2000

# Integrating internet technology to support fraction instruction in the elementary classroon

Melonie Ann Jacksin

# INTEGRATING INTERNET TECHNOLOGY TO SUPPORT FRACTION INSTRUCTION IN THE ELEMENTARY CLASSROOM

---

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

Education:

Instructional Technology Option

---

by

Melonie Ann Jackson

December 2000

# INTEGRATING INTERNET TECHNOLOGY TO SUPPORT FRACTION INSTRUCTION IN THE ELEMENTARY CLASSROOM

---

A Project

Presented to the

Faculty of

California State University,

San Bernardino

---

by

Melonie Ann Jackson

December 2000

Approved by:

[redacted]

Amy Leh Ph.D., First Reader

11-21-00

Date

[redacted]

Sylvester Robertson Ph.D., Second Reader

ABSTRACT

Internet technology has been prevalent in education and society as a whole for many years. However, utilizing the Internet to educate elementary age children has a limited existence. The integration of the Internet as an instructional tool in elementary education may be one of the most crucial ways to ensure student success in the future.

Internet assisted instruction is compatible with many subject areas. One of the most favorable areas is abstract math concepts. For upper elementary students, one of the most complex, abstract math subjects is fractions. Traditionally, students, parents, and teachers struggle with the teaching and learning of fractions.

Exploring and discussing the possibilities of incorporating the Internet as an educational, learning, and communication tool, within and between school and home, to support fraction instruction to upper elementary age children is the main purpose of this project. A review of the literature will give a summary of the role of hypermedia and Internet technologies in education, as well as compatible learning theories and mathematical subject matter.

In addition to this written project, a Web Site was created as an introduction to fractions specifically geared for 4th and 5th grade students, their parents, and teachers (http://www.geocities.com/mjacson.geo/). The Web Site was designed to provide optimal educational opportunities for students with varied learning styles and abilities.

The conclusions, suggestions, and recommendations will be discussed as to the author's findings related to the project and the future of Internet integration as an educational tool.

ACKNOWLEDGMENTS

I would like to thank the professors of the Program of Instructional Technology who helped guide and inspire me to further my experiences and knowledge. Through this process they have supported me to better myself, giving me improved capabilities to support and motivate future students.

I owe a debt of gratitude to Dr. Amy Leh who worked above and beyond the realm of her duties to make the completion of this project possible. It was her positive attitude and willingness to patiently direct me in completing the process of the project that gave me the opportunity I needed to succeed.

I would like to express my love and admiration to my husband, Keith, who encouraged me and stayed by my side throughout the completion of this program and project, never wavering to provide me with understanding, love, and an abundance of patience. A heartfelt thank you is also due to my husband for the many hours of editing and computer services he generously gave without hesitation.

I would like to thank my mother, Shyron, for always being willing to listen and for giving sound advice and ideas which have contributed much to this project.

Finally, without the unconditional love and ongoing support of my parents, Shyron and Howard, this project would not have been possible. I love you both.

TABLE OF CONTENTS

ABSTRACT ..... iii

ACKNOWLEDGMENTS ..... v

LIST OF TABLES ..... ix

CHAPTER ONE: INTRODUCTION

Introduction ..... 1

The Statement of Problem ..... 8

The Project Overview ..... 9

Goals of the Project ..... 12

CHAPTER TWO: REVIEW OF RELATED LITERATURE

Introduction ..... 15

Technology and Learning Theories in the Classroom ..... 15

Hypermedia and Constructivism ..... 17

Hypermedia and Collaboration ..... 22

Internet Technology and Collaboration in Education ..... 29

Benefits of Using the Internet in Instruction ... 35

Difficulties of Learning and Teaching Fractions ..... 37

The Internet and Fractions ..... 39

The Internet and Design Models ..... 41

CHAPTER THREE: DESIGN AND DEVELOPMENT

Introduction ..... 46

Project Design ..... 46

Needs Assessment ..... 48

Development and Goals of the Educational Web Site ..... 52

Educational Web Site Testing and Evaluation ..... 61

CHAPTER FOUR: CONCLUSIONS

Introduction ..... 67

Suggestions and Recommendations ..... 69

APPENDIX A: SURVEY ..... 74

APPENDIX B: JACKSON'S FRACTION FACTORY EVALUATION .... 76

APPENDIX C: WEB SITE FLOW CHART ..... 78

APPENDIX D: WEB SITE SCREEN SHOTS ..... 80

APPENDIX E: NO MATTER WHAT SHAPE YOUR FRACTIONS ARE IN ..... 88

APPENDIX F: FUNBRAIN.COM - QUIZ LAB ..... 92

APPENDIX G: MATH PARENT'S HANDBOOK ..... 94

REFERENCES ..... 96

LIST OF TABLES

Table 1. Jackson's Fraction Factory Evaluation Survey Summary and Results (Part I) ..... 64

Table 2. Jackson's Fraction Factory Evaluation Survey Summary and Results (Part II) ..... 65

# CHAPTER ONE:

# INTRODUCTION

## Introduction

Students, from an elementary education, should emerge with the fundamental building blocks to become successful adults. Today, every aspect of daily life is tied to technological advances to some degree. Additionally, more emphasis is being put on teamwork and collaborative problem solving in the workforce as technologies progress. Children who have entered elementary school in the last few years of the 20th century will be entering the workforce around the year 2015 and will be expected to possess technology, communication, problem solving, and critical thinking skills.

It is necessary to investigate the research on technology and education in the elementary classroom. Specifically, to search for superlative uses of how to integrate technology with communication, problem solving, and critical thinking to enable students to gain experiences and knowledge which are applicable to their futures. The contents of this project will be used to support the rationale of integrating technology into the elementary curriculum, and how it can be utilized to enhance cooperative learning and higher order thinking.

Additionally, the type of technology and design to integrate will be examined.

Collaborative learning, the pairing or grouping of students to reach a common academic goal, has been broadly researched and advocated throughout educational professional literature for many years. During the process students are responsible for each other's learning, as well as their own. They divide the work according to a plan and share ideas in a quest for knowledge and understanding. Supporters of collaborative learning maintain that the active exchange of ideas in small cooperative groups not only promotes interest among the students but also encourages critical thinking (Gokhale, 1995).

Educational technology is a high priority. Teachers and students alike need to learn new technologies and use these new technologies to learn. Some of the most recommended and advanced forms of technology are multimedia and hypermedia. Multimedia is a format that incorporates many different types of media including text, graphics, video, and audio. Hypermedia is a type of multimedia that allows the user to examine the information in a flexible, nonlinear manner. Typically, the user can control the movement from one source of information to

another. This allows the instruction to be individualized by the user, making it capable of being highly efficient.

Students can successfully participate in complex, collaborative projects utilizing hypermedia in their classrooms. The student is given the exposure to situations that require problem solving skills as opposed to rote memorization of facts. Additionally, the multitude of stimuli provided by hypermedia can appeal to individual learner characteristics such as audio, visual, or learning by doing. The student becomes proactive in shaping their learning process. No longer is the learner a passive receiver of information, instead the student is a collaborator, decision maker, and designer.

Hypermedia is conducive to widely accepted learning theories. Specifically, learning theories that focus on interactivity and constructivism, critical thinking, peer collaboration, learning by doing, and social/cultural processes. The foundation of constructivism is learning through design. Students who choose their own sequence in accessing a hypermedia project or who design their own projects are able to exchange ideas with other learners to finish a worthwhile assignment. Additionally, these learning experiences allow the student to utilize complicated cognitive skills to complete the task.

Students are challenged to constantly define and consistently clarify the nature of the problem and reconstruct their knowledge to fit the problem (Jonassen, 1996).

One of the most commonly used types of hypermedia in schools today is the Internet. During the 1996 State of the Union Address, President Clinton said, "In our schools, every classroom in America must be connected to the information superhighway with computers and good software and well-trained teachers" (Clinton, 1996). With the arrival of Internet technology in the classroom, the tools are being provided to allow students to participate in their learning process.

However, with the integration of the Internet, some significant questions emanate from its use. Does the Internet promote collaborative learning? Will the integration of the Internet reform the way children are educated? Is the Internet capable of redirecting learning and teaching methods? Can accessing the expansive resources of the Internet be conducive to an effective learning environment? These questions are a foundation for this project. However, it is not the intent of the author to answer each of these questions but to investigate the

implications of integrating the Internet into elementary education.

Research indicates (Berge & Collins, 1995; Brown, Collins, & Duguid, 1989; Ryder & Hughes, 1997; Silva & Breuleux, 1994) that the Internet is exceptionally well suited for collaborative learning. It provides one of the most effective and exciting ways for students to learn how to work in teams and communicate by encouraging groups of students to utilize unlimited resources and explore effective on-line communication possibilities. "The active environment of social learning provided by a computer with local, national, and international networks increases interaction and communication among students, their teachers, peers, parents, and other members of the world community" (Berge & Collins, 1995, p. 7).

Additionally, the Internet has been used to teach a variety of topics in the classroom. One of the benefits of utilizing it to teach is that abstract ideas can be demonstrated using models or graphics to relate the concept being taught to the learner's prior experiences (Neafsey, 1997; Ryder & Hughes, 1997). This can be particularly useful when teaching mathematics. Teachers often employ manipulatives and/or pictures when teaching a new mathematical concept. Traditionally, students and

teachers alike struggle to clarify the meaning of fraction relationships and concepts. The difficulty arises from the extremely abstract nature of fractions. Incorporating the Internet into the elementary curriculum to educate children may be one of the most efficient ways to embed the goals of instructional technology. An integration that is capable of furthering all students toward an eye opening, stimulating, and interactive experience.

The author believes that the Internet is changing the way we live our lives. This is true for the educational setting as well. In the author's opinion, Internet incorporation in the classroom is already beginning to change the way students are being educated. The nature of the Internet allows the learner to become an active participant in their own learning process. Specifically, the student is able to construct their own learning by accessing information in a sequence they determine. In this situation the teacher becomes the facilitator and is no longer the source of knowledge needed for student success. Teachers and students become collaborators in the knowledge construction process (Jonassen, 1996).

This reform is causing teachers to rethink the teaching methods they employ. Traditional teaching methods may no longer be proficient when addressing the realm of

technology and the Internet. Although there may be a need for teachers to reevaluate and reexamine their current teaching methods, teachers are likely to resist this change. Education's history is laden with the agent of change. Educators are likely to harbor fear, anxiety, and reluctance when faced with the task of relearning how to teach with the integration of Internet technology into their curriculum.

Additionally, with the time constraints teachers experience while meeting the ever widening demands of their profession, it becomes very difficult to explore possible solutions to the technology dilemma. There is a need for ready-made examples of how to implement Internet technology into elementary instruction. It is one of the intents of this project to address this problem.

Specifically, the developer intends to provide an educational Web Site that will enable teachers to explore and execute Internet integration in their classroom curriculum while investing minimal preparation time to do so. Enabling teachers to employ the Internet in a ready-to-use fashion may be one way to lessen their apprehensions and concerns. By accomplishing this, the individual teacher may be more likely to investigate the need to rethink their teaching methods.

## The Statement of Problem

Based on the author's findings from reviewing the available literature, it became evident that Internet technology had not been implemented into the elementary curriculum as expected. However, the benefits of using the Internet in elementary instruction could not be obtained without investing large amounts of time and resources to execute such a change. The dilemma is to find a superlative way to provide teachers with the support, resources, and time to effectively integrate the Internet into their classroom instruction.

A further review of the literature revealed that teachers, parents, and students struggle with the concepts of teaching and learning fractions. Conceptually, the theory of fractions is very abstract to the learner. Therefore, the challenge for teachers and parents to address is how to make the concepts of fractions more concrete for the student. In order for the concepts to become concrete, the learner needs to engage in activities that are capable of showing the relationships, either through graphics and/or interactivity, of fractions to the learner's prior experiences.

Another integral part of the difficulty of teaching fractions is finding an accessible medium to provide

effective intercommunication between the parent(s), student, and teacher. There are many ways to teach and learn the concepts of fractions. It becomes important for the parent(s) to be informed of the instructional strategies and content of the classroom lessons in order to be an effective aide to the student at home. An efficient medium should be capable of providing the parent users flexibility, on-line communication, immediate feedback, and the multi-sensory learning resources provided to the students.

Therefore, the problem investigated by the author was, "What is the optimal method of integrating the Internet into the $4^{th}/5^{th}$ grade curriculum to provide hands-on, interactive, collaborative learning opportunities, as well as on-line communication and feedback to support the teaching and learning of fractions for students, parents, and teachers?" The development of this question was based on the results of the needs assessment survey and the literature review.

The Project Overview

In conjunction with this paper, a Web Site project was created and loaded on the Internet entitled: "Jackson's Fraction Factory" and is available at (http://www.geocities.com/mjacson.geo/). The Web Site was

created after implementing a needs assessment survey (located in APPENDIX A). It was the intent of the author to implement an educational Web Site that not only supported classroom instruction of fractions but also assisted parents and teachers. The Web Site was intended to provide on-line communication with parents about the content of the subject area of fractions being taught and to help bridge the gap between parent, student, and teacher communications. Additionally, through the integration of the Web Site with the curriculum, it was the author's intent to inspire and motivate students and teachers to value the possibilities and knowledge the Internet has to offer.

One foundation of the project was constructivism. The constructivist model's fundamental principle is that what a person knows is actively assembled by the learner (Grabe & Grabe, 1993). Thus, the purpose of learning is to assist the individual to function in his/her own environment. In education, students are at various levels of knowledge and experience with regards to Internet utilization both personally and in the classroom. By allowing the user to control the sequence in which information is accessed, the beginner and experienced user can find information in unique and proficient ways.

The project also targeted visual learners. This was accomplished by providing graphic examples of concepts. By seeing a concept the visual memory can encode and retrieve the information more readily (Neafsey, 1997).

The project also provided an opportunity for learning to occur by providing a hands-on, interactive experience. By participating in active learning the potential for generating more concrete or meaningful learning is greatly increased (Grabe & Grabe, 1993).

Finally, the project was intended to enhance collaboration among students, as well as parents and teachers. The project was introduced into the classroom setting as a cooperative learning style lesson. Throughout the project, collaboration was encouraged not only in the classroom but also within the home and between the home and school. Collaboration among students, parents, and teachers can be increased through the use of the Internet (Berge & Collins, 1995).

