review of research literature revealed the importance of science misconceptions and how these misconceptions can interfere with learning in science; what is needed to remove the misconceptions, or for conceptual change to take place; why conceptual change is hard to accomplish; understanding how we learn and how that can impact prior concepts formed; and finally how computer technology could be used as a tool to help students accomplish conceptual change in science and ultimately enhance their learning in science.
CHAPTER THREE

METHODOLOGY

Introduction

Chapter Three documents the steps used in developing the project. Specifically, how the project was developed, the project’s content validation, the design of the project, the population served in this project and the treatment the data received, and how the data was analyzed for the project.

Development

The life science concept of how the lungs are involved in the circulatory system was chosen based on previous observations that more than half of my students, even after traditional teacher directed instruction, frequently were unable to replace misconceptions concerning how the heart circulates the blood. Interviews of several middle school science teachers who have taught this same concept revealed that they were also frustrated with the knowledge that after instruction a significant number of students would continue to hold onto misconceptions concerning how the heart circulates the blood.
Osborne and Squires have stated there was a "...need for children to be regarded as active and purposeful learners..." (1987, p. 373). Computer based instruction used in addition to or in place of traditional instruction, seemed a natural way to engage students in activities which would make them "active and purposeful learners." This project was therefore designed to investigate whether or not a computer aided lesson which would provide a way in which the students could be active participants in the learning process, could be a more effective way to replace misconceptions. My hypothesis for this project is that a lesson which uses computers to engage students as active participants, would be a more effective pedagogical tool in facilitating replacement of misconceptions with more correct science concepts than a traditional lesson.

Resources and Content Validation

Validation for this project culminates from the synthesis of many resources: Eric documents, California State University of San Bernardino School Library, the California State Science Education Standards as published by the California Department of Education, Sacramento, California (Bruton & Ong, 2000), various curriculum guides for science text and workbooks, as well as attendance of
national, state, and regional educational science and educational computer conference workshops.

Design

The science concept this study focused on was how the blood circulates through the human body, including how the blood picks up oxygen in the lungs for the purpose of exchanging oxygen for carbon dioxide. Learning about the circulatory system of the human body is a requirement of the seventh grade California State Science Education Standards as published by the California Department of Education, Sacramento, California (Bruton & Ong, 2000). The lessons dealt with the chemistry of oxygen/carbon dioxide replacement in the lungs on a basic blood and cellular level.

All students were given four open-ended questions as a pre-assessment (Appendix D), designed to evaluate students’ prior knowledge about how the lungs are involved with the circulatory system. The four questions were:

1) How do we get oxygen into our bodies?
2) Where does it go first?
3) How are blood cells involved?
4) Briefly describe, the best you can, the path the blood takes through our bodies, including the path through the heart.
These questions were given on May 30th, 2001. General notes about the circulatory system, including vocabulary, were given on June 4th, 2001 to all classes. On June 5th, 2001, all classes received a lesson in which students were given a diagram of the heart. Lesson plans for both lesson and worksheets can be found in Appendix E. In the traditional classes, students were shown how the blood circulates through the heart and to the lungs to pick up oxygen and release carbon dioxide before returning to the heart to be pumped to the rest of the body, by the teacher using an overhead of the same diagram. Students complete the diagram, "The Heart", showing how the blood circulates through the heart including labeling the parts of the heart, as the teacher models how to complete the diagram. This lesson has been taught this way for several years. Students were then given the worksheet, "Keep the Blood Moving", to complete on their own. The worksheet consisted of questions about the path of the blood through the heart, which could be answered using the diagram they had just completed.

Students in the computer aided lesson worked in pairs on computers in the school computer lab. They were required to complete the same diagram, "The Heart", and the worksheet, "Keep the Blood Moving", by visiting
appropriate, teacher designated, animated web sites on the human heart and respiratory systems. The main difference provided by the animated web sites compared to the traditional lesson, was that the heart could be observed actually working. This is not possible in a traditional classroom setting. This is a "real world" experience that computer technology can provide easily. Computers may also require an active participation on the part of the student, for example by having them answer questions, click on items for information, or solve problems. Students using computers in this way are able to get immediate and individualized feedback. Traditional lessons cannot always offer this, especially when the lesson involves internal organs of the human body, and there is only one teacher for immediate feedback in a classroom of students.

The project web sites are shown in Appendix G. These include:

1) Nova online Electric Heart
   http://www.pbs.org/wgbh/nova/eheart/human.html
   (Human heart)

2) Think Quest Junior
   http://tqjunior.thinkquest.org/5777/cir3.htm
   (Human heart of the circulatory system)
http://tqjunior.thinkquest.org/5777/respl.htm
(Respiratory system)

These educational web sites, some of which are animated, give tours through the heart and the respiratory system along with facts and information.

All students were also given three more worksheets on June 6th, 2001, a word search/puzzle sheet, a basic "fill in the blank" worksheet, and a concept map to reinforce the concept of the lungs involvement in the circulatory system and vocabulary for the circulatory system. They were to complete these during class time working alone or with students at their tables. Any work which was not completed during class time was to be completed as homework.

Two days after the lesson, (June 7th, 2001), the worksheets handed out on the previous day were discussed by having the students volunteer answers. Students then handed in all notes and worksheets, and a post-test (Appendix D), was given which contained the same four questions as the pre test. All students received a grade for completing the questions. Their grade did not depend on "correct" answers. The pretests and post tests of students involved in the study were later evaluated for accuracy of responses and misconceptions.
The lessons took about three class periods (three days) to complete over a period of one week. Students were given the post-assessment within three school days of students completing the lessons and assigned work.

Individual interviews were also going to be a part of this project. The interviews would consist of the same four questions which were used pre and post of the lessons, and would be conducted approximately two to three weeks after the lessons. However, because of testing schedules at the school and end-of-the-year activities that were going on during the last two weeks of school, there was not enough time to complete interviews with the students involved in the study.

Population Served

Students and their parents/guardians were given information about the study (Appendix A). Signed permission forms from both were required in order for a student to participate in the study. Four of my science classes were selected to be the focus of the study. Two classes were randomly chosen to receive a traditional lesson and the other two were chosen to participate in computer aided instruction. Out of the four science classes, each consisting of 32-35 students, 71 students
chose to participate. Of this number, 20 matched pairs of students were selected. Matched pairs consisted of a student representing each lesson (traditional and computer aided) and matched according to their age, gender, race, home language, attendance records, sixth grade SAT 9 scores when available and student’s science grades for the year. Data was collected and evaluated for the twenty matched pairs for the main part of the study. Data collected from the other 31 students was also evaluated and included in the study, and are referred to as “the non-matched students”.

Treatment

Data collected during the study includes the student’s gender, race, home language, English language development level, attendance record, last SAT 9 scores, science grades for this school year, and the results of the students’ learning about the circulatory system. Once the data was collected, any identifying code that links data to an individual student would be removed and destroyed. No publication will identify the district, the school, or an individual student or provide information that would enable their identification. Participation in this study was totally voluntary and students were free to
withdraw at any time during the study. Students not participating in the study still completed one of the two lessons; however no data was collected on these students.

Data Analysis Procedures

Data analysis was done by using Microsoft Excel to create tables and graphs in which student responses could be categorized, counted, and displayed.

Summary

Chapter three has explained how this project was developed, how the project was validated, how the project was designed, what population is served for this project, how the data in the project was treated and received, and finally how the data in this project was analyzed.
CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

Included in Chapter Four is a presentation of the results from this project. The findings consist of student responses to four questions which were used as pre and post assessments. These are displayed in three different tables. Table #1 shows the findings for student responses considered accurate or correct for the four questions. Tables #2 and #3 show how all the other responses to the four questions were categorized. Figures #1-#4 show the data in graphs. The tables and figures refer to the computer aided instruction lesson as “CAI”, and the traditional lesson as “TL”. Further, all these findings are discussed.

Presentation of the Findings

The four questions and the type of responses which were considered correct for the pre and post assessment of both lessons were:

Question #1 How do we get oxygen into our bodies?

We get oxygen into our bodies by breathing or inhaling.
Question #2  Where does it go first?

The oxygen goes into our lungs first.

Question #3  How are our blood cells involved?

Our blood cells carry the oxygen to all parts of our body.

Or

Blood cells exchange carbon dioxide for oxygen.

Question #4  Briefly describe, the best you can, the path the blood takes through our bodies, including the path through the heart.

The path the blood travels is through the heart, to the lungs, back to the heart, out to the body, and back to the heart.

Or

A diagram showing the same path.

Table 1 shows the number of responses made by students which were considered correct or accurate for the four questions in both lessons, pre and post.
Table 1.

Chart of Correct or Accurate Answers Pre and Post

<table>
<thead>
<tr>
<th>Accurate Answers</th>
<th>Question #1</th>
<th>Question #2</th>
<th>Question #3</th>
<th>Question #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matched Pairs</td>
<td>Pretest</td>
<td>Pretest</td>
<td>Pretest</td>
<td>Pretest</td>
</tr>
<tr>
<td>CAI</td>
<td>17</td>
<td>12</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>TL</td>
<td>12</td>
<td>9</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Matched Pairs</td>
<td>Post-test</td>
<td>Post-test</td>
<td>Post-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>CAI</td>
<td>10</td>
<td>12</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>TL</td>
<td>9</td>
<td>5</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Non-matched</td>
<td>Pretest</td>
<td>Pretest</td>
<td>Pretest</td>
<td>Pretest</td>
</tr>
<tr>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>18</td>
<td>9</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>8</td>
<td>9</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Non-matched</td>
<td>Post-test</td>
<td>Post-test</td>
<td>Post-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>TL</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>2</td>
</tr>
</tbody>
</table>

CAI = Computer Aided Instruction  
TL = Traditional lesson

Pre Assessment Data

In the pre-assessment for the members of the matched pairs that received computer aided instruction, 85% provided correct responses for question #1, 60% for question #2, 30% for question #3, and 1% correct for question #4. In the pre-assessment for the members of the matched pairs that received traditional instruction, 60% provided correct responses for question #1, 45% correct
for question #2, 30% correct for question #3, and zero for question #4.

In the pre-assessment for the 31 non matched students that received computer aided instruction, 58% gave correct responses for #1, 29% for #2, 16% for #3, and 0% for #4. In the pre-assessment for the traditional lesson of the same group of students, 25% gave correct responses for #1, 29% for #2, 1% for #3, and 0% for #4.

Post Assessment Data

In the post-assessment for the members of the matched pairs that received computer aided instruction, 50% gave correct responses for question #1, 60% for #2, 40% for #3, and 20% for #4. In the post assessment for the members of the matched pairs that received the traditional lesson, 45% gave correct responses for question #1, 25% for #2, 40% for #3, and 10% for #4.

In the post assessment for the members of the 31 non-matched students that received computer aided instruction, 26% gave correct responses for #1, 23% for #2, 23% for #3, and 20% for #4. In the post assessment for the members of the 31 non-matched students that received the traditional lesson, 23% gave correct responses for #1, 13% for #2, 23% for #3, and 1% for #4.
Computer Aided Lesson/Matched Pairs

Figure 1 contains a graph which compares the 20 matched pairs of student responses, pre and post, which were considered accurate or correct for the four questions.

Figure 1.
Computer Aided Lesson Matched Pairs Pre and Post Responses

Question #1

This question showed a drop of 35%, or a change of 17 students responding correctly on the pretest, to only 10 students responding correctly on the post-test.
**Question #2**

This question showed no change in the number of correct responses for the pretest and post-test.

**Question #3**

This question showed a gain 10%, or a change of six students responding correctly on the pretest, to eight students responding correctly on the post-test.

**Question #4**

This concept was the primary focus of this study. It was hoped that the greatest gains would be made with this concept, post assessment. This question showed a gain of 15%, or only one student responding correctly on the pretest, to four students responding correctly on the post-test.

**Traditional Lesson/Matched Pairs**

Please refer to Figure 2, Traditional lesson Matched Pairs Pre and Post Responses for the following results.

**Question #1**

This question also showed a drop of 15%, or 12 students responding correctly on the pretest, to nine students responding correctly on the post-test.
Figure 2.

Traditional Lesson Matched Pairs Pre and Post Responses

Question #2

This question showed a drop of 20%, or a change of nine students responding correctly on the pretest, to only five students responding correctly on the post-test.

Question #3

This question showed a gain of 10%, or a change of six students responding correctly on the pretest, to eight students responding correctly on the post-test.
Question #4

This question showed a gain of 10% with no correct responses for the pretest, to two students responding correctly on the post-test.

Discussion of the Findings

Table 2 represents how all the responses which were considered not accurate or correct for the 20 matched pairs of students were categorized. Discussions of these findings were based on what these alternative responses were and their numbers.

Table 2. Chart of Matched Pairs Alternative Responses Pre and Post

<table>
<thead>
<tr>
<th>Matched Pairs</th>
<th>Question #1</th>
<th>Question #2</th>
<th>Question #3</th>
<th>Question #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>#1 Nose/Mouth</td>
<td>#2 Nose/Mouth</td>
<td>#3 Blood Cells Need Oxygen</td>
<td>#4 Veins/Heart/Blood</td>
</tr>
<tr>
<td>CAI</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>3</td>
<td>6</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Post-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 Yawn</th>
<th>#2 Mouth/Throat/Stomach</th>
<th>#3 Heart Pumps Blood Cells/Helps</th>
<th>#4 Goes Around Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Post-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pretest</td>
<td>#1 Lungs</td>
<td>#2 Carbon 1st then Oxygen</td>
<td>#3 Help Muscles/Body Work/Grow</td>
<td>#4 Veins/Body</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
<td>---------------------------</td>
<td>-------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>CAI</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-test</th>
<th>#1 Pulmonary Arteries</th>
<th>#2 To Body</th>
<th>#3 Help Process/Get Oxygen</th>
<th>#4 Heart/Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

| CAI       | 2                     | 0          | 1                         | 0            |
| TL        | 0                     | 0          | 0                         | 0            |