Additionally, a survey entitled Jackson's Fraction Factory Evaluation was administered and is located in APPENDIX B. The evaluation survey of the Web Site was given after an introductory lesson and a lab session to explore the site and complete the Scavenger Hunt located in the Kid's Korner. During the lab session, students

worked in pairs. This encouraged collaboration to complete the task. During this time the author conducted a formative evaluation by observing the students as they worked and by making inquiries after the lab session regarding their experiences. The evaluation survey was administered to the same sample as the needs assessment survey.

Both surveys and the formative evaluation supplied pertinent and important information about the project. The needs assessment survey provided a substantial part of the rationale for the Web Site. The evaluation survey and formative evaluation furnished significant information regarding the perception of the Web Site's presentation, user friendliness, and goals. The evaluation survey and formative evaluation also addressed the changes needed to make the Web Site more productive and appealing. The feedback from these evaluations provided valuable information about the project.

## Goals of the Project

By creating, implementing, and testing the project it was the developer's intention to progress toward multiple educational goals. The project was directed towards three audiences, elementary students, teachers, and parents. The main purpose was to educate the children on using the

Internet while teaching an introduction to fraction concepts.

There were two supplemental goals inherent in the project. The first was to supply resources and ideas to parents to help their children at home. Especially, for those children who were struggling with the subject matter. The second was to provide teachers an opportunity to use the Web Site with their students. The reason for this was two-fold. Due to high demands on elementary teachers today to implement and teach a variety of subjects, it is very difficult for them to find the time to create technology lesson plans to use in their classrooms. Furthermore, the school, in which the project was implemented, has no other teacher created Web Sites for student and teacher use. The only existing Web Site is an informational site about the school created by the school Technology Mentor. This suggested that the teachers in the school may have also lacked the knowledge to create and implement their own Web Site.

Throughout the following chapters of this paper there will be a review of the literature regarding all aspects of this project, a description of the design and development of this project, and the author's/developer's goals, conclusions, and recommendations regarding the

project will be given. It is the author's objective to provide valuable and pertinent information to allow the reader to determine the usefulness of this project for further examination, research, and implementation.

# CHAPTER TWO:

# REVIEW OF RELATED LITERATURE

## Introduction

In this chapter, computer technologies in the classroom and Internet use in education will be discussed in relation to teaching fractions in an elementary curriculum. Specifically, the medium of technology will be examined to determine how best to integrate technology with instruction. Simultaneously, the author will examine the learning theory, learning environment, and design model conducive to technology integration.

## Technology and Learning Theories in the Classroom

The introduction of computers in K-12 classrooms began in the 1970's. Since that time, sophisticated technologies have been swiftly intertwined into our daily lives and our society as a whole. Technology has not played the same intrinsic role in our classrooms as it has in our every day lives. There is a vast need for practical, understandable information about incorporating technology into K-12 classrooms.

Throughout the 1970's and much of the 1980's, one of the most prevalent uses of computer-assisted instruction (CAI) was drill-and-practice programs. One reason for using computers in this way was to promote automaticity.

It is widely held that in order for learners to engage in higher order thinking skills, they must first possess the ability to perform lower level skills. While these drill programs can help remedial learners who need practice, they may not be the most proficient way to implement computers in education and learning (Jonassen, 1996).

While examining the role of computers in education, it is important to identify the learning theory inherent in the technological application. In the scenario of drill-and-practice, computers in the classroom are largely seen as givers/teachers of information. The learner is viewed as a passive receiver of information. This view of learning suggests that knowledge exists outside of the learner, sometimes referred to as objectivism (Biehler & Snowman, 1997).

The opposite of objectivism is constructivsm. Educational constructivists assert that optimal student learning takes place when the student is actively engaged and participating in their learning process. Proponents of this theory contend "that meaningful learning is the active creation of knowledge structures (for example, concepts, rules, hypotheses, associations) from personal experience" (Biehler & Snowman, 1997, p. 428). Modifications of these interpretations come from the

sharing of multiple perspectives, a cognitive apprenticeship between student and teacher, and working with realistic problems and conditions (Bednar et al., 1991). In addition, students participating in an active learning environment are observing, exploring, experimenting, discussing, manipulating, and using various sensory modalities (Ryder & Hughes, 1997).

## Hypermedia and Constructivism

Hypermedia is one of the most recent forms of technology instruction in American schools today. Since hypermedia is a relevantly new form of technology, it is necessary to review the research on hypermedia to determine how it can be optimally utilized in the classroom to enhance positive results on learning. One question to be addressed is if hypermedia can facilitate a contstructivist and interactive learning environment. Additionally, whether this active learning environment is capable of fostering critical thinking, teamwork, a hands-on learning approach, and social/cultural processes.

The current perception of hypermedia is divided into two different areas. One is multimedia and the other is hypertext (Liao, 1998). Due to this, the definition of hypermedia is sometimes unclear. The words multimedia, interactive video, and hypermedia are often used

interchangeably in much of the research. These definitions are very similar, and they consist of two basic concepts. The first is multiple representations of information. The second is interactivity between users and the information.

Researchers and educators have noted the potential of hypermedia in education. Liao (1998) conducted a study to analyze and synthesize the research on the effects of traditional instruction and hypermedia-based instruction. He indicated that hypermedia applies a tactic that is beneficial to students, as the learner is in charge and can use a variety of media to approach the content. Liao (1998) also pointed out that there are many advantages to using hypermedia, including the combining of sound and picture, the interactive possibilities for the learner, the capability to structure an individual learning approach, the competence of the system to remember, the capacity to pursue cross-references, and the growth of the student's control over the subject being studied.

The research method of Liao's study is the meta-analytic approach. This approach requires a researcher to (a) find studies through objective and replicable searches, (b) code the studies for important features, (c) explain results on a common scale, and (d)

use statistical methods to correlate study characteristics to results (Liao, 1998).

The results of this meta-analysis indicated that hypermedia instruction has positive effects on students' performances over traditional instruction (Liao, 1998). Sources of the studies in a meta-analysis is always a crucial element to be scrutinized. The fact that approximately 57% of the studies were located from journal articles is a strength of this study. It indicates that the majority of the studies have been critically reviewed.

Further research is needed to determine which factors truly contribute to the positive outcomes on learners' achievements. Studies of this question will require further clarification of the exact relationship between hypermedia and learning. This meta-analysis points out only that improvements of students' academic achievements are possible.

It is important to note that a history of hypermedia, along with its definition, has been well documented since 1994 (Ayersman, 1996). Additionally, with the development of computer-mediated communications, hypermedia has been able to take on a new role in learning. Hypermedia has a limitless amount of resources through networks. In many ways this has increased the attention given to hypermedia

computer applications. Finally, hypermedia has made the control of applications more equitable between the user and the author. While the author still has control of the actual content of the program, the user has control over sequence and presentation of the data to suit individual needs.

There are many areas where hypermedia is effective in supplying information to students. The use of hypermedia is not restricted to learning cognitive and semantic information. It can also be used to address procedural information.

According to Ayersman (1996), there are four areas where research on hypermedia has been conducted:

- Clarifying between the method and the medium being used and compared
- Whether individual differences can be accommodated efficiently by hypermedia
- The design of hypermedia systems and how well they relate to cognitive structures of the learner
- The effects of hypermedia on the skill level and performance of the user

Within these areas of research, there is a subdivision between using hypermedia as a tool for constructing knowledge and for presenting knowledge.

Ayersman (1996) summarized that utilizing hypermedia for instruction in the classroom is at least as effective as lecture. This is particularly true for remedial or disabled learners. Further investigation is needed to determine the most effective structures within a hypermedia system to address individual differences.

In conclusion, Ayersman (1996) found that the majority of research focusing on students' performance and skill level has come from teachers using hypermedia as a tool for information presentation and representation rather than construction. A more solid research base is needed for the effectiveness of employing hypermedia as a knowledge construction tool.

Incorporating hypermedia as a teaching tool in the classroom could result in action research (Ayersman, 1996). Authentic classroom research could be the most meaningful for educators due to its relevance. This study has focused on various research methods as well as topics. By examining the methods, as well as the information, an enhanced assessment of the research has been given. Additionally, the research was reviewed with respect to

age-level groups, making it apparent where more age-level research should be focused.

Various hypermedia programs have been successful in improving the performance of elementary age children. These programs include but are not limited to vocabulary development, a deeper comprehension of text, study skills, mathematics and science (Ayersman, 1996). To gain a deeper understanding of hypermedia integration in education and the development of collaboration, individual classroom research will be reviewed.

Hypermedia and Collaboration

Turner & Dipinto (1997) conducted a study for four years with middle school students as hypermedia designers to determine the factors that promote the development of collaboration. The research questions that were focused on were as follows; how collaboration is encouraged, facilitated, and taught, the advantages of student collaboration, the affect of peer collaboration on learning, and the disadvantages of collaboration. The questions were addressed with a focus on the factors that helped support and establish collaboration in a technological learning environment.

The authors cited research to support the use of constructivism to promote collaboration. They made the

point that learning through design is the basis of constructivism. Hence, students designing their own hypermedia projects allows them to interact with other students to accomplish a meaningful task. The authors also cited research that demonstrated both hypermedia and Logo to be exemplar environments for learning through design (Turner & Dipinto, 1997).

This study used a qualitative research model. This may be an appropriate paradigm to study the process of collaboration, because it is a complex process which occurs naturally, in an environment with the flexibility and freedom it requires. Three sources of data were studied including participant observations, teacher interviews, and written student reflections.

There were two teachers/researchers involved in the project. During each session (sessions were held three times a week for ten weeks over four years) one of the researchers would observe individual or pairs of students for 5-10 minutes each on a rotating basis. The observations focused on students' interactions with the software, each other, and with the teacher. During the fourth year sessions were videotaped and transcribed.

The students wrote reflections every 2-3 weeks on what they had learned. Students also wrote a final essay

after they completed their projects. They included their thoughts on how it felt to give and receive help and about their interactions with the teacher.

This data was entered into a qualitative analysis software program. Observation notes and student reflections relating to the main research questions were tagged and grouped in order to identify subthemes.

The authors' findings represent four different groups over the four year period. Most of the researchers' findings are supported by more than one of the three sources of data used (participant observations, teacher interviews, and written student reflections). They found that collaboration is encouraged, facilitated and taught through; exploration, teaching on a need-to-know basis, mastery-oriented help seeking and help giving, teacher as facilitator of peer collaboration, student experts, teacher as co-learner, peer assessment, sense of audience, and sense of community. Additionally, the researchers found that the benefits of collaboration included enhanced self-esteem generated through the ability to help another student. The negative aspects of collaboration included; receiving bad advice from other students, less opportunity for teacher time and attention, expert students spent more time helping than working on their own projects,

frustration when students were not able to get help from other students, and a reduction in self-esteem when students were not asked for help or could not answer other student's questions (Turner & Dipinto, 1997).

The researchers concluded that design experiences provide students an opportunity to develop complex cognitive skills. However, they stated that social factors are as important as cognitive ones. Being successful in the workforce requires social skills. They are as important as the knowledge needed to do the job. The negative aspects of collaboration in the study give students opportunities to cope with these naturally occurring problems effectively.

Another classroom research study focusing on hypermedia and collaboration was done by Sedbrook (1996). This study explained the Partnership of Students and Instructors (PSI) hypermedia authoring and delivery system, which investigated new ways to create partnerships between teachers and students for the purpose of creating, updating, and maintaining a course's knowledge base. The system employed a hypermedia presentation to implement instruction versus the old-fashioned text base instructional materials. The system also provided

hypermedia presentations of the course's subject matter, review questions, and explanations.

Sedbrook (1996) cited references to explain traditional and evolving roles of the educator and student. Specifically, he referred to the banking model of education. This model refers to educators as the producers of lessons about the subjects/concepts to be learned. The student then receives the information and is called upon to memorize the information. This model does not require the student to know about the subjects/concepts or to practice any acts of cognition. Therefore, the educator is the producer and the student is the consumer.

In contrast, computer technology and educational hypermedia offer developing opportunities for students to participate in their own learning. PSI hypermedia is a constructive and collaborative learning environment, which allows teachers and learners to share the responsibilities of producing lessons, designing topic reviews, and developing a knowledge base for a course (Sedbrook, 1996).

According to Sedbrook (1996), hypermedia courseware currently focuses on the teacher as the developer of the system. The system is designed to transfer knowledge to students through self-directed learning. The PSI hypermedia creates a partnership between teacher and

student. Instructors are responsible for lecture notes, tests, assignments, examples, and readings. Students contribute text, video and audio media, as well as judgments rating the helpfulness of course resources. Thus, the responsibilities for evaluating, refining, and maintaining a course's knowledge is a joint effort of the teacher and students.

Educational interactive hypermedia enables a student to actively participate in learning through experimentation. It allows the student to discover and manipulate knowledge instead of passively recording it. By actively comparing and restructuring knowledge, a student can learn by building on experiences.

Sedbrook (1996) went into great detail about the specific type of system recommended for PSI hypermedia. He stressed the importance of implementing an easy-to-use interface that allows students and teachers to extend and maintain the course knowledge. Furthermore, he focused on an authoring approach that had flexibility, control, and experimentation in the design of new course media.

The key information contained in a PSI system are lessons, topics, questions, and explanations. The lessons provide a place to collect the topics. Each topic within a lesson specifies text connected with the topic, an

optional hypermedia presentation file and question file specific to that topic. An interactive on-line review for each topic consists of multiple-choice questions, with hypermedia explanations of correct answers.

Sedbrook (1996) concluded that allowing students to participate in courseware production developed their skills in communication, teamwork, and accessing and manipulating computer-based resources. He also believed it promoted student independence. He claimed class time was used more effectively because the focus was on the quality and refinement of knowledge versus information transfer. Finally, the author stated that enthusiasm improved and students developed a connection between past, present, and future students.

He was working with a prototype that he deemed to be successful. An extension of his research is required to validate his conclusion. However, the project had the capability to enhance student learning through collaboration (with the instructor) to make the learning more meaningful and individualized through the construction of the learning materials.

Both of these classroom research studies have demonstrated that hypermedia can be effectively utilized in the classroom to enhance collaboration, which has been

shown to foster critical thinking and problem solving. Furthermore, hypermedia offers opportunities for learners to construct their own projects, presentations, and/or sequence of the information that may be conducive to individual learners' thought processes.