<table>
<thead>
<tr>
<th>#3 Blood Cells go Around Body/Cycle</th>
<th>#4 Lungs/Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-test</th>
<th>#1 Pulmonary Arteries</th>
<th>#2 Heart Chamber/Arteries</th>
<th>#3 Gets Blood Cells Pumped Up</th>
<th>#4 Heart/Body/Bra In</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-test</th>
<th>#1 Heart Chamber/Arteries</th>
<th>#2 Heart Chamber/Arteries</th>
<th>#3 Gets Blood Cells Pumped Up</th>
<th>#4 Heart/Body/Bra In</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#3 Fight Bacteria/Clean Blood</th>
<th>#4 Heart, Veins, Lungs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 By the Sun</th>
<th>#2 Blood Cells Blood</th>
<th>#3 Help Lungs Work</th>
<th>#4 Brain Veins/Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-test</th>
<th>#1 Circulatory System</th>
<th>#2 Lungs to Heart</th>
<th>#3 Help Lungs Work</th>
<th>#4 Brain Veins/Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-test</th>
<th>#1 Circulatory System</th>
<th>#2 Lungs to Heart</th>
<th>#3 Help Lungs Work</th>
<th>#4 Brain Veins/Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pretest</td>
<td>#3 Without BC's no Skin/You die</td>
<td>#4 Circulatory System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------------</td>
<td>-----------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-test</th>
<th>#3 Gets Heart Started</th>
<th>#4 Head/Lungs/H eart/Stomach</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#3 Gives Oxygen to Heart</th>
<th>#4 Heart Chambers</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#3 Get Oxygen from Lungs/to Lungs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 No Answer</th>
<th>#2 No Answer</th>
<th>#3 No Answer</th>
<th>#4 No Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-test</th>
<th>#1 No Answer</th>
<th>#2 No Answer</th>
<th>#3 No Answer</th>
<th>#4 No Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Totals</th>
<th>#1 No Answer</th>
<th>#2 No Answer</th>
<th>#3 No Answer</th>
<th>#4 No Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI</td>
<td>17+3=20</td>
<td>12+8=20</td>
<td>6+14=20</td>
<td>1+19=20</td>
</tr>
<tr>
<td>TL</td>
<td>12+8=20</td>
<td>9+11=20</td>
<td>6+14=20</td>
<td>0+20=20</td>
</tr>
<tr>
<td>CAI</td>
<td>10+10=20</td>
<td>12+8=20</td>
<td>8+12=20</td>
<td>4+16=20</td>
</tr>
<tr>
<td>TL</td>
<td>9+11=20</td>
<td>5+15=20</td>
<td>8+12=20</td>
<td>2+18=20</td>
</tr>
</tbody>
</table>

CAI = Computer Aided Instruction
TL = Traditional lesson
Table 3 represents how all the responses which were considered not accurate or correct for the 31 non-matched students were categorized. Discussions of these findings were based on what these alternative responses were and their numbers.

Table 3. Chart of Non Matched Student Alternative Responses Pre and Post

<table>
<thead>
<tr>
<th>Non-Matched Pairs</th>
<th>Pretest</th>
<th>#1 Nose/Mouth</th>
<th>#2 Nose/Mouth</th>
<th>#3 Blood Cells Need Oxygen</th>
<th>#4 Heart/Body/ Veins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>CAI</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Post-test</td>
<td>CAI</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 Lungs</th>
<th>#2 Body/Stomach</th>
<th>#3 Keeps Oxygen Flowing</th>
<th>#4 Veins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>CAI</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Post-test</td>
<td>CAI</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 From Blood</th>
<th>#2 Heart</th>
<th>#3 Help Muscles/Body Work</th>
<th>#4 Through the Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>CAI</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Post-test</td>
<td>CAI</td>
<td>2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 Pulmonary Arteries</th>
<th>#2 Windpipe</th>
<th>#3 Fights Bacteria/Cleans Blood/Air</th>
<th>#4 Heart to Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>CAI</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Post-test</td>
<td>CAI</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pretest</td>
<td>#1 Blood/Veins</td>
<td>#2 Skin</td>
<td>#3 Pumps</td>
<td>#4 Heart &amp; Veins</td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
<td>---------</td>
<td>----------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blood/Circulates Blood</td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 Blood/Veins</th>
<th>#2 Skin</th>
<th>#3 Pumps</th>
<th>#4 Heart &amp; Veins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blood/Circulates Blood</td>
<td></td>
</tr>
<tr>
<td>Post-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 Heart Chamber/Arteries</th>
<th>#2 Heart Blood move Lungs/Heart/Veins/Mouth</th>
<th>#3 Blood Cells Produce Blood/Oxygen</th>
<th>#4 Heart Chambers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 Lungs to Heart</th>
<th>#2 Blood</th>
<th>#3 Blood Cells Produce Blood/Oxygen</th>
<th>#4 Heart Chambers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 Yawn</th>
<th>#2 Blood</th>
<th>#3 Heart and Lungs</th>
<th>#3 Need Red Blood Cells</th>
<th>#4 Circulatory System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#1 Yawn</th>
<th>#2 Blood</th>
<th>#3 Need Red Blood Cells</th>
<th>#4 Circulatory System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#3 Involved with Lungs</th>
<th>#4 Lungs to Tummy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#3 Stores Oxygen/Gives</th>
<th>#3 Stores Oxygen/Gives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>TL</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pretest</th>
<th>#3 Stores Oxygen/Gives</th>
<th>#3 Stores Oxygen/Gives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>TL</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>#1 No Answer</td>
<td>#2 No Answer</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>CAI</td>
<td>0</td>
<td>1F</td>
</tr>
<tr>
<td>TL</td>
<td>0</td>
<td>1F</td>
</tr>
</tbody>
</table>

Post-test

| CAI     | 0            | 0            | 0            | 4F, 1M       |
| TL      | 0            | 0            | 1M           | 1F, 2M       |

**Totals:**

<table>
<thead>
<tr>
<th>CAI</th>
<th>Pretests</th>
<th>Post-tests</th>
<th>Pretests</th>
<th>Post-tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>18+1=19</td>
<td>9+10=19</td>
<td>5+14=19</td>
<td>0+19=19</td>
<td></td>
</tr>
<tr>
<td>8+4=12</td>
<td>9+3=12</td>
<td>2+10=12</td>
<td>0+12=12</td>
<td></td>
</tr>
<tr>
<td>1F</td>
<td>2M</td>
<td>1F, 2M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TL</th>
<th>Pretests</th>
<th>Post-tests</th>
<th>Pretests</th>
<th>Post-tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAI</th>
<th>Pretests</th>
<th>Post-tests</th>
<th>Pretests</th>
<th>Post-tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>8+11=19</td>
<td>7+12=19</td>
<td>7+12=19</td>
<td>6+13=19</td>
<td></td>
</tr>
<tr>
<td>7+5=12</td>
<td>4+8=12</td>
<td>7+5=12</td>
<td>2+10=12</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

CAI = Computer Aided Instruction
TL = Traditional lesson

Figures 3 and 4 are graphs showing the data collected from the 31 non-matched student responses pre and post for both lessons.

![CAI Non-Matched Pre/Post-test Accurate Responses](image)

Figure 3.

Computer Aided Lesson Non-matched Students Pre and Post Responses
Figure 4.

Traditional Lesson Non-matched Students Pre and Post Responses

Question #1

The correct or accurate response expected for how we get oxygen into our lungs was that we breathe it in. All of the students in the traditional lesson, who responded in the pretest that we get oxygen through our nose and/or mouth, changed their answers in the post test to breathing or breathing through our nose and/or mouth. The student in the computer aided lesson, who responded in the pretest that we get oxygen through our nose and/or mouth, changed
his/her answer to “It comes from the mouth to the lungs...” in the post test. Alternative responses stating that the oxygen comes to the lungs first or to the pulmonary arteries increased as a post-test response with the computer aided lesson by five more students. These responses show the students understood that the oxygen we take in is connected to the function of the lungs. The other alternative responses indicated the students were thinking in terms of the blood and the heart as pumping and/or carrying the oxygen. These alternative responses would not be considered misconceptions even though these were not the accurate or correct response expected.

The only unexpected responses or misconception that came to my attention for this question were found in both the pretest responses for the traditional lesson and the computer aided lesson. One response listed the sun as our source of oxygen and the other stated that we got oxygen by yawning rather than breathing. The post-test response for the sun was changed to “We get oxygen into our bodies from our lungs.” The post-test response for the yawn was changed to “We get oxygen into our bodies by breathing and yawning.”
Question #2

The number of responses considered accurate or correct for where the blood goes first for the computer aided lessons, remained the same for both the pretest and the post-test. Alternative responses for the computer aided lesson on the post-test show that students thought about oxygen going into the mouth and/or nose first. The responses for the traditional lesson went down by 20%. The other alternative responses for the computer aided lesson and the traditional lessons on the post-test show the students were beginning to think in terms of the lungs and the heart receiving the blood first. There were a total of eight of these responses for the computer aided lessons and nine for the traditional lessons. Again, these alternative responses would not be considered misconceptions.

Question #3

The responses for how the blood cells are involved in how we get oxygen improved in the post-test by two more correct answers in both the computer aided lesson, and the traditional lesson. Alternative responses for the pretest, computer aided lesson, which were the highest in number, were that the blood cells need oxygen, and the blood cells help process or get oxygen. The largest number of new
responses for the post-test computer aided lesson contained statements about the fact that the blood cells fight bacteria or clean the blood. This is not necessarily a misconception; it could simply show the students were not thinking about blood cells in terms of carrying oxygen.

As in the computer aided lesson, many alternative responses for the traditional lesson pretest contained statements which stated the blood cells help process and/or get oxygen. Many alternative post-test responses contained statements which showed that the students in the traditional lessons were also thinking about the fact that the blood cells fight bacteria or clean the blood.

**Question #4**

Responses to Question #4 were important as the students' answers would indicate whether or not they had made the connection of how the lungs are involved in the path of the blood through the heart and the rest of the body. The post-test responses for this question show a small gain for both the computer aided lesson and the traditional lesson. The highest number of new post-test responses for both the computer aided lesson and the traditional lesson, contained statements about the blood circulating to the heart and the lungs without mentioning
the blood going to the body. These alternative responses increased from zero in the pretest to six in the post-test. This would indicate that the students were definitely making a connection of the fact that the lungs are involved in the how the blood circulates through the heart. As with all questions that consist of two parts, sometimes students forget about answering the second part of the question, (Briefly describe, the best you can, the path the blood takes through our bodies, including the path through the heart). This does not necessarily mean they do not know the correct answer, or that they have developed misconceptions.

A significant change was found from the pretest to the post-test responses of the computer aided lesson and the traditional lesson. Seven students in the computer aided lesson, and three students in the traditional lesson, wrote initially about the blood circulating between the heart and the body. This response was not given for either the computer aided lesson or the traditional lesson in the post-tests. This is important as it shows the students started thinking of how the blood circulates throughout the body in different ways.

Another significant response was found in the post-test category of the computer aided lesson. A new
response was given by four students who described the path of the blood through the chambers of the heart. This indicates the animated web sites of the circulatory system had a positive effect on the students in learning how the blood circulates through the heart.

Question number #4 also had the highest number of “no answer” for the pretests of both the computer aided lesson and the traditional lesson. Nine students did not give answers for the computer aided lesson and six students did not give answers for the traditional lesson. This number decreased in the post-tests for the computer aided lesson by five students (nine students pre and only four students post), but the number did not change for the traditional lesson (six students pre and post). This would indicate that some of these students may still have misconceptions about the concept, or they may still not understand the concept, or they were very uncertain of their knowledge of the concept.

Summary

Chapter Four explains the findings for the student responses to the four questions which were used as pre and post assessments for this project. These responses are
also displayed in three tables and four graphs in this chapter. Further, all these findings are discussed.
CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Introduction

Included in Chapter Five is a presentation of the conclusions from data (responses to the four questions used as pre and post assessments for the 20 matched pairs of students) collected as a result of completing the project. Further, recommendations are presented based on the questions and responses given in the project and on the procedures of the project for additional research and instruction. Lastly, the Chapter concludes with a summary

Conclusions

The conclusions extracted from the project follows:

1. Two misconceptions identified in question #1 of the pre assessment for both lessons were changed to more correct concepts in the post assessment, showing that both lessons helped the students make conceptual changes.

2. The pre and post for both lessons for question #2 indicated no change in correct responses. Some of the responses may indicate that a few students gave answers to what they thought the teacher wanted. This does not mean they
necessarily understood the concepts in the lessons, it may merely show that students can memorize what is needed to pass a test. The alternative responses did not indicate any misconceptions were formed; however without personal interviews a conclusion cannot be drawn.

3. Question #3 was somewhat misleading in that the alternative response many students made was that the blood cells fight bacteria. It depends on how the student was thinking at the time. This does not appear to be a misconception, it may be a student getting off the train of thought the questions were following.

4. The most gain anticipated for this project was the change in the number of responses from pre to post for question #4. It is encouraging that no students gave a response about the blood circulating between the heart and body only on the post tests. However, four students responded by naming the chambers of the heart as the path the blood takes, but left out the lungs, so either no connection was made with the lungs and the circulation of the blood, or they simply
memorized the chambers of the heart thinking this was the answer needed for the test.

5. The “no answer” response for question #4 in the computer aided lesson showed the largest gain (nine students did not respond in the pre and only four students did not respond in the post). It is encouraging that more students in the computer aided lesson gave more responses on the post assessment. The animated web sites of the heart and the respiratory system seemed to help some students engage in the lesson enough to gain confidence and attempt answers for the post assessment. The traditional lesson apparently did not have the same effect, as the number of responses for pre and post did not change (six students in both).

6. Three students gave the complete correct answer in response to question #4 in the computer aided lesson, and two students in the traditional lesson. This project does not appear to have proven that a computer aided lesson would have more effect in helping to replace misconceptions for this question.
7. There were fewer alternative responses in the computer aided lesson than the traditional lesson in questions #2, #3 and #4. All of the alternative responses for #1 were considered correct. Here again it may be that the computer aided lesson helped to engage the students to become active participants in the lesson and in the process helped to change any misconceptions into more correct concepts.

8. The fact that there was not a great difference in the number of responses in the post assessment for question #4 is also encouraging. Traditional lessons apparently also work. A hands-on lesson which included a dissection of an animal heart would have been a good lab for this lesson, but this is not always possible because of cost, available equipment, and/or the teacher’s expertise and comfort level. However, even with the dissection of the heart, this investigator has experienced that it is hard to demonstrate the lung’s involvement. This investigator has done a sheep heart dissection lab with high school students. Students used a bamboo skewer to demonstrate how the blood
flowed through the heart, to the lungs, and back into the heart before going out to the body. Several students did not understand this concept. Students who did not understand were instructed to watch as other students explained and demonstrated the pathway. Eventually most of these students would then be able to perform their own demonstration correctly. Computer technology seems to be a good way to engage students to become active participants and give the students "real world" experiences, such as looking into a pumping heart, that traditional classrooms often cannot. Computer technology can also supply as much practice as needed and immediate feedback, which is also not always possible in a traditional classroom setting.

Recommendations

The recommendations resulting from the project for further research follows:

1. This project could be set up early in the school year by reserving the school computer lab several times during the school year, if possible, in order for classes to participate in
computer aided lessons. The students would then consider the project to be just another lesson. This would help the students not involved in the computer aided lesson from feeling left out and might encourage more participation.

2. This project could be set up to involve several teachers and their science classes in order to collect more data.

3. The alternative responses might be analyzed more effectively if a later post assessment of the same four questions was given in personal interview with the students. This would also help determine if any students reverted back to their prior concepts, including misconceptions, they might have formed.

4. In order to have a more effective analysis of Question #4, I would suggest that it not have two parts. Students sometimes do not answer both parts of a two-part-question, and that should not be a factor in the analysis of the data.