## Internet Technology and Collaboration in Education

One of the most recently received forms of hypermedia in the classroom is the Internet. As American classrooms work to meet Clinton's expectations to become connected, educators will have increased opportunities to integrate collaborative learning methodologies with new ways of providing curricular activities, projects, and traditional educational tasks (Sellers, 1994).

In using the Internet, students are invited to investigate diverse sources, generate questions, and pursue answers to their questions. Also advocated is the process of problem solving by accumulating knowledge, guidance, and support from individuals and/or sources on the Internet. The Internet may be capable of bestowing many benefits to the learner. It is necessary to assess these benefits through a review of the literature pertaining to integrating the Internet with instruction in the classroom.

Students learn in various ways. They learn better when they can relate their personal experiences and perceptions to the knowledge they are attaining. Learning with the Internet can afford students the opportunity to access and obtain information and/or approach assignments in different ways. Producing models for learning (essays, journals, videos, class presentations, information placed on an Internet site) in a manner that best suits the needs of the leaner can be very productive (Ryder & Hughes, 1997).

Learners working together are inclined to become actively involved in their own educational experiences. This enables the students to contemplate various points of view and create a mutual respect with their classmates. The Internet is capable of facilitating cooperative learning beyond the confinements of the classroom to include other students, parents, and the community (Ryder & Hughes, 1997).

Another benefit of Internet projects is the ability for students to create partnerships with experts in a field. These partnerships can be structured in order to simulate what Brown, Collins, and Duguid (1989) call cognitive apprenticeships. The goal of the apprenticeship is to "embed learning in an activity and make deliberate

use of the social and physical context..." so that learning coincides with developing cognition and communication skills (Brown, Collins, & Doguid, 1989, p. 32).

A different approach to enhancing collaborative learning using technology is by employing participatory design. Participatory design is a theory originating from the Scandinavian nations that specifies the inclusion of the user in the planning and implementation of any new technology as its goal (Schuler & Namioka, 1993). Participatory design was implemented to overcome the inefficiencies of traditional systems to introduce new technologies in the workplace.

The Internet provides one of the most effective and exciting ways for students to learn how to collaborate and communicate by connecting groups of students with other classrooms around the globe (Silva & Breuleux, 1994). Learning through collaboration becomes even more crucial when the participants who are working cooperatively are from different parts of the world with their diverse cultures, histories, societies, and governments (Silva & Breuleux, 1994).

Interactive communication technologies in use today include computer networks which are two-way text-based.

The invention of computer network communities can unite students and teach them to work together. Although these network facilities are ordinary in higher educational settings, they remain uncommon in elementary schools (Silva & Breuleux, 1994). However, there is a trend developing to design projects that utilize the Internet/networks for teaching and learning.

Silva & Breuleux (1994) proposed the use of participatory design in schools, in conjunction with collaborative Internet/network projects. Participatory design is consistent with current educational theories that focus the attention on the learner instead of the instructional methodology or technology. According to Silva and Breuleux (1994), a potential exists for participatory design to introduce and implement new technologies while promoting the use of cooperative learning.

Furthermore, student and teacher involvement may create a more valuable understanding of the needs of the learners. Learner participation gives them the power to directly influence matters that concern them. Active participation in the design and objectives of the Internet/network project creates a mutual need to implement the new technologies.

Computer networking has been proposed as an ideal vehicle to foster collaboration in the classroom. It has been argued that the flexibility of the Internet/networks should allow for enhanced collaboration for students in the same classrooms or remote classrooms. Networking projects have been introduced under the assumption that communications among groups having different skills, backgrounds, and experiences should enhance collaboration.

Silva & Breuleux (1994) give examples of how cognition can be improved through participatory designed Internet/network projects. By helping to create projects students are able to contextualize and cognitively situate learning. If collaborative writing projects include writing to a person(s) who immediately responds, then writing is no longer an isolated activity. The student is given an opportunity to write for a purpose to an authentic audience.

Additionally, Internet/network projects allow for students to seek the advice or input of an expert in their field of study. The authors cited many projects which provided such an opportunity. These teleapprenticeships should embed the learning in a social and physical context (Silvia & Breuleux, 1994).

The introduction of new technologies in schools has encountered some difficulties. Although schools are receiving new computer technologies in their classrooms, teachers have yet to participate in its introduction as expected (Schultz & Higginbotham-Wheat, 1991). According to the National Center for Educational Statistics (NCES, 1995), 49.1% of teachers reported using the computer. Furthermore, secondary and elementary teachers are less likely to use computers than other professionals (Chiero, 1997; Dusick, 1998). However, with the growing use of networks in the classroom, a potential exits for participatory design to introduce and implement new technologies while promoting the use of cooperative learning.

Student and teacher involvement may create a more valuable understanding of the needs of the learners while incorporating technology with everyday tasks. The objective of the teacher is to integrate these tasks with the use of the Internet so that student participation and cooperation is maximized. Only at this level will the students completely understand and accept new technology (Silvia & Breuleux, 1994).

## Benefits of Using the Internet in Instruction

Integrating the use of the Internet with instruction can provide choice and self-directed learning. It facilitates learning by providing new alternatives for individualized input and information (Lieberman, 1991). Instead of the instructor deciding the order of topic presentation, the students construct the learning path through computer-assisted instruction data. It allows the novice and the expert opportunities to access the information in an efficient and individualized manner (Neafsy, 1997). According to Jonassen (1986), this nonlinear presentation of ideas may be a preferred learning environment because it resembles the structure of the human memory.

For visual learners, computer graphics can exemplify complex ideas. The learner can control and interact with the result of the animation of on-screen buttons. The visual memory is then encoded and more readily recalled during practice (Neafsey, 1997).

Another useful aspect of using the Internet in instruction is interactive practice/test sequences. Incorrect responses can give more information to help guide the learner to the appropriate answer. This embedded instruction gives the student freedom to explore correct

answers (Neafsey, 1997). The learner also gets valuable feedback on his/her learning.

Teachers and students can successfully learn to use instructional technology through self-regulated learning (Dusick, 1998). A self-regulated learner is motivated to take on the responsibility of regulating his/her behaviors and environment to promote effective learning. Self-regulated learners must understand that acquiring proficiency is within their reach, by setting specific goals and making a commitment to obtaining their goals (Dusick, 1998).

Teachers who utilize the Internet with their students, support them to partake in the future of instructional technology. These teachers work toward instilling into their students the ability to become lifelong learners by giving them the tools and skills to achieve this goal. This objective is one that has been discussed for years by education reformers. Teachers who integrate the Internet into their curriculum turn students into independent learners instead of immersed listeners (Ellsworth, 1994).

The literature dealing with integrating the Internet into the classroom shows it has been used in a variety of subject areas. Some of the strengths Internet instruction

brings to the student include graphics, interactivity, immediate feedback, on-line communication, accessibility, and nonlinear design. These attributes of implementing the Internet in instruction may further students learning of abstract mathematical concepts.

In the National Council of Teachers of Mathematics (NCTM) Standards (1989, 1991, 1995, 1998), mathematics is represented as a discipline that requires conceptualization and collaboration. Recently, the percentages of students in the United States who are proficient in mathematics in grades 4, 8, and 12 have increased (NCTM, 2000). However, these students still fall short of attaining the goals set forth by the National Education Goals Panel for the year 2000 (NCTM, 2000).

Specifically, the standards outline that, during the $4^{th}$ and $5^{th}$ grade levels, the student must be able to interpret and understand the concepts of fractions, and be able to use these procedures "to solve problems arising in concrete situations involving...fractions" (The California Mathematics Academic Content Standards, 1998).

## Difficulties of Learning and Teaching Fractions

According to Kennedy and Tipps (1994), when learners acquire a solid understanding of fraction concepts, they can utilize this information to depict real-world

phenomena and apply it to problems involving statistics, probability, and measurement. In addition, comprehension of fractions widens students' awareness of the power and usefulness of numbers and expands their knowledge of the number system. Thus, it is critical for students to develop concepts and relationships about fractions throughout their elementary education in order to build a foundation to acquire more advanced skills and concepts (Kennedy & Tipps, 1994).

According to Niemi (1996), an ideal example of a significant elementary school mathematics concept is the concept of fractions. Traditionally, elementary age children struggle with fractions. In many regards, fractions represent a model venue for exploring mathematical understanding at the elementary level, because studies show that students across a range of grade levels (a) see fractions as disconnected to concepts and/or principles, (b) show ineffectual evidence of conceptual understanding in problem solving involving fractions, and (c) are unable to justify their problem solving process (Bright, Behr, Post, & Wachsmuth, 1988; Davydov & Tsvetkovich, 1991). The NCTM (1989) states that they are in favor of teaching fractions in a direct and systematic way and even argues that time must be found to

give increased attention to fractions (Bezuk & Cramer, 1989).

However, Groff (1994) reported that traditional instruction of fractions is highly susceptible to criticism from numerous of perspectives. He continues by stating that reports from such sources as the federally sponsored National Assessment of Educational Progress indicate that fractions are extremely difficult for children to understand. Furthermore, he contends that students learn little about fractions each year, frequently unable to remember fraction information from one year to the next.

Thus, it becomes essential to investigate how to effectively implement alternative methods of fraction instruction. Utilizing the Internet to implement classroom instruction may be one of the most practical and competent ways to strengthen teaching of abstract, mathematical concepts such as fractions.

The Internet and Fractions

Recently, the annual meeting for the National Council of Teachers of Mathematics focused on Mathematics and the Internet (NCTM, 1999, 1998). Both of these conferences focused on the numerous ways students and teachers can enhance their education through using the Internet. The

conferences introduced the latest resources, services, and related research through presentations, small group investigations, and hands-on activities in an Internet computer lab. A variety of math topics were covered (including fraction concepts) and problem solving involving concrete, on-line manipulatives to help the student become successful.

An example of such a presentation was given at the NCTM (1999) conference by Lanius (1997). She offers a variety of on-line lessons that involve math and science. She is currently the Executive Director of the Center for Excellence and Equity in Education (CEEE). One exemplar on-line lesson she has composed is entitled "No Matter What Shape Your Fractions Are In" and is available at (http://math.rice.edu/~lanius/Patterns/). This lesson employs concrete geometrical figures to solidify the whole to part concept students need to master, to develop an understanding of fractions.

The idea of implementing the Internet to enhance mathematical instruction becomes extremely engaging when all considerations are weighed. Among these are time considerations, appealing to different learning styles, hands-on, interactive experiences, graphics, versatility in usefulness and accessibility, on-line communication and

feedback, real-time data, and the implementation of both instructional and societal technology goals. According to President Clinton (2000), "We know we must connect all our classrooms to the Internet, and we're going to get there." From elementary school to higher education, teaching the importance of the Internet may be a means of access to success and accomplishment in the job market of the future (Gianocavo, et al., 1996).

## The Internet and Design Models

Finding the optimal medium of technology to be integrated into a particular curricular area is crucial. However, once this has been established, it is imperative to investigate the role that the interface and instructional design plays in relation to learning.

According to Villamil-Casanova & Molina (1996), because multimedia gives the learner so many different ways to understand the subject matter, their level of knowledge is increased. Specifically, they discuss the process necessary for the student to completely retain their understanding of the information in their long term memory. This process consists of attention, rehearsal, encoding, and retrieval. These authors continue by reviewing how best to address the necessary steps of this process when considering instructional technology design:

- Keep the screen simple, consistent, and use text, color, motion, and sound sparingly.
- Avoid dividing the learners attention by keeping one topic per screen.
- Keep important instructive and supportive information on the screen.
- Encourage practice exercises after presenting the subject.
- Use design to make the information as concrete as possible (sound, graphics, text, video, and animation).

Instructional design is the systematic development of instructional specifications using learning and instructional theory to ensure the quality of instruction. It is the entire process of analyzing learning needs and goals and the creation of a delivery system to meet those needs. It includes the development of instructional materials and activities, including the tryout and evaluation of all learner instruction and activities.

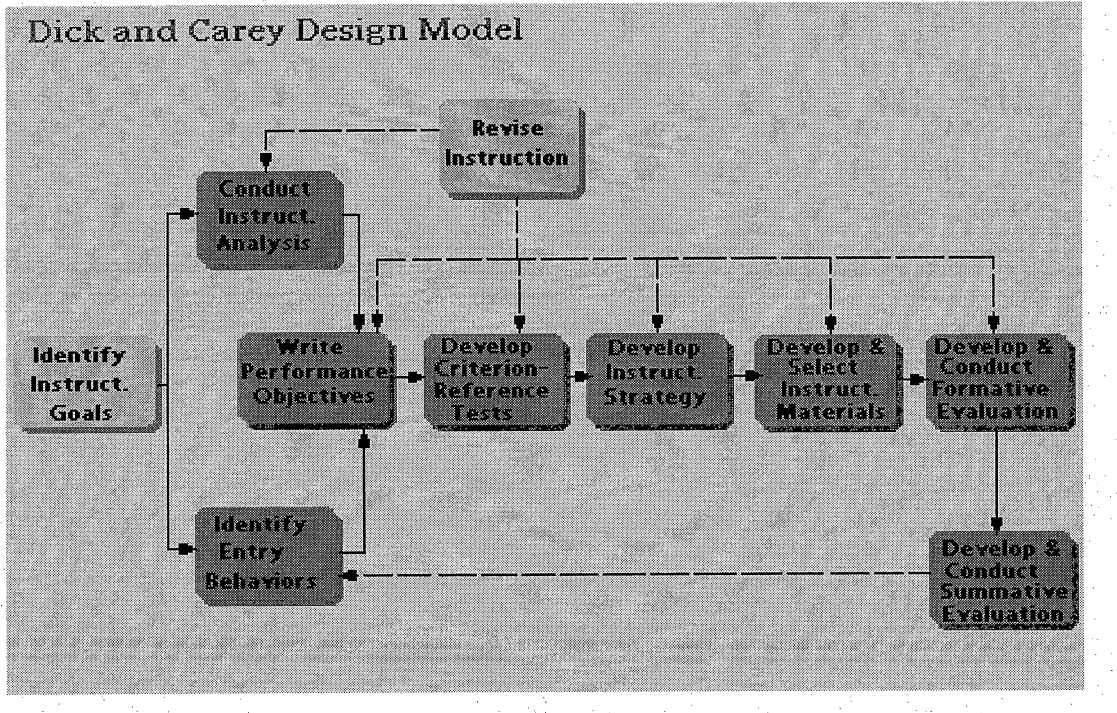
One example of a design model that may be conducive to an instructional web site is the Dick & Carey Model (1990). The processes included in this model are as follows:

- Assess needs to identify the goal.