The recommendations resulting from the project for instruction follows:

1. Overall, this project has shown that the use of computer technology in a lesson can enhance
students' learning, and does not necessarily create any more misconceptions than a traditional lesson might. Post test results were consistently higher for questions #1, #2, and #4, and remained the same for question #3. Question #3 asked students to infer that the purpose of the blood in this situation (by circulating to the lungs and back to the heart), was to carry oxygen to all parts of the body to exchange carbon dioxide for oxygen. Many other students inferred or made connections correctly but different from what was considered accurate or correct for this question.

This study indicates that using computer technology is recommended to enhance a traditional lesson or even replace it. All students learn differently and offering more vehicles to engage students and make them "active and purposeful learners", would simply be good teaching.

2. This project also raises the need to more fully define the characteristics of "active" and "hands-on" teaching and learning, including the extent to which computer technology use actually
engages student thinking and investigation and experiences beyond the strategies employed in traditional instruction. This study suggests that using computer aided instruction per se may not add significantly more to student learning of science concepts than traditional instructional approaches unless computer aided instruction is designed to engage student involvement in thinking and experiencing much beyond the involvement required with traditional instructional tasks.

Summary

Chapter Five reviewed the conclusions based on the analysis of student responses to the four questions in the project which were used as a pre and post assessment. Lastly, the recommendations derived from the project were presented for further research and for instruction.
APPENDIX A

INFORM CONSENT
Dear Student of Ms. Peterson’s Science Classes:

I am asking your permission to have you take part in a study that will be conducted by me, under the supervision of Dr. Bonnie Brunkhorst, Professor at California State University San Bernardino. The Institutional Review Board of California State University San Bernardino has approved this study. Your informed consent is required by California Education Code law section EC51513.

This study is an opportunity for you to be involved in my science project, complete with a problem or question, a hypothesis or prediction, collection of data, and a conclusion similar to the science skills you use in my science class. My question or problem is about which two different teaching methods work better to improve your learning in science. You will be randomly selected to be in one of the two lessons, one that uses a hands-on computer technology lesson, and the other that is more like a regular classroom lesson. Data will be collected on what is learned with each lesson. You will be asked to take notes on the human circulatory system, complete a diagram/map of how blood circulates through the human heart, and answer four questions about the human circulatory system.

In order to collect data about which different teaching method works best, you will be asked four questions about the circulatory system before the lesson, within three days after the lesson, and finally about two to four weeks after the lesson is completed. These four questions will take approximately twenty minutes each time. The final assessment will be an individual interview using these same four questions, and no other questions. Students who are involved in the hands-on computer instructional strategy, and do not have parent/guardian consent for Internet use, will complete a similar lesson using library resources (books) on the human circulatory system.

Data that I will collect during the study will include your gender, race, home language, English language development level, attendance record, last SAT 9 scores, science grades for this school year, and the results of what you learned about the circulatory system. Once the data is collected and my report is written, please be assured that no one will be able to identify you, your school, or even the school district.

Please understand that your participation in this study is totally voluntary and you are free to withdraw at any time during this study without affecting your science grade. If you do not choose to participate in the study, you will still be completing one of the two lessons for a science grade, however no data will be collected on you or the class work you complete on the circulatory system.

You should find the results of this study very interesting. There are no foreseeable risks to students involved in this study. The goal of the study is to have you learn about the circulatory system. At the conclusion of the study (hopefully by next fall), you and your parents may receive a report of the results if you wish. If you have any questions or concerns, please see me, when appropriate, during class or anytime after school until 3:15 P.M.

Please sign below your acknowledgment that you have been informed of, understand the nature and purpose of this study, and freely consent to participate or not participate.

I __________________________ agree to participate in this study.

Student’s Name

I __________________________ do not want to participate in this study.

Student’s Name

Class Period _______ Date _______

________________________________________ Date ____________________

Researcher’s (Ms. C. Peterson’s) Signature
Dear Parent and Guardians of Ms. Peterson's Science Classes:

I am asking your permission to have your child take part in a study that will be conducted by me, under the supervision of Dr. Bonnie Brunkhorst, Professor at California State University San Bernardino. This study has been approved by the Institutional Review Board of California State University San Bernardino. Your informed consent is required per the California Education Code law section EC51513.

This study is an opportunity for your child to be involved in one of two different, district approved, instructional strategies. In an effort to tailor different individual learning styles, two different teaching methods will be used and compared. Students will be randomly selected to receive instruction using a hands-on computer technology environment, or a traditional instructional strategy. Data will be collected on what is learned in each environment, as data would normally be collected for any regular science instruction. Students in each class will be asked to take notes on the human circulatory system, complete a diagram/map of how blood circulates through the human heart, and answer four questions about the human circulatory system.

In order to evaluate the effectiveness of the two different learning methods for replacing students' science misconceptions, students' knowledge about the circulatory system will be assessed before the lesson, within three days after the lesson, and finally about two to four weeks after the lesson is completed. The assessment will consist of four questions related to the circulatory system, and will take approximately twenty minutes each time. The final assessment will be an individual interview format, using the same four questions. Students who are involved in the hands-on computer instructional strategy, and do not have parent/guardian consent for the Middle School's Internet Acceptable Use Agreement form on file with a sticker showing this permission on their student identification cards, will complete the lesson using library resources (books) on the human circulatory system.

Data collected during the study will include the student's gender, race, home language, English language development level, attendance record, last SAT 9 scores, science grades for this school year, and the results of the students' learning about the circulatory system. Once the data is collected, please be assured that any identifying code that links data to an individual student will be removed and destroyed. No publication will identify the district, the school, or an individual student or provide information that would enable their identification.

Please understand that participation in this study is totally voluntary and you are free to withdraw your student at any time during this study without affecting their science grade. Students not participating in the study will still be completing one of the two lessons, however no data will be collected on these students.

Parents should find the results of this study very interesting. There are no foreseeable risks to students involved in this study. The goal of the study is to have students learn about the circulatory system using two, district approved, acceptable instructional strategies. At the conclusion of the study (hopefully by next fall), you may receive a report of the results if you wish.

Please sign below your acknowledgment that you have been informed of, understand the nature and purpose of this study, and freely consent to have your student participate or not participate. By signing your name below, you also acknowledge that you are at least 18 years of age.

I ____________________________ freely consent to have my child participate in this study.
I ____________________________ do not wish to have my child participate in this study.

Child's Name ____________________________ Date ________________
Science Class Period ____________________________

_________________________________________ Date ____________
Researcher's (Ms. C. Peterson's) Signature
Estimados padres y tutores de los alumnos de la clase de Ciencias Naturales de la Sra. Peterson:

Este estudio proporciona la oportunidad para que su estudiante se involucre en una de las dos estrategias metodológicas aprobadas por la administración de la escuela, con el objeto de implementar diferentes estilos individuales de aprendizaje; dos métodos diferentes de enseñanza serán aplicados y comparados. Los estudiantes serán seleccionados al azar y serán expuestos a estrategias metodológicas diferentes. Los estudiantes serán seleccionados para recibir instrucción apoyada por el uso de los computadores, o para recibir instrucción en formas tradicional. Los datos que arrojen los diferentes métodos en relación con el aprendizaje alcanzado por los estudiantes serán registrados de la misma manera como se registran datos en cualquier instrucción normal dada en la clase de ciencias. A los estudiantes en cada grupo se les pedirá que tomen notas acerca del sistema circulatorio humano, que complete un mapa o un diagrama de cómo la sangre circula por el corazón humano, y que contesten a cuatro preguntas relacionadas con el sistema circulatorio. Los estudiantes que fueron seleccionados para someterse a la estrategia metodológica de los computadores, pero que no tienen en el archivo de la escuela el consentimiento de los padres o tutor expresado en la forma del Contrato del Uso Apropiado del Internet requerido por la Escuela Secundaria Sierra, con la correspondiente calcomanía adherida a la tarjeta de identificación, completarán las lecciones utilizando los recursos relacionados con el sistema circulatorio disponibles en la biblioteca escolar.

La información de alumno recopilada durante el estudio incluirá el género, la raza, el idioma del hogar, el nivel en el desarrollo del idioma inglés, las calificaciones del último examen SAT, las calificaciones de su clase de ciencias naturales de este año, y los resultados de la evaluación sobre el sistema circulatorio que se hizo antes y después de la clase. Una vez que la información sea recopilada, este seguro que en el estudio no revelará la identidad de la escuela, del distrito, ni la de los alumnos. Los alumnos recibirán calificaciones por completar el trabajo del sistema circulatorio.

Los padres encontrarán los resultados de este estudio muy interesantes. Se entiende que la participación en el estudio es completamente voluntaria. Usted puede sacar a su hijo/a del estudio en cualquier momento sin que afecte sus calificaciones en su clase de ciencias naturales. Los alumnos que no participen en el estudio completarán de todas maneras una de las dos clases y recibirán una calificación por el trabajo hecho. Sin embargo no se registrara información personal de estos alumnos.

Los alumnos no deben pasar por ninguna incomodidad o riesgo al participar en este estudio. La meta del estudio es que los alumnos aprendan acerca del sistema circulatorio usando dos estrategias de instrucción aprobadas por la administración de la escuela. A la conclusión del estudio, después del examen del estudio, al que lo desea puede recibir un informe sobre los resultados. Si tiene alguna pregunta por favor comuníquese conmigo en la Escuela Secundaria Sierra al 369/735-7301 después de las 4:45 p.m.

Por favor firme abajo para afirmar que se le informó acerca del estudio que entiende la naturaleza y propósito del mismo, y para dar su consentimiento para que su hijo/a participe o para negar su permiso de participación si así lo prefiere.

Doy mi consentimiento para que mi hijo/a __________________________________________ participe en este estudio.

Nombre del alumno

No doy consentimiento para que mi hijo/a __________________________________________ participe en este estudio.

Nombre del alumno

Firma del Padre/Tutor __________________________ Fecha: ____________

Firma del investigador __________________________ Fecha: ____________
APPENDIX B

DEBRIEFING
Study of Science Misconceptions and Computer Aided Instruction Debriefing
Statement For Child Participant

The study you have just completed was designed to investigate how effective two different science lessons are for replacing any science misconceptions you might have concerning the circulatory system. This study is like the science experiments you do in science. The study has a problem or a question, and a hypothesis or prediction about the outcome. The question for this study was: Will a computer aided science lesson help replace science misconceptions better than a more traditional science lesson?

Misconceptions are incorrect ideas about a science concept. You come each day to class with ideas or concepts you have formed about what you have learned and what you will be learning. Sometimes at the beginning, and/or at the end of a lesson, the concepts formed are incorrect. When incorrect concepts or ideas are formed they are called misconceptions. In this study, I am particularly interested in how effective the two different science lessons are in replacing a misconception you may have formed about the circulatory system with a more correct concept.

Thank you for participating in this study. If you have any questions about the study, please feel free to contact me, Ms. C. Peterson, during class, after school, or over the summer. If you would like to obtain a copy of the results of this study, please contact Professor Bonnie Brunkhorst, Department of Geological Sciences and Department of Science, Mathematics and Technology Education at California State University San Bernardino at the end of Fall Quarter of 2001.
Study of Science Misconceptions and Computer Aided Instruction Debriefing Statement For Parents and Guardians

The study your child has just completed was designed to investigate the effectiveness of two different approved instructional strategies for replacing students' science misconceptions. Students come to each science class with concepts about what they have learned and what they will be learning. Sometimes these concepts are correct and sometimes the concepts they form are incorrect. When students have incorrect ideas about a science concept, we call these misconceptions. I am particularly interested in how effective the two different instructional strategies are in replacing a student's misconceptions about the circulatory system with a more correct concept.

Thank you for letting your child participate in this study. If you have any questions about the study, please feel free to contact Ms. Cyndie Peterson. If you would like to obtain a copy of the results of this study, please contact Professor Bonnie Brunkhorst,Department of Geological Sciences and Department of Science, Mathematics and Technology Education at California State University San Bernardino at the end of Fall Quarter of 2001.
APPENDIX C

PARTICIPATION RECRUITMENT,  
PROJECT DESCRIPTION, AND RISKS  
AND BENEFITS
Participation Recruitment:

The participants in this study will be my seventh grade students in my science classes. I hope to include four of the five classes that I teach on a regular basis. The students are between 11 and 13 years old. I plan to do matched pairs using sex, race, English Learner Development Levels, home language, recent SAT 9 scores, attendance records, and their first and second trimester grades for science this school year (9/2000-6/2001).

The total number of possible students involved in the study is 134. Students will be informed of the study in their science class. I will send a letter home for parent and/or guardian consent.
Project Description:

The objectives of my research is to determine if lessons using computer software/programs, concerning specific science concepts, are better at enabling students to replace their science misconceptions with correct concepts or information. My hypothesis for this project is that I believe computer aided lessons will help to replace students' science misconceptions with correct concepts or information better than a regular lecture type lesson.

This study will use four of my seventh grade science classes, consisting of 32-35 students in each class. A total of 134 students is possible if all choose to participate. Matched pairs will be used in the data analysis. Students will be matched according to their age, gender, race, English Learning Development Level, home language, attendance records, most recent SAT 9 scores, and their first and second trimester science grades for the present school year.

The science concept this study will focus on is how the blood circulates through the human body, including how the blood picks up oxygen in the lungs. Learning about the circulatory system of the human body is a requirement of the seventh grade California State Science Standards, specifically, Standards 5a, b, and 6k. It will not deal with the chemistry of oxygen/carbon dioxide replacement on a cellular level.

Students will first answer four questions about how the blood circulates through the human body to pick up oxygen:

1. How do we get oxygen into our bodies?
2. Where does it go first?
3. How are our blood cells involved?
4. Briefly describe, the best you can, the path the blood takes through our bodies, including the path through our heart.

These questions will be a pre-assessment of knowledge and any misconceptions students might have concerning the human circulatory system. This will take one class period to complete. Answers will be evaluated for accuracy and misconceptions held by students. Students will receive a grade for completing the questions. Their grade does not depend on "correct" answers.

Two lessons will then be given to two different class sets. Two classes will be given a lesson consisting of a lecture on the circulatory system of the human body, in which students will take notes and complete a diagram/map of how the blood circulates through the human heart. The other two classes will work in pairs on computers in a library computer lab. They will be required to take
notes and complete a diagram/map of how the blood circulates through the human heart by visiting appropriate, teacher designated, web sites on the circulatory and respiratory system. Students in both classes will again be graded on work completed (notes and the diagram/map of the human heart). Students’ science grade will not be affected by their participation in the study. Their work for the study will be evaluated for misconceptions still being held or new ones that have developed.

These lessons should take one to three class periods (or one to three days) to complete. Students will be given the same four pre-assessment questions to answer now as a post-assessment evaluation. These questions will be given within three school days of students completing the lessons and assigned work.