- Conduct an instructional analysis.
- Analyze the learners and contexts.

- Write performance objectives.
- Develop assessment instruments.
- Develop an instructional strategy.
- Develop and select instructional materials.
- Design and conduct a formative evaluation of the process.
- Design and conduct a summative evaluation.

These processes are depicted by the following flowchart:




This flowchart is available at http://www.seas.gwu.edu/~tlooms/ISD/GIFS/dc_design.gif (Braxton, S., Bronico, K., & Loomis, T., 1997).

One of the strengths of this model is its basis on phases of an interactive process between the instructor/designer and the student. The input from the learner may help the teacher to focus instructional strategies on the individual needs of the students.

Another attribute of the Dick & Carey Model (1990) is that it can be applied to any of the learning theories. Dick (1994) discussed his design model but avoided learning theory. Specifically, he viewed that many different learning theories can be successfully applied to the basic practice of instructional design. Tripp (1994) affirmed this viewpoint by arguing that instructional theory need not be tied to any particular learning theory. He continued by stating that instructional theory can be derived directly from observation of instructional practice.

Finally, the Dick & Carey Model (1990) uses a systematic approach. This approach is similar to that of software engineering. Thus, making the model compatible with implementing an instructional Internet Site.

By reviewing the literature related to finding an optimal medium of technology to integrate into the elementary curriculum for teaching fractions, the developer of this project also examined learning theories,

styles, and environments and design models. All of the topics covered were utilized by the developer to determine the design and the logistics of creating the project described in the next chapter.

# CHAPTER THREE:

# DESIGN AND DEVELOPMENT

## Introduction

In this chapter the developer will discuss the design model the Internet project was based on and how the project was developed. Details will be given about how the design model relates to the various parts of the project. The rationale for the choices made during the stages of the development will also be reviewed including results from a needs assessment survey. The developer will explain the specifics of the Internet project including content, utilization, intended audiences, benefits, and goals. Finally, the developer will provide information about how the project was tested and evaluated. These discussions will be based on the findings from the literature review in the previous chapter and the needs assessment results generated from the project.

## Project Design

The design model used as the basis for this Web Site is the Dick and Carey Model (1990). The author believes that the basis of this design model is a strength of the project because of the interactive nature of the design model. The students are allowed to give input before the design process begins, enabling them to take an active

role in their learning. The developer implemented this component of the model in the project by conducting and analyzing a needs assessment survey to determine the primary goal of the Web Site. It provided information regarding previous student instruction of fraction concepts and information about the needs and environments of the students regarding their knowledge of and access to the Internet. The results of this survey will be reviewed in depth in the next section of this chapter.

Additionally, the Dick and Carey Model (1990) is structured to have a formative and a summative evaluation. The summative evaluation permits the students to assess the helpfulness and usefulness of the project and gives them the opportunity to provide the author/teacher with valuable feedback. These attributes of the design model may assist the author/teacher to target individual student needs. The developer of the project conducted both a formative and summative evaluation after testing the Web Site. The results of these evaluations will be provided later in this chapter.

Other desirable features of this model include the writing of performance objectives and the development of assessment and instructional materials. The author of the project developed and/or implemented various assessment

and instructional materials based on performance objectives. Some of them include a scavenger hunt, an on-line quiz, an on-line lesson, and graphic resources to teach the basic concepts of fractions. These will be discussed at length subsequently in the chapter.

Furthermore, according to Dick (1994), the learning theory behind the development of the instructional strategy is independent of the design model application. This is another attribute of the design model, because it gives the author/teacher the flexibility to adopt the learning method deemed to be the most beneficial to the learner. This Web Site is based on the constructivist learning theory. Students are able to choose their own paths and control the sequence in which they access the information within the Web Site. According to Jonassen (1996), learners should be constructors and producers of knowledge rather than passive receivers of inert knowledge. Enabling learners to construct their own knowledge makes it more memorable, meaningful, and applicable.

Needs Assessment

The Web Site was designed to be used by $4^{th}/5^{th}$ grade students. Before the Web Site was created, a needs assessment survey was given to the students in the $4^{th}/5^{th}$

grade classroom. (See APPENDIX A for a sample of the Needs Assessment Survey). The survey was designed to evaluate whether the majority of students had the basic computer/Internet skills and were able to access the Internet in order to make the Web Site beneficial to them. The survey was also intended to assess whether the students had prior instruction/knowledge of fractions to help determine the content of the Web Site. This is conducive to the Dick and Carey Model (1990), which states that the needs of the learner should be assessed in order to determine the goal of instruction.

It was necessary to analyze the results of the Needs Assessment Survey in order to design and implement an effective instructional technology project to support teaching fractions to this class. The results were also used to analyze the learners behaviors and their environments outside of the school setting to determine the potential usefulness and effectiveness of the Internet project. The Dick and Carey Model (1990) states that not only should an instructional analysis be done but that the learners and contexts should also be analyzed.

According to The California Mathematics Academic Content Standards (1998), fractions should be introduced in the third grade. It is interesting to note that 64% (18

out of 28 students) of the entire class indicated that they either had only some or no understanding of fractions from the previous year. Together with the fact that 57% (16 out of 28 students) of the class was in 4th grade, helped to determine that the project should support teaching fractions at an introductory level for the grades being taught. Additionally, 17% (2 out of 12 students) of the 5th graders did not learn about fractions at all in the previous year and 8% (1 out of 12 students) answered that they somewhat learned about fractions in the previous year.

Furthermore, an overwhelming majority of the students, included in the survey not only had access to a computer outside of school (96%) but also had access to the Internet outside of school (86%). This indicated that the integration of the Internet as the medium for this project was possible. However, questions related to the frequency of computer and Internet use revealed that the students did not use the computer on a frequent basis. Specifically, 11% (3 out of 28 students) of the class reported using the computer 5 or more times per week, while only 4% (1 out of 28 students) of them utilized the Internet equally as often. Additionally, the survey showed that 46% (13 out of 28 students) of the participants used

a computer 3-4 times per week but only 14% (4 out of 28 students) spent equivalent time on the Internet. This suggested that infusing Internet technology into the classroom curriculum to be an optimal way to increase student experience and knowledge of the Internet. It was the hope of the author that the project would motivate the students to use the Internet more often and realize the value of it in their learning.

The author's rationale for selecting the Internet as the media for this project is founded in the rapid growth rate of the technology related fields. The Internet is one of the most advanced forms of technology enabling it to keep pace with the swift growth of the industry. It is pervasive and highly versatile in its usability and accessibility. In addition, the Internet is non-linear in design which allows the user to navigate through data in an individualized sequence to fulfill personal, educational needs. The Internet also has the capabilities to obtain real time data, and on-line communication and feedback. Another benefit of the media selection for the project is that all the classrooms in the school and district it was intended for were connected to the Internet.

Development and Goals of the Educational Web Site

The web site was created using Net Objects Fusion. This software program is designed to create web pages using templates and other graphics, which can be obtained within the program or from other graphic files the author wishes to access. This program was well suited to the author's needs. It was efficient in saving time and was user friendly.

The primary purpose and goal of the Web Site was to provide an introduction to learning fractions, aimed specifically at $4^{th}$ and $5^{th}$ grade students. The Web Site explained the basic concepts of fractions and their parts. It also provided opportunities for students to practice the knowledge they obtained, allowing them to rehearse, encode, and retrieve the information presented in the Web Site. This process is conducive to retaining information in long term memory (Villamil-Casanova & Molina, 1996).

A flowchart of the Web Site was created and is located in APPENDIX C. Screen shots (computer pictures of the Web Site) have been included to document the permanent pictures of the Web Site (located in APPENDIX D of this paper.) The content of the Web Site includes a home page and 6 other pages. The titles of these pages are Kids Korner, Facts, Fraction Strips, Fraction Circles, Parents,

and Teachers. The developer created the project for her $4^{th}/5^{th}$ grade combination class and their parents. It is also the developer's intention to promote other students, teachers, and parents in the school/district community to use the Web Site.

The Web Site was utilized in the classroom for six weeks. The developer integrated the components within the site into the curriculum in various ways. These included different instructional strategies and assessments to target visual learning, learning by doing, collaborative learning, and learning through exploration. The implementation of the Web Site was meant to supplement the curriculum already in place for teaching fractions in a $4^{th}/5^{th}$ grade classroom.

One of the instructional strategies of the Web Site was the page entitled Kids Korner. The page includes an Internet scavenger hunt that was designed to motivate students to explore different parts of the Web Site, as well as links to resources located at other addresses on the Internet. These outside links were carefully examined and selected by the author. Through these explorations students were engaged in problem solving situations involving fractions, basic skills practice with immediate feedback on performance including remediation, and using

fraction models/graphics to answer questions given in the Scavenger Hunt.

After receiving a basic introduction to fractions and how to use models to assess them, all of the students in the $4^{th}/5^{th}$ classroom participated in working on the Scavenger Hunt. The developer gave minimal instructions about how to navigate to different links within the site and outside of the site by clicking on the highlighted words/titles above each question or groups of questions. It was the developer's intention to encourage collaboration through giving only basic instructions (about both fractions and the site) and then requiring students to work in pairs. The activity took place during a lab session lasting approximately 1 hour and 30 minutes. Students worked together to answer the questions, with pencil and paper, and the results were used as one of the assessment instruments of the Web Site. Some students required additional time to complete the activity and were given time in class with their original partner to complete it. During the lab session, the author conducted a formative evaluation of the students ability to utilize and access the Web Site. The developer believes that since only minimal instructions were given before this observation the validity of the results was increased.

The Facts, Fraction Strips, and Fraction Circle pages were included in the Web Site to assist students, parents, and teachers. Specifically, the Facts page was used by the developer in the classroom setting by assigning students to include the definitions about fractions from this page in their math journal. Every student kept a math journal throughout the year of definitions and formulas. The journal was the only notes allowed to be used for quizzes and tests.

Each student was scheduled, along with their partner, for 25 minutes of time to access the Web Site each week in the classroom. In addition, students were allowed to access the Web Site while working on in class assignments from their math book for help. The Fraction Strips and Fraction Circles pages were used by students for class assignments to help them determine the relationships between fractions. Being able to see visual comparisons of fractions may support students' perceptions of fractions to become more concrete. Finally, these pages could also be used by teachers in other classrooms to assist students and by parents working with their child on homework assignments.

Another element of instruction and assessment used in the classroom curriculum by the author included an on-line

lesson entitled "No Matter What Shape Your Fractions Are In" which is linked to the Kids Korner and the Teachers page and is available at (http://math.rice.edu/~lanius/Patterns/). This site was created by Lanius (1997), who is currently the Executive Director of the Center for Excellence and Equity in Education (CEEE). This lesson was conducted using a presentation system to display the computer screen contents on a television screen so all students could see. The group presentation method was chosen because there was only one computer in the room connected to the Internet.

The lesson employed concrete geometrical figures and the use of color to help solidify the whole to part concept and relationships between fractional parts that students need to master, in order to develop an understanding of fractions. The lesson was completed by the students during one 40 minute class session using paper and pencil. The author then accessed the answer page located in the Web Site so students could receive immediate feedback on their work, by comparing their answers to those displayed on the screen (see APPENDIX E for screen shots of both the on-line lesson, "No Matter What Shape Your Fractions are In" and answer page). The lesson included class discussion and a preview of other

parts of this Web Site to encourage students to explore its other components during class computer and/or math time.

Finally, the developer created an on-line quiz utilizing the Funbrain.com - Quiz Lab (Family Education Networks, 1997) link on the page entitled Teachers and is available at http://www.funbrain.com/quiz/index.html (see APPENDIX F for a screen shot of the Quiz Lab). Students completed the quiz collaboratively during their class computer time as an assignment for the week. The results were automatically e-mailed to the developer and relayed to the student the same day they took the test. The Quiz Lab is a free resource on the Internet for teachers. It requires a teacher and student password to take the quiz, adding to the security of site. The capability of on-line scoring and communication is another strength of the Quiz Lab.

Besides the main goal of introducing fractions, the Web Site included many supplementary goals. The first was intended to benefit students and parents. The developer explained the components of the Web Site to approximately 35 parents during parent teacher conference time and furnished the Web Site address before using it in the classroom. The developer used this means of communication

due to the extremely high participation rate of the parents and was able to conference for every child with at least one parent. In different settings, communication through a written letter to the parents, returned with their signature, may be more feasible for obtaining contact with all students' parents/guardians.

It has been the experience of the author that many students and parents struggle and become frustrated with homework assignments related to fractions. By creating the Web Site the developer enabled parents to access and utilize some of the teaching tools used in the classroom. This is a strength of the project because it empowers parents to be able to know the teaching methods of the classroom instruction. Fractions are complex and can be taught in many ways. By enabling parents to mirror classroom instruction at home, the students' chances of being successful are improved.

In an effort to alleviate the potential problems of learning fractions, an e-mail link was provided (on the Home page of the Web Site) to the author/teacher for students and parents to use regarding homework questions or areas of concern. The e-mail was checked by the author/teacher on a daily basis in the evening to give students and parents a chance to attempt homework

assignments. The developer believes that this is a very significant asset of the project. Effective and efficient communication between parent(s)/student and teacher is essential to the success of each and every child. The best way to ensure a student's success is for the teacher and parent(s) to work closely together pursuing the same goals and objectives. A resource page entitled Parents was also created by the developer. The links on the page were meant to help support student learning by providing hands-on activities they could do at home. One example of this, entitled Math Parent Handbook, is located in APPENDIX G and is also available at http://www.eduplace.com/math/res/parentbk/phs2.html#8 (Houghton Mifflin Company, 1997).

The second supplementary goal of the project was to support teachers in integrating technology in the classroom to enhance fraction instruction. A resource page entitled Teachers was provided. The developer was able to hold a 45 minute lab session to introduce the Web Site to some of the teachers at Dona Merced Elementary School, including all 3 of the other 5$^{th}$ grade teachers. The developer received immediate positive feedback from the participants, including their opinions that they could use the Web Site in their classrooms. In addition, all 3$^{rd}$-5$^{th}$

grade teachers at the school site were notified about the location and contents of the Web Site through e-mail. The developer believes this component of the project may increase the validity and usefulness of the project.

Instructional technology has become a high priority for society and within the school setting. Teachers are faced with the enormous task of tackling how to integrated technology into their curriculum, while continuing to perform the multitude of jobs they are already responsible for. It was the objective of the developer to enable teachers to implement the Internet as an instructional tool in their classrooms, with a minimal investment of their valuable time. They could do this by accessing on-line, ready-to-use fraction lessons and a free, on-line quiz lab for teachers. The quiz lab is very user friendly and allows the teacher to create quizzes and automatically e-mails the results. Other ways they can implement it in their classroom include using the Kids Korner, Facts, Fraction Strips, and Fraction Circles with their students to help explain and teach the concepts and relationships of fractions.

Finally, since there were no other teacher created web sites for classroom use in the school, the author also

wanted to advocate the Internet as a viable medium to integrate into classroom instruction.

By utilizing the Web Site and all of its components in a $4^{th}/5^{th}$ grade combination classroom, the students who were new to the Internet and/or fractions received an introduction to both the subject matter and the capabilities and advantages of the Internet simultaneously. Additionally, by linking the Web Site to the school web site where it has been implemented (Dona Merced Elementary School in Rancho Cucamonga, California), the author hopes to encourage its use in other classrooms and homes of students within the school and district.

Educational Web Site Testing and Evaluation

An evaluation of the Web Site was conducted by the author during the lab session where students were introduced to the site through the Scavenger Hunt. This formative evaluation was conducted after giving students minimal instructions on how to access the site through the bookmark command and what the assignment was. The author conducted the evaluation through observing the students and facilitating their work within the Site. The students were required to find answers in the Scavenger Hunt by accessing the links provided on the page to find the information. The author concluded the evaluation by asking

the students questions such as, "Have you ever been given an assignment like this on the Internet before? How did you feel about looking up answers on the Internet instead of in a book?"

The author's evaluation provided helpful insights. The developer perceived that the Web Site was user friendly. It is the author's finding that the majority of the students were able to navigate through the site successfully and complete the assignment, once they understood that the highlighted, underlined text were links to the information they needed. Additionally, the developer perceived that the students understanding of the Internet Site assignment, their capabilities to utilize the site successfully, and the thoughts of the students regarding the assignment and site were very positive learning experiences. It was also observed that in most cases students used collaboration with their partner to figure out any questions and/or problems before asking the author/teacher. Finally, the responses to the author's questions and written answers to the Scavenger Hunt reflected that the students enjoyed and gained knowledge from the experience pertaining to both fractions and how to navigate and utilize an Internet site effectively.

The Web Site was also tested using a summative evaluation survey entitled Jackson's Fraction Factory Evaluation. This survey was completed by the same 28 students who completed the Needs Assessment Survey given before the Web Site's creation. During a 6 week period of time, the participants were allowed to investigate the site (in structured settings and free exploration sessions), complete the Scavenger Hunt in a collaborative computer lab situation, participate in an on-line lesson and quiz, and use the site while completing in-class assignments. The survey was administered during a 25 minute classroom session. All participants completed the survey using pencil and paper. The developer explained the importance of keeping the survey anonymous. A summary of the results are as listed in the following table.

Table 1. Jackson's Fraction Factory Evaluation Survey Summary and Results (Part I)

| Summary | Results | | |
|---|---|---|---|
| | Yes | No | Somewhat |
| Visually appealing | 25 | 3 | - |
| Project goal clear | 27 | 1 | - |
| Easy to use | 22 | 1 | 5 |
| Enjoyed using project | 23 | 0 | 5 |
| Project useful and helpful | 19 | 0 | 8 |
| Project information understandable | 21 | 0 | 7 |

The second part of this evaluation survey asked what things could be done to improve the Web Site and what things were liked. A summary of the results are listed in the following table.

Table 2. Jackson's Fraction Factory Evaluation Survey Summary and Results (Part II)

| Things That Were Liked | Suggested Changes |
|---|---|
| Definition page about fractions and their relationships | Adding audio to the web page including music and/or talking |
| The Scavenger Hunt and the links it provides | Increasing the fraction strips to include fractions after the tenths |
| The Web Site is easy to navigate through | Add more color to the Web page |
| The Web Site shows and tells how to answer problems | Include a picture of the whole class on the home page |

The results from both the formative evaluation (completed by the author) and the summative evaluation survey (completed by the students) revealed that the Web Site provided a positive learning environment, relating to both fractions and effective use of the Internet. These results were extremely valuable, because they provided significant information and observations about the Web Site. A review of these results will hopefully create an opportunity for improvement on similar projects for educators to experience and use in the future. The author's conclusions, suggestions, and recommendations

based on these results will be discussed in the next chapter.

# CHAPTER FOUR:

# CONCLUSIONS

## Introduction

The final chapter of this paper will address the author's conclusions with regards to the literature review and the results of the needs assessment and evaluations of the project. Suggestions and recommendations to other teachers and professionals who share common interests and goals of the project will be given by the author. It is the expectation of the author to support other professionals with this research and project.

The literature review in this paper demonstrates that advanced technology integration is pervasive in every day life and valuable in the elementary school setting. However, teachers have not participated in the implementation of technology in the elementary classroom as anticipated. There is a need to examine how this gap can be bridged so that elementary students can emerge from an elementary education with the skills and tools to build their abilities to succeed in the information/technology age.

It is clear that, based on the futuristic capabilities of the Internet, learners can benefit from all the attributes the Internet has to offer including,

non-linear design, versatility of usability and accessibility, hands-on, interactive learning experiences, graphics, on-line communication and feedback, and real-time data.

It has also been demonstrated, through the review of literature, that teaching abstract mathematical concepts is conducive to integrating Internet technology in the classroom. Specifically, one of the most abstract and tough to teach topics in the upper elementary curriculum is the concepts and relationships of fractions. The research shows that traditional methods of teaching fractions has been lacking and requires additional and/or alternative methods to support student learning from one year to the next.

The vast capabilities of the Internet promote its use beyond classroom instruction. It can be effectively utilized to help bridge the gap between home and school collaboration, teacher peer collaboration, student and teacher collaboration, and student peer collaboration. The possibilities are limitless and extremely beneficial to all users. The crucial benefit of these possibilities is the ability to promote student success. Besides the ability to communicate on-line, the parents, students, and teachers have the ability to share resources and teaching

techniques to improve student chances of success. Finally, students are able to learn the subject matter in conjunction with technology skills and abilities that will promote their prosperity in the future.

It is the author's conclusion that this project was a stepping stone in finding an effective utilization of the Internet in classroom instruction. It is also the author's perception that the project was successful in bridging the gap between home and school communication. Specifically, the author feels that out of approximately 35 parents, that were conferenced with directly, an overwhelming majority expressed enthusiasm about the project. Finally, the author concludes that the project fostered student learning to occur within the realms of the Internet and fractions.

Suggestions and Recommendations

The principal suggestion to other teachers/professionals pursuing this type of Internet Integration is to seek the input of students before beginning the project. The developer of this project found that the results from the needs assessment survey to be invaluable. It was crucial in setting the focus of the subject matter, as well as the media to incorporate.

Another suggestion is to conduct parent and teacher communication on a personal basis if possible. By communicating with parents during parent/teacher conference time the developer felt participation was increased at the parent level. Additionally, the 3 teachers who participated in the introductory lab session about the project were more likely and willing to participate in utilizing the Web Site with their classrooms than those teachers who did not attend.

Finally, the author suggests using evaluation surveys for the adults involved to provide additional information about the usefulness of the project. The results of both the formative and summative evaluations showed that the Web Site was well presented and relatively easy to utilize and navigate through. Additionally, the majority of students rated the site as helpful, useful, and understandable, and enjoyed using the site. The suggestions made by the students about their likes and dislikes of the site were somewhat useful. Some student ideas were not possible to execute, which made them less valuable. For example, a suggestion was made to include a picture of the whole class. This was impossible due to the legalities of acceptable use policies. Thus, it may have been worthwhile to ask for suggestions from the adults

about their likes and dislikes to construct more realistic proposals.

However it is not the advice of the author not to collect this data from the students. Other suggestions made by the students were very useful. One of these is increasing the Fraction Strips page past the tenths to include subject matter required by the established curriculum. Another is to include sound to enhance learning and positive reinforcement.

It is beneficial to examine ways to improve this project and/or ones like it in the future. The author recommends using student drawings of themselves or artwork from each student instead of an actual photograph of the whole class. This would take care of the problem of not being able to obtain parent permission to publicize their photographs. Although one must still attain permission to publish student work, it is usually much easier to obtain. This would enable students to increase their sense of ownership in the project.

Additionally, the author recommends including graphics to illustrate the Facts page in the Web Site. The capabilities for students to embed this knowledge into their memories may be increased by adding pictures that exemplify the concepts being explained.

The principal recommendation emerging from this review of the literature and this project is for elementary teachers and schools to invest time and resources in promoting Internet technology in their classrooms. Such investments must be designed to help the educators to succeed in implementing advanced technology into their curriculums. This indicates that schools need to invest in training and education, ready-to-use Internet curriculums, and/or invest in a full-time developer of technology curriculum to empower both the teachers and students to reach their full potentials.

In order for students to become knowledgeable in the advanced realm of technology, they must utilize these technologies on a regular basis. Technology should not be taught in schools as a stand alone subject. It should be seamlessly integrated into the curriculum in order to prepare students for the promises of tomorrow. What seems to be lacking in many elementary curriculums is the infrastructure to support individual teachers. The need for providing these professionals with training/education and up-to-date instructional technology capabilities and opportunities is a critical educational issue to be addressed.

Students currently in elementary school will be entering the workforce and become adult members of society around the year 2015. It is imperative to investigate how to best prepare these children utilizing a technology media capable of surpassing the years of growth between the present and future. The most advanced and versatile form of media to date is the Internet. With this promising form of media, one can expect its position to impart on the learning of our young children.

# APPENDIX A:

# SURVEY

# Needs Assessment Survey

**Directions**: Please circle the best answer to each question.

1. What grade are you in? 4th 5th

2. Do you have a computer at home? Yes No

3. Do you have Internet access at home? Yes No

4. Do you use a computer at home or outside of school? If no, skip to number 6.

   Yes No

5. If you answered yes to number 4, about how often do you use the computer?

   | 0-2 times a week | 3-4 times a week | 5 or more times a week |
   |---|---|---|

6. Do you use the Internet at home or outside of school? If no, skip to number 8.

   Yes No

7. If you answered yes to number 6, about how often do you use the Internet?

   | 0-2 times a week | 3-4 times a week | 5 or more times a week |
   |---|---|---|

8. Did you learn about fractions last year? Yes No Somewhat

# APPENDIX B:

# JACKSON'S FRACTION FACTORY EVALUATION

# Jackson's Fraction Factory Evaluation

**Directions**: Please circle the best answer to each question.

1. Did you like the way the web site looked? Yes No Somewhat

2. Was the goal of teaching about fractions through the web site clear?

   Yes No Somewhat

3. Was it easy to use? Yes No Somewhat

4. Did you enjoy using the web site? Yes No Somewhat

5. Was the web site useful and helpful? Yes No Somewhat

6. Were you able to understand the information in the web site?

   Yes No Somewhat

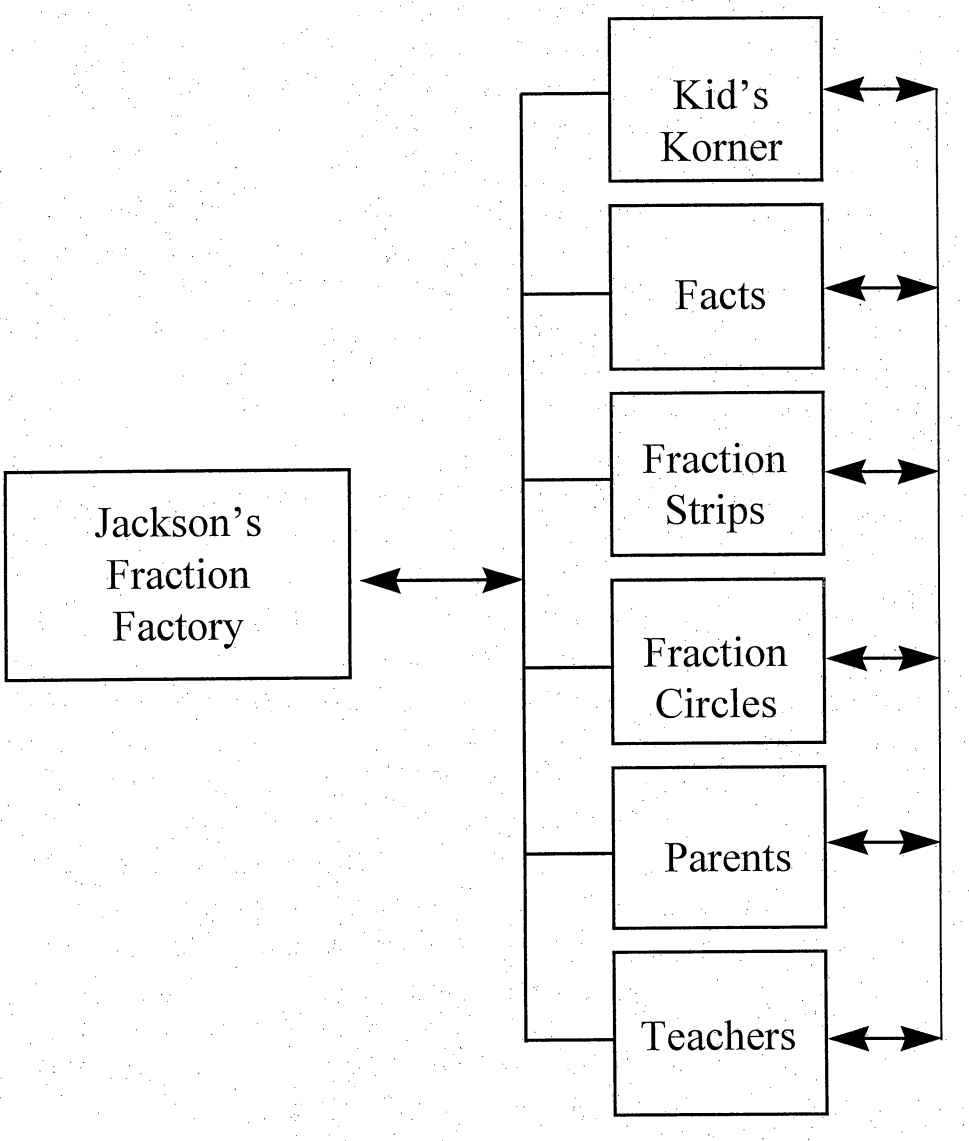
7. Please describe any part(s) of the web site you liked.