A final individual interview consisting of the same four (pre and post) questions will be given approximately two to three weeks later.
Risks and Benefits:

The immediate benefit of this study is that the students will learn about the circulatory system as required by the State of California Science Standards. Another benefit of the study would be to have misconceptions concerning the circulation of blood through the human body replaced by correct concepts or information.

I do not see any risks immediate or long-range to the students involved in this study. The lessons are designed to teach the students about the circulatory system. Data from this study should indicate whether or not using computers in a science lesson helps students to replace misconceptions about the circulatory system better than a lecture type lesson. If my hypothesis is correct, and computers do enable students to replace science misconceptions with correct concepts or information better, then it would be my recommendation to have teachers re-think how they present science concepts to students.
APPENDIX D

PRE AND POST ASSESSMENT
1. How do we get oxygen into our bodies?

2. Where does it go first?

3. How are our blood cells involved?

4. Briefly describe, the best you can, the path the blood takes through our bodies, including the path through our heart.
Overhead notes for the Circulation/Circulatory System and Blood

Cardiovascular System Includes:
Heart, blood, and kilometers of blood vessels.
Blood moves continuously through you body in a closed system of vessels.

Your Heart:
Made of cardiac muscle
Has 4 cavities called chambers-
2 upper-right and left atria
2 lower-right and left ventricles.
Valves separate each atrium and ventricle, so blood does not mix.

There are 3 Systems:

**Pulmonary Circulation:**
The flow of blood thru the heart, to the lungs to pick up oxygen, and back to the heart.

**Systemic Circulation:**
Oxygen rich blood leaves the heart thru arteries to go to all your organs and body tissues.
Once nutrients and O2 are exchanged for carbon dioxide and wastes, the blood returns to the heart thru veins.

**Coronary Circulation:**
Your heart has its own blood vessels to supply
nutrients and O2 and remove wastes. If this flow is blocked and O2 cannot reach the cells of the heart – Heart Attack!

Blood:

Parts of blood:

**Plasma**
- Is the liquid part of blood- 90% water.
- Contains: dissolved nutrients, minerals, and O2.

**Blood Cells**:
- **Red Blood Cells**- 5,000,000/mm3 carries O2 and CO2 to and from the lungs.
  - Live 100-120 days.
- **White Blood Cells**:
  - 5000-10,000/ mm3 Fight bacteria.
  - Live few days to many months.

**Platelets**:
- 400,000/ mm3 Aid blood clotting.
  - Are fragments of cells.
  - Live 5-9 days.
Keep the Blood Moving

Name: ______________________
Date: ______________________
Period: ____________________

1. When the blood comes into the heart from the body, which artery or vein does it come from?

2. Which chamber does the blood go to first?

3. Which chamber does the blood go into next?

4. Which valve does the blood pass through to do this?

5. Where does the blood go next?

6. Why?

7. How does the blood get back into the heart?

8. Which chamber does the blood now enter first?

9. Which valve does the blood pass through?

10. Which chamber does the blood go before it leaves the heart to go to the body?
1. How do we get oxygen into our bodies?

2. Where does it go first?

3. How are our blood cells involved?

4. Briefly describe, the best you can, the path the blood takes through our bodies, including the path through the heart.
APPENDIX E

LESSON PLANS
Traditional Lesson Plan

7th Grade

How The Lungs Are Involved With The Circulatory System

Objectives:
1. Students will see how the organ, the heart, circulates blood.
2. Students will learn the physical principals involving the chambers, the valves of the heart, and the direction of blood flow.
3. Students will understand how the circulatory system is dependent on the lungs to rid the blood of carbon dioxide and to pick up oxygen before the blood can return to the rest of the body.

California State Science Education Standards:
Standard 5: Structure and Function in Living Systems
The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. As a basis for understanding this concept:

a) Students know plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism.

b) Students know organ systems function because of contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.

Standard 6: Physical Principles in Living Systems (Physical Science)
Physical principles underlie biological structures and functions. As a basis for understanding this concept:

j) Students know that contractions of the heart generate blood pressure and that heart valves prevent backflow of blood in the circulatory system.

Materials:
Worksheets:
Day 1 1. Circulatory system notes outlined for students on overhead sheets.
Day 2 2. Worksheet diagram of the heart showing the chambers and valves.
Day 2 3. Worksheet “Keep the Blood Moving”-questions that students will answer after completing the labeling all the parts of the heart and drawing arrows to show blood flow through the heart.

Day 3 4. Worksheets “Overview- The Circulatory System” and the “Circulatory System”-these worksheets are for review of all the information covered in the notes and the first two worksheets on how the blood circulates through the heart and to reinforce vocabulary.

Vocabulary:
1. Atrium
2. Ventricle
3. Aorta
4. Valve
5. Pulmonary circulation
6. Systemic circulation
7. Coronary circulation
8. Plasma
9. Red blood cells
10. White blood cells
11. Platelets
12. Veins
13. Arteries
14. Capillaries

Procedure:
Day 1 1. Give pre test on circulatory system as a pre assessment. Allow about 15-20 minutes and then collect.
2. Use outlined notes on circulatory system on overhead.
3. Show students a couple of notes at a time while they copy. Discuss notes/ask questions as you go.

Day 2 1. Have student help hand out “Heart” worksheet (diagram of the heart).
2. Teacher will use overhead copy of the diagram and model question #1 with the students. As the teacher explains and labels of the parts of the heart on the overhead diagram, students will follow the model and label their diagrams.
3. Students, working individually, will then follow the instructions for #2 and #3 on the worksheet and lightly shade the different sections of the heart (blue for the blood carrying carbon dioxide and red for the blood carrying oxygen). Teacher can allow 10 minutes for students to attempt this themselves. The teacher can
then shade in the sections and draw the path the blood takes on the overhead model for students to check their work.

4. Students will use the information from the diagram of the heart and the path the blood takes to answer the questions on the “Keep the Blood Moving” worksheet. This worksheet follows the path of the blood through the heart. This should reinforce the path the blood takes.

Day 3 1. Students will work on two additional worksheet on the circulatory system for review of notes, diagram of heart, and vocabulary with this concept.

2. Students can work on the worksheets with partners or table groups. Teacher may use overheads of the worksheets and have students give answers at end of the class period so students can check their work.

Day 4 1. Students will hand in all worksheets based on the circulatory system.

2. Students will then take post test on the circulatory system as the post assessment. Students can draw a diagram to answer question #4 if they choose in place of or in addition to a written answer for that question.

Extensions:

1. Students can perform labs based on heart rates (pulses) at resting, standing, sitting, and after short exercise of walking or jogging in place. Students can then calculate the average resting heart rate for one minute, one hour, 24 hours, and finally how much their heart or an average heart beats over a lifetime.

2. Students can research different heart diseases— their cause(s) and effects on the heart and any other organs. If possible students could present their reports as Power Point presentations.

3. Students can do a survey of ten or more adults for risk factors of heart disease. Students can brainstorm what those risk factors are, such as smoking, not exercising, not eating healthy, age over 40, etc.
Computer Aided Lesson Plan

7th Grade

How The Lungs Are Involved With The Circulatory System

Objectives:
1. Students will see how the organ, the heart, circulates blood..
2. Students will learn the physical principals involving the chambers, the valves of the heart, and the direction of blood flow.
3. Students will understand how the circulatory system is dependent on the lungs to rid the blood of carbon dioxide and to pick up oxygen before the blood can return to the rest of the body.

California State Science Education Standards:
Standard 5: Structure and Function in Living Systems
The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. As a basis for understanding this concept:
   a) Students know plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism.
   b) Students know organ systems function because of contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.

Standard 6: Physical Principles in Living Systems (Physical Science)
Physical principles underlie biological structures and functions. As a basis for understanding this concept:
   j) Students know that contractions of the heart generate blood pressure and that heart valves prevent backflow of blood in the circulatory system.

Materials:
Worksheets:
Day 1  1. Circulatory system notes outlined for students on overhead sheets.
Day 2  2. Worksheet diagram of the heart showing the chambers and valves.
Worksheet “Keep the Blood Moving”-questions that students will answer after completing the labeling all the parts of the heart and drawing arrows to show blood flow through the heart.

Worksheets “Overview - The Circulatory System” and the “Circulatory System” - these worksheets are for review of all the information covered in the notes and the first two worksheets on how the blood circulates through the heart and to reinforce vocabulary.

Vocabulary:
1. Atrium
2. Ventricle
3. Aorta
4. Valve
5. Pulmonary circulation
6. Systemic circulation
7. Coronary circulation
8. Plasma
9. Red blood cells
10. White blood cells
11. Platelets
12. Veins
13. Arteries
14. Capillaries

Procedure:
Day 1 1. Give pre test on circulatory system as a pre assessment. Allow about 15-20 minutes and then collect.
2. Use outlined notes on circulatory system on overhead.
3. Show students a couple of notes at a time while they copy. Discuss notes/ask questions as you go.

Day 2 1. Students will go to the school computer lab and choose a partner to work with.
2. Have student help hand out “Heart” worksheet (diagram of the heart).
3. Students will see teacher web site on computer screens telling them to go to pre-selected web sites that they can simply click on about the heart and the respiratory system. They will use these animated sites to complete the “Heart” diagram worksheet with their partner.
4. Students will then follow the instructions for #1, and #3 on the worksheet, which involves the labeling of the parts of the heart
and drawing arrows to indicate the path the blood takes. Students will not shade in the different colors for #2 as they will not have these supplies with them. They can do this later as homework.

5. Students will then use the information from the diagram of the heart and the path the blood takes to answer the questions on the “Keep the Blood Moving” worksheet. This worksheet follows the path of the blood through the heart. This should reinforce the path the blood takes.

Day 3
1. Students will work on two additional worksheet on the circulatory system for review of notes, diagram of heart, and vocabulary with this concept.

2. Students can work on the worksheets with partners or table groups. Teacher may use overheads of the worksheets and have students give answers at end of the class period so students can check their work.

Day 4
1. Students will hand in all worksheets based on the circulatory system.

2. Students will then take post test on the circulatory system as the post assessment. Students can draw a diagram to answer question #4 if they choose in place of or in addition to a written answer for that question.

Extensions:
1. Students can perform labs based on heart rates (pulses) at resting, standing, sitting, and after short exercise of walking or jogging in place. Students can then calculate the average resting heart rate for one minute, one hour, 24 hours, and finally how much their heart or an average heart beats over a lifetime.

2. Students can research different heart diseases— their cause(s) and effects on the heart and any other organs. If possible students could present their reports as Power Point presentations.

3. Students can do a survey of ten or more adults for risk factors of heart disease. Students can brainstorm what those risk factors are, such as smoking, not exercising, not eating healthy, age over 40, etc.
The Heart

From the information given on page 12, complete the following activities:

1. Label the parts of the heart with the words listed:
   - right atrium
   - left atrium
   - right ventricle
   - left ventricle
   - pulmonary artery
   - pulmonary vein
   - superior vena cava
   - inferior vena cava
   - tricuspid valves
   - pulmonary valves
   - mitral valves
   - aortic valves

2. Lightly shade the sections blue that transport blood carrying carbon dioxide to the lungs.
   Lightly shade the sections red that carry blood with a fresh supply of oxygen from the lungs to the body.

3. Draw arrows on the heart diagram to show the path blood takes on its journey through the heart.
Keep the Blood Moving

Names: __________________________
Period: __________________________
Date: ____________________________

1. When the blood comes into the heart from the body, which artery or vein does it come from?

2. Which chamber does the blood go to first?

3. Which chamber does the blood go into next?

4. Which valve does the blood pass through to do this?

5. Where does the blood go next?

6. Why?

7. How does the blood get back into the heart?

8. Which chamber does the blood now enter first?

9. Which valve does the blood pass through?

10. Which chamber does the blood go before it leaves the heart to go to the body?
Overview: The Circulatory System

Directions: Use the following terms to complete the concept map below:

- aorta
- arteries
- veins
- pulmonary artery
- pulmonary veins

Diagram:

- Heart
- Superior or inferior vena cava
- Lungs
- Capillaries
- Directions: Use the following terms to complete the concept map below:

- aorta
- arteries
- veins
- pulmonary artery
- pulmonary veins

Diagram:

- Heart
- Superior or inferior vena cava
- Lungs
- Capillaries
Complete the sentences below by adding the correct vowels.

1. R__d bl__d c__ls c__rr__ x__g__n nd c__rb__n
   d__x__d__

2. Wh__t__ bl__d c__ls d__str__ b__ct__r__

3. Bl__d pl__t__ls __d bl__d c__lt__ng.

4. Th__ h__rt s th__ p__mp f th__ c__r__ l__ t__ f__ s__t__m.

5. Th__ fl__d f th__ c__r__ l__ f__ s__t__m s__ bl__d__

Complete the sentences below by adding the correct consonants.

1. _a__ _a__ _a__ _a__ a__ e__ e__ e__ e__ _e__ _oo__

2. A__ e__ _e__ _ea__ a__ ay__ o__ e__ ea__

3. _e__ _ea__ o__ e__ ea__

4. _e__ _u__ a__ o__ y__ y__ e__ _l__ _co__

5. _a__ _a__ a__ _e__ _u__ a__ _a__ _o__ _oo__
APPENDIX F

PRE AND POST TEST ACCURATE RESPONSES
CAI Matched Pairs
Pretest/Post-test Accurate Responses

Number of Accurate Responses

The Four Questions

CAI Pretest Accurate Responses
CAI Post-test Accurate Responses
CAI Non-Matched Pairs
Pre/Post-test Accurate Responses

- CAI Pretest
- CAI Post-test

The Four Questions

Number of Accurate Responses

0 2 4 6 8 10 12 14 16 18
1 2 3 4
Traditional Lesson Non-Matched Pairs
Pre/Post-test Accurate Responses

![Bar Chart]

- The Four Questions
- Number of Accurate Responses

Legend:
- Traditional Lesson Pretest
- Traditional Lesson Post-test
APPENDIX G

WEBSITES
Did you know that your heart is the strongest muscle? Your heart is divided into two sides. The right side pumps blood to your lungs where it picks up oxygen. The left side pumps oxygen-soaked blood out to your body. They do not work on their own, but together as a team. The body's blood is circulated through the heart more than 1,000 times per day. Between five and six thousand quarts of blood are pumped each
Heart
Your heart's job is to pump blood around your body. Its muscles contract and squeeze out blood. The left-hand side pumps blood from the lungs to the rest of your body. The right-hand side pumps stale blood from your body back to your lungs for a fresh supply of oxygen.
Welcome to the Respiratory System

All animals need oxygen to live. Land animals get oxygen from the air. Without the oxygen in the air we cannot survive more than a few minutes. Breathing happens automatically, we do not have to even think about it.
We breathe in order to take oxygen into our bodies and get rid of carbon dioxide. The oxygen is carried in the blood to all the body's cells. The air we breathe out has 100 times more carbon dioxide than the air we breathe in.

Nose and Throat

Windpipe and Bronchial Tree

Lungs

If you think you would like to go to the site map instead follow me
REFERENCES