8. Please describe any part(s) of the web site that you think should be changed and tell why you think so.

# APPENDIX C:

# WEB SITE FLOW CHART

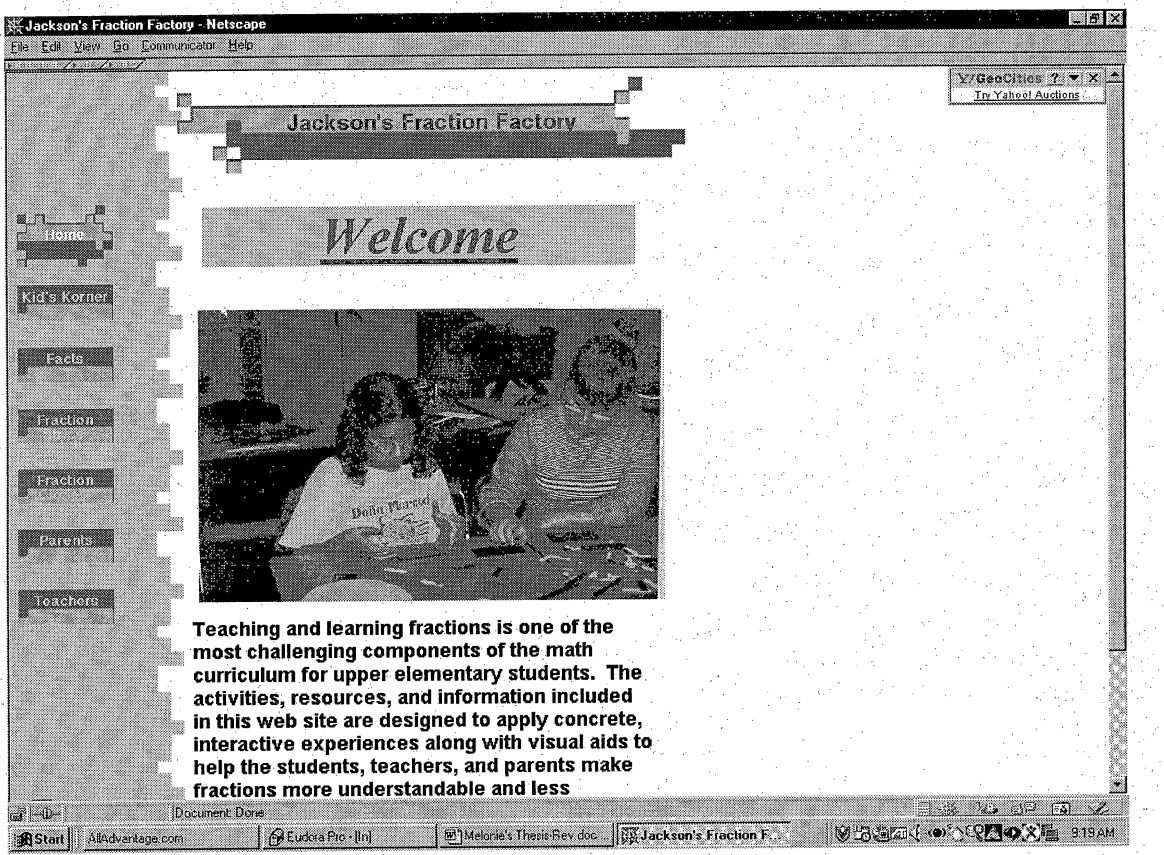
**Web Site Flow Chart**



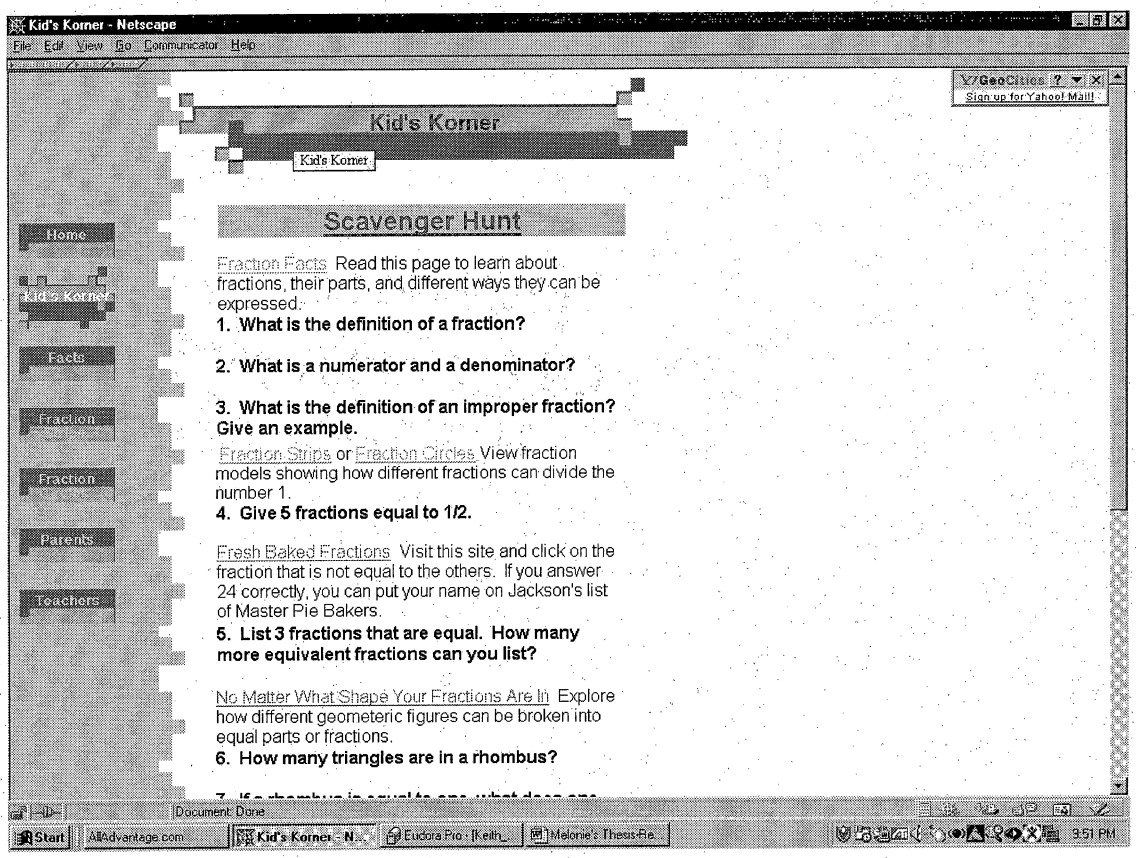
# APPENDIX D:

# WEB SITE SCREEN SHOTS

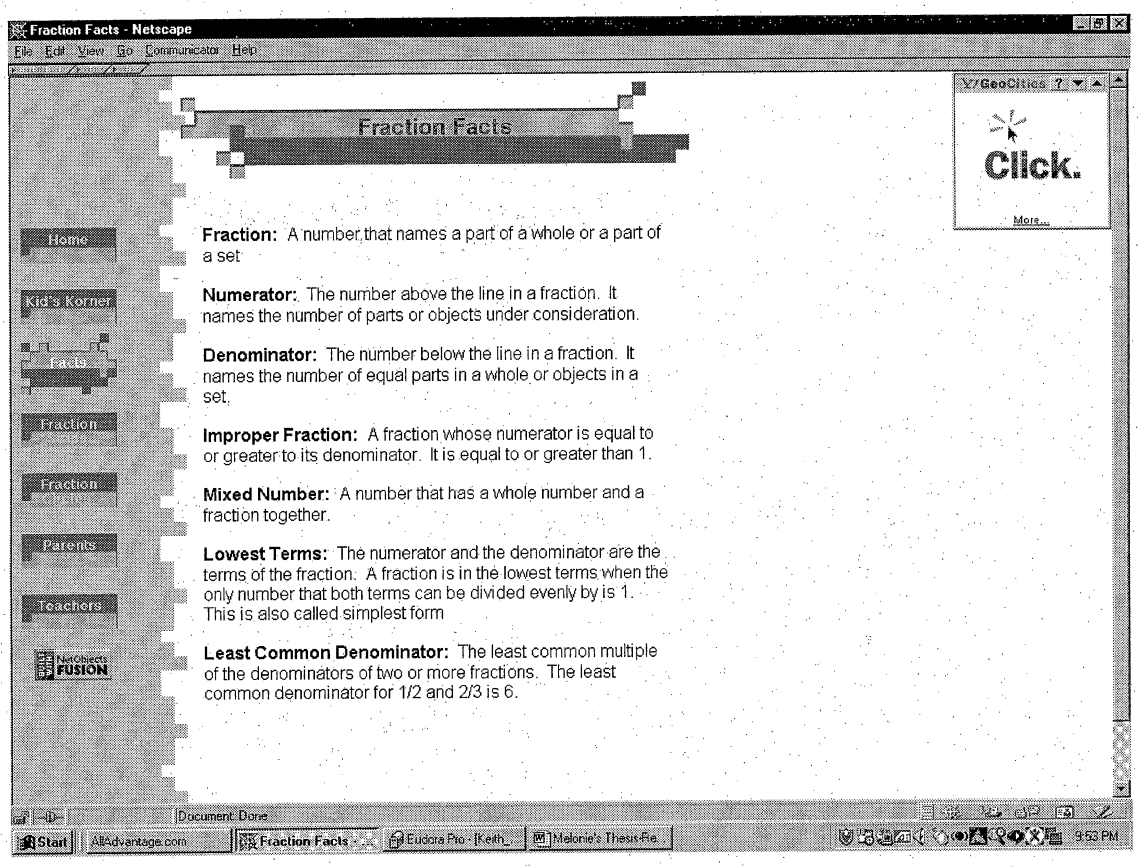
## Jackson's Fraction Factory Home Page



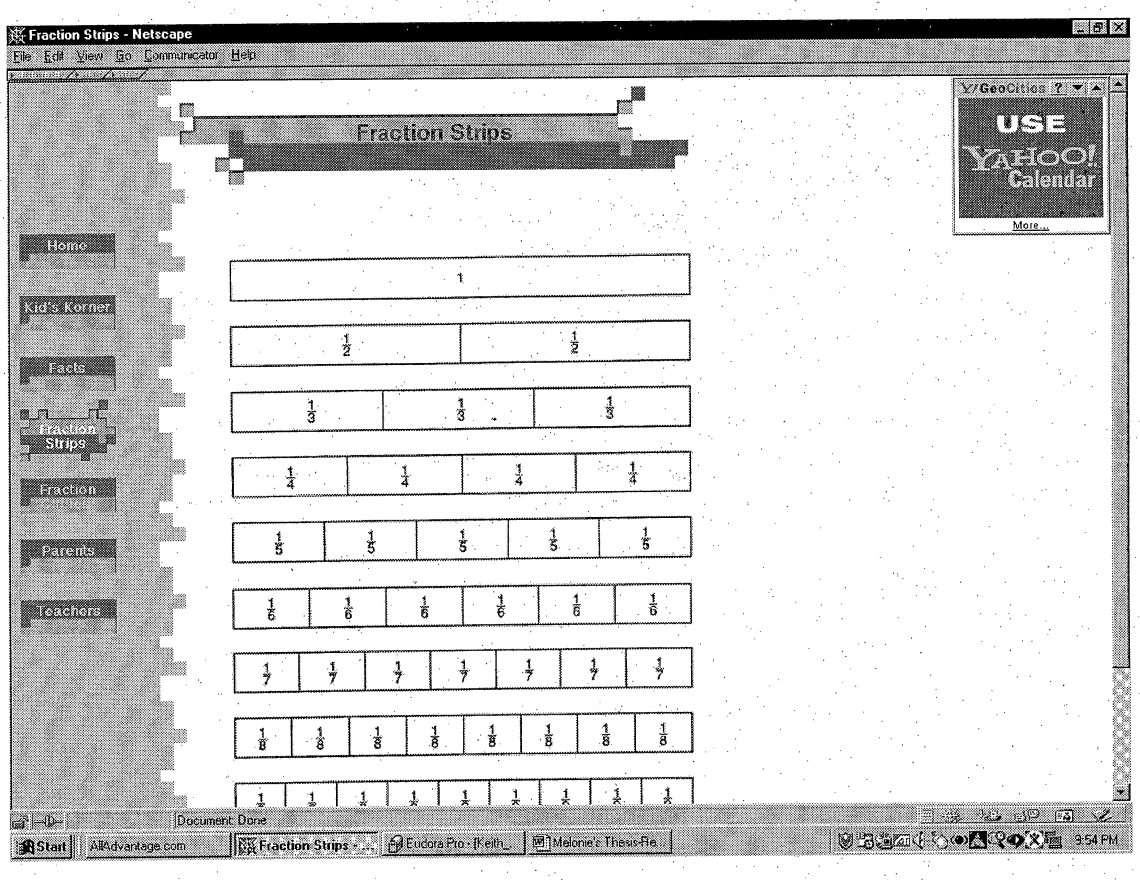
# Kid's Korner


Kid's Korner - Netscape
File Edit View Go Communicator Help
Sign up for Yahoo! Mail!
Kid's Korner
Kid's Korner
Home
Kid's Korner
Facts
Fraction
Fraction
Parents
Teachers
Scavenger Hunt
Fraction Facts Read this page to learn about fractions, their parts, and different ways they can be expressed.
1. What is the definition of a fraction?
2. What is a numerator and a denominator?
3. What is the definition of an improper fraction? Give an example.
Fraction Strips or Fraction Circles View fraction models showing how different fractions can divide the number 1.
4. Give 5 fractions equal to 1/2.
Fresh Baked Fractions Visit this site and click on the fraction that is not equal to the others. If you answer 24 correctly, you can put your name on Jackson's list of Master Pie Bakers.
5. List 3 fractions that are equal. How many more equivalent fractions can you list?
No Matter What Shape Your Fractions Are In Explore how different geometeric figures can be broken into equal parts or fractions.
6. How many triangles are in a rhombus?
Document: Done
Start
AllAdvantage.com
Kid's Korner - N...
Eudora Pro - [Keith_
Melonie's Thesis-Re...
9:51 PM

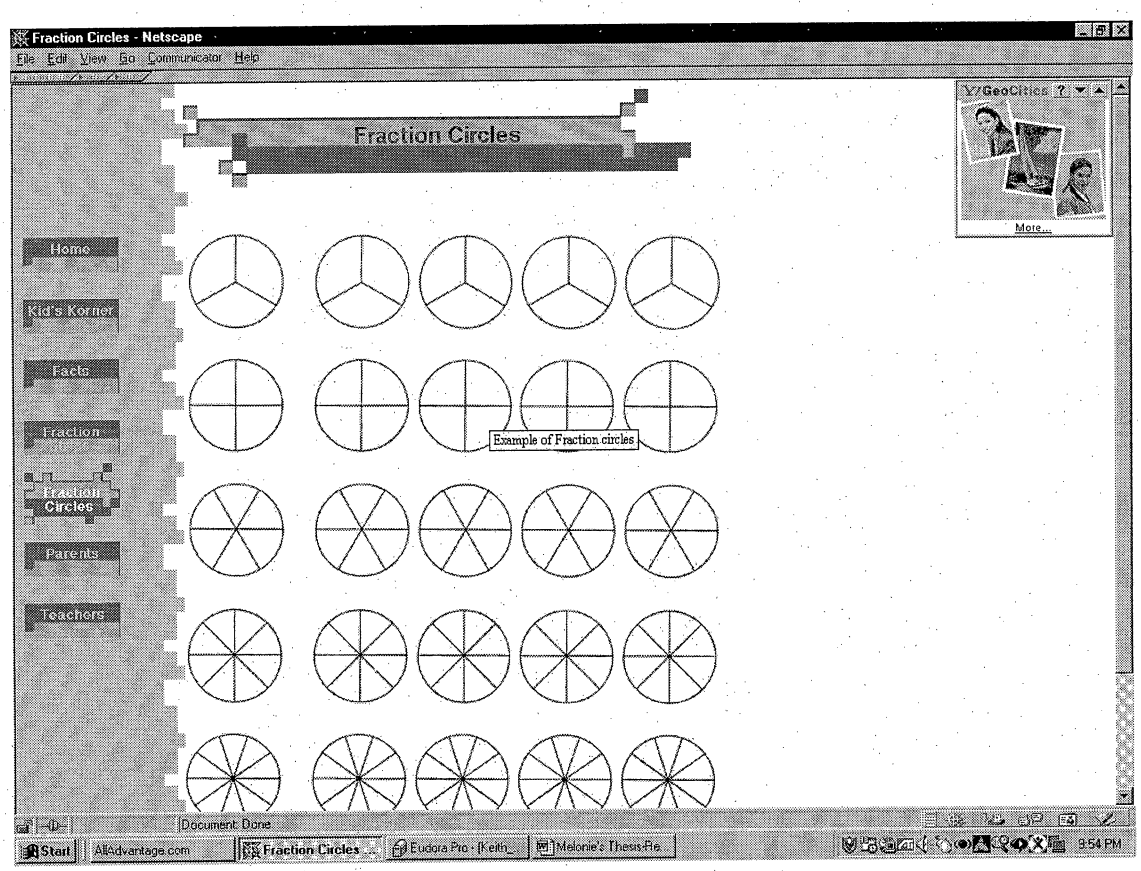
# Fraction Facts



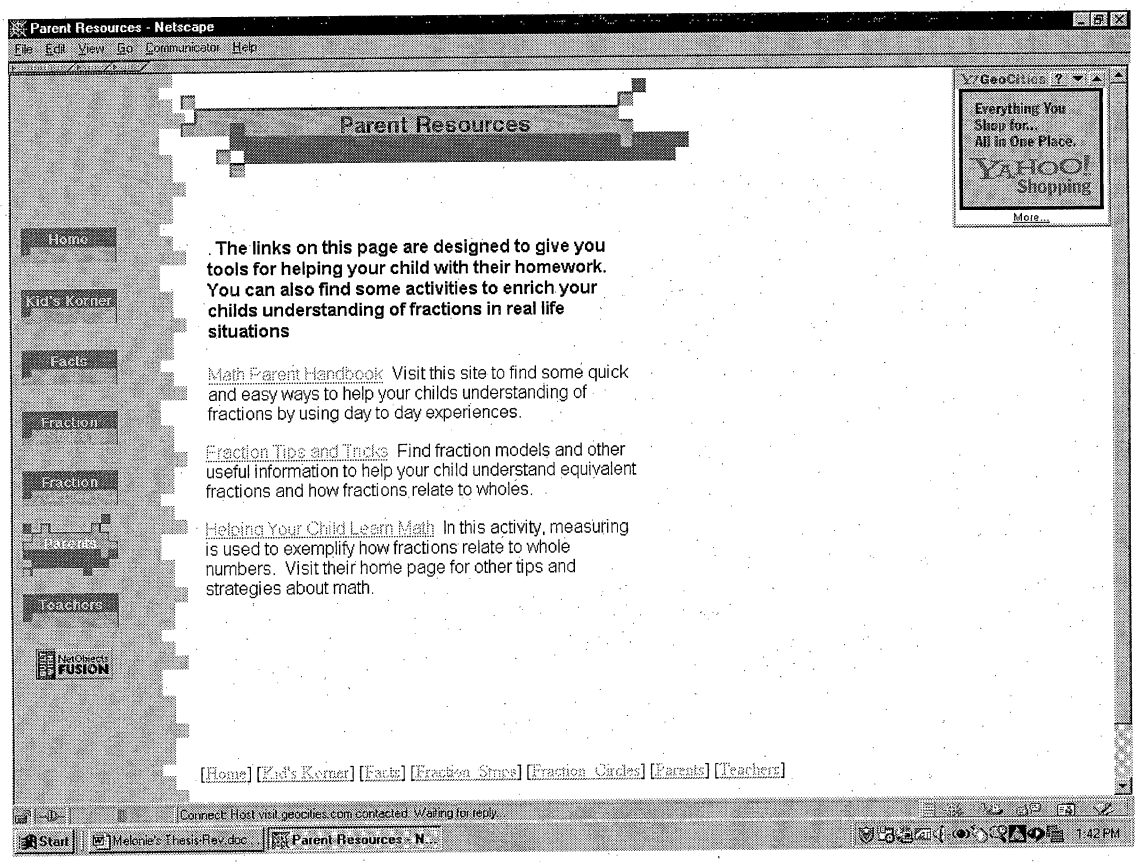
## Fraction Strips



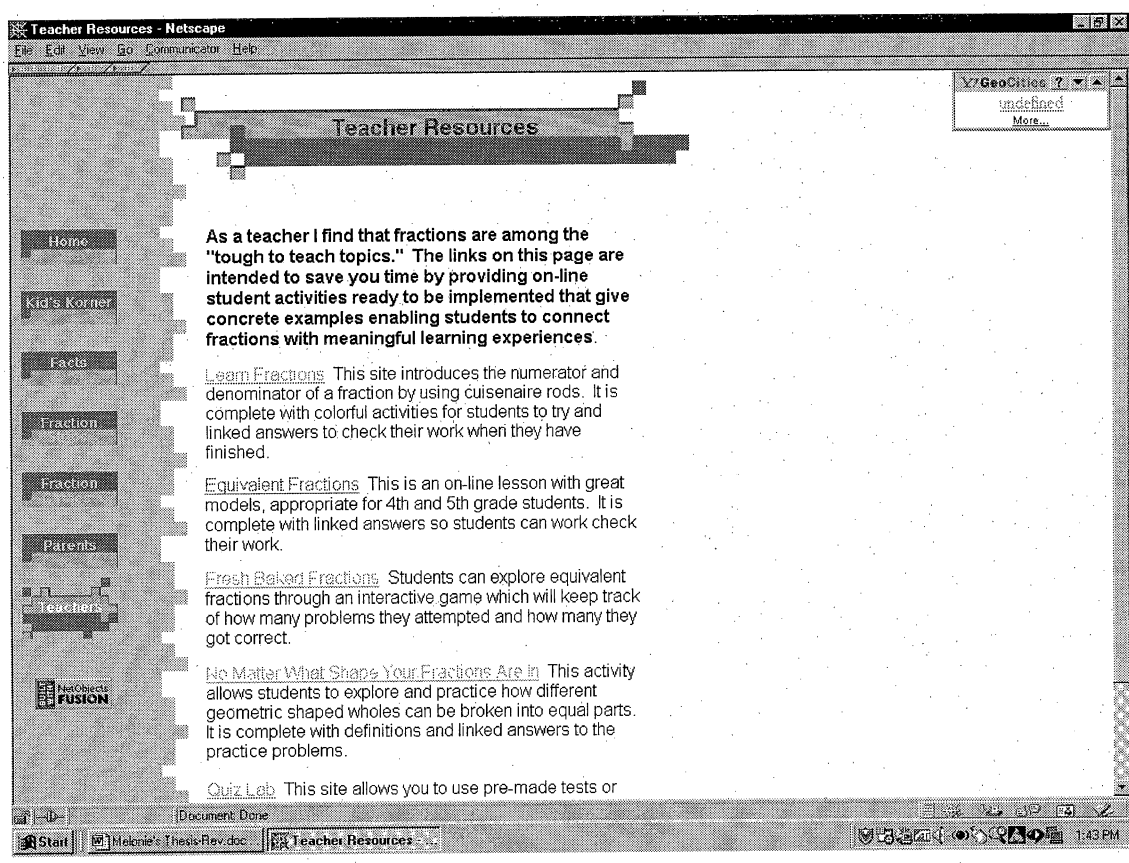
## Fraction Circles



## Parent Resources



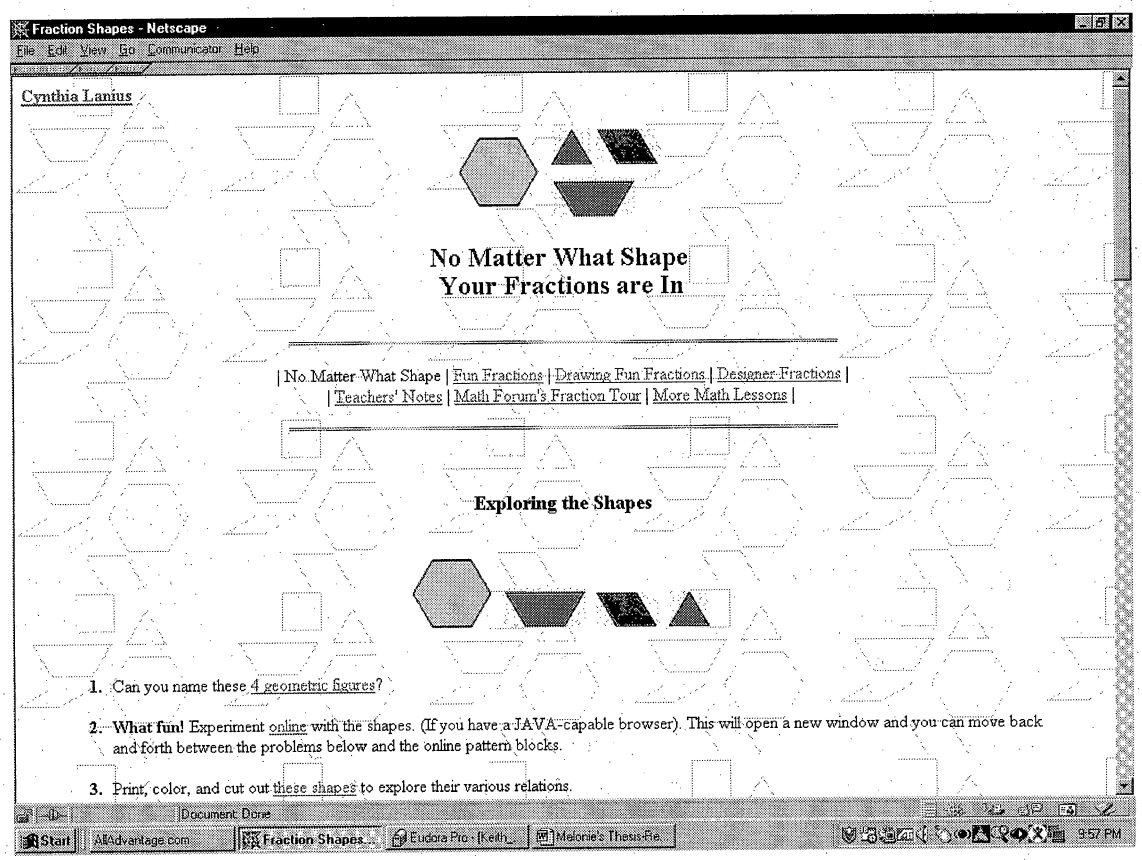
# Teacher Resources



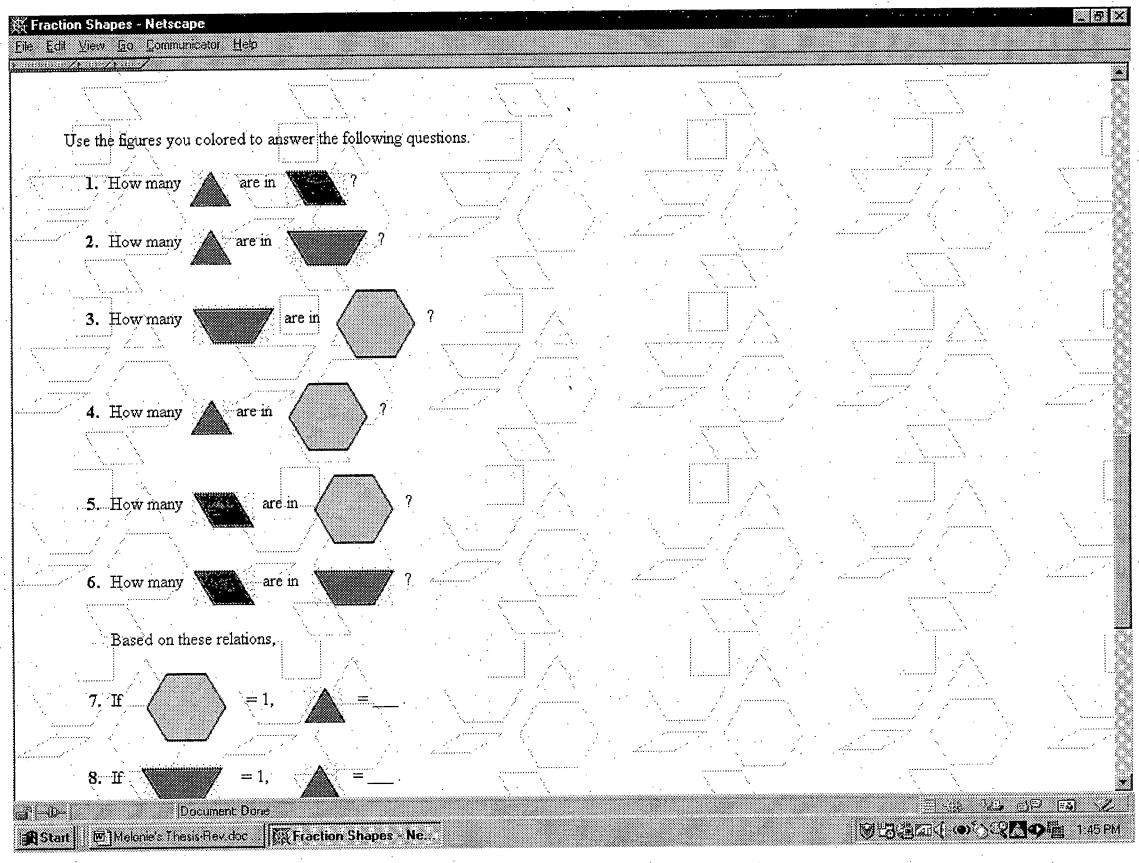
# APPENDIX E:

# NO MATTER WHAT SHAPE YOUR FRACTIONS ARE IN

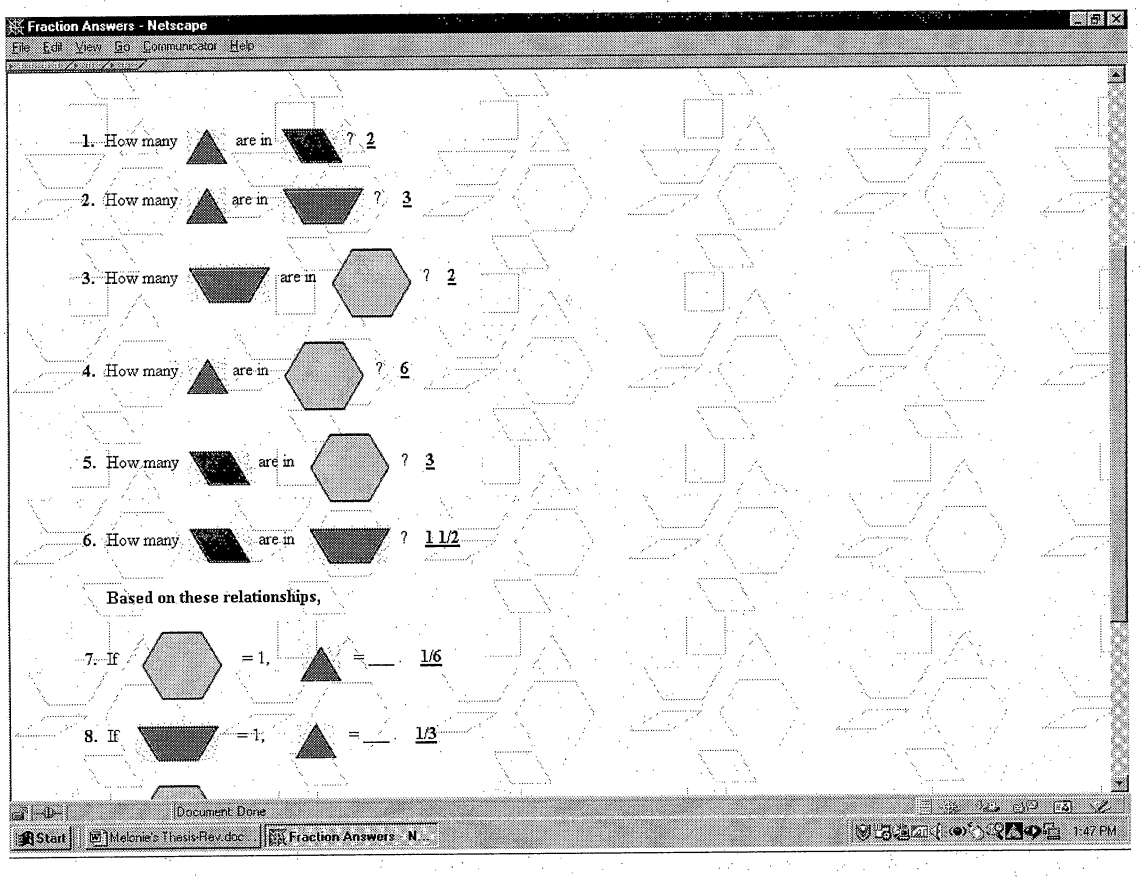
**NO MATTER WHAT SHAPE YOUR FRACTIONS ARE IN**



## Determining the Relations



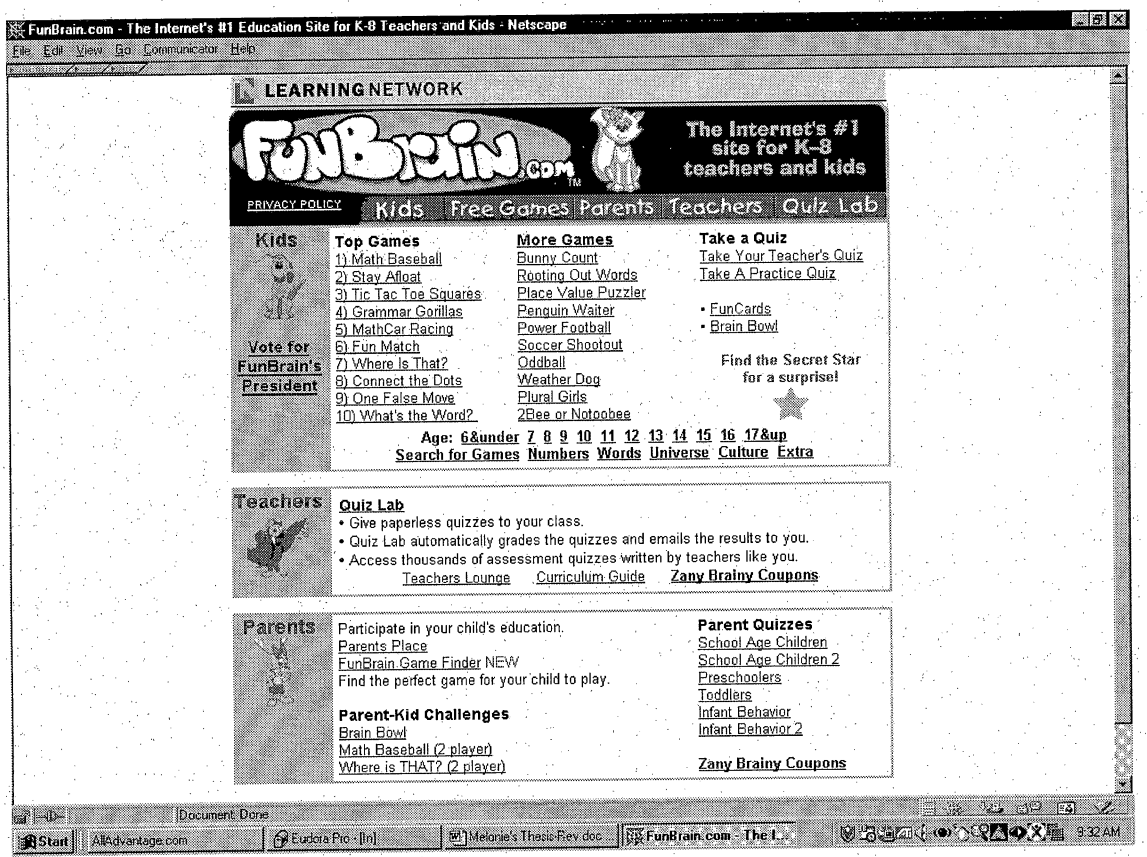
## Fraction Shapes-Answers



# APPENDIX F:

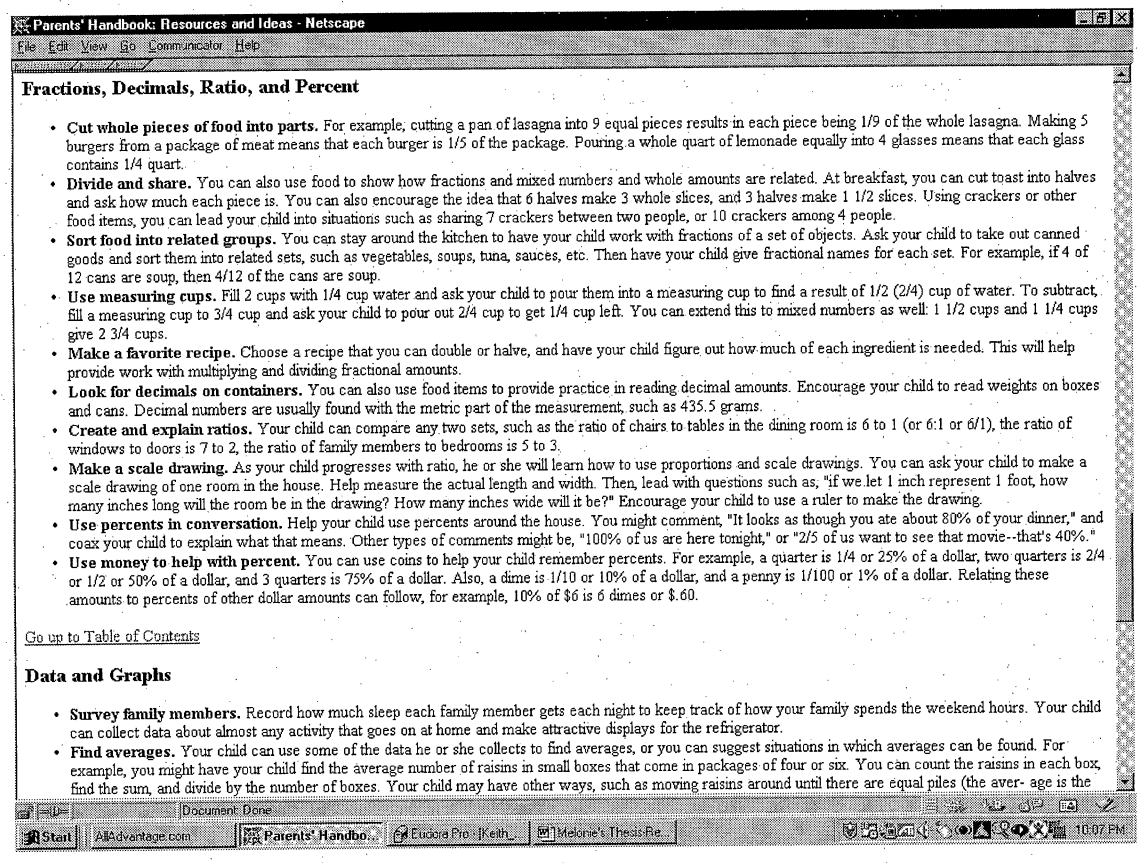
# FUNBRAIN.COM - QUIZ LAB

**FunBrain.com**



# APPENDIX G:

# MATH PARENT'S HANDBOOK


Parents' Handbook: Resources and Ideas - Netscape
File Edit View Go Communicator Help
Fractions, Decimals, Ratio, and Percent
• Cut whole pieces of food into parts. For example, cutting a pan of lasagna into 9 equal pieces results in each piece being 1/9 of the whole lasagna. Making 5 burgers from a package of meat means that each burger is 1/5 of the package. Pouring a whole quart of lemonade equally into 4 glasses means that each glass contains 1/4 quart.
• Divide and share. You can also use food to show how fractions and mixed numbers and whole amounts are related. At breakfast, you can cut toast into halves and ask how much each piece is. You can also encourage the idea that 6 halves make 3 whole slices, and 3 halves make 1 1/2 slices. Using crackers or other food items, you can lead your child into situations such as sharing 7 crackers between two people, or 10 crackers among 4 people.
• Sort food into related groups. You can stay around the kitchen to have your child work with fractions of a set of objects. Ask your child to take out canned goods and sort them into related sets, such as vegetables, soups, tuna, sauces, etc. Then have your child give fractional names for each set. For example, if 4 of 12 cans are soup, then 4/12 of the cans are soup.
• Use measuring cups. Fill 2 cups with 1/4 cup water and ask your child to pour them into a measuring cup to find a result of 1/2 (2/4) cup of water. To subtract, fill a measuring cup to 3/4 cup and ask your child to pour out 2/4 cup to get 1/4 cup left. You can extend this to mixed numbers as well: 1 1/2 cups and 1 1/4 cups give 2 3/4 cups.
• Make a favorite recipe. Choose a recipe that you can double or halve, and have your child figure out how much of each ingredient is needed. This will help provide work with multiplying and dividing fractional amounts.
• Look for decimals on containers. You can also use food items to provide practice in reading decimal amounts. Encourage your child to read weights on boxes and cans. Decimal numbers are usually found with the metric part of the measurement, such as 435.5 grams.
• Create and explain ratios. Your child can compare any two sets, such as the ratio of chairs to tables in the dining room is 6 to 1 (or 6:1 or 6/1), the ratio of windows to doors is 7 to 2, the ratio of family members to bedrooms is 5 to 3.
• Make a scale drawing. As your child progresses with ratio, he or she will learn how to use proportions and scale drawings. You can ask your child to make a scale drawing of one room in the house. Help measure the actual length and width. Then, lead with questions such as, "if we let 1 inch represent 1 foot, how many inches long will the room be in the drawing? How many inches wide will it be?" Encourage your child to use a ruler to make the drawing.
• Use percents in conversation. Help your child use percents around the house. You might comment, "It looks as though you ate about 80% of your dinner," and coax your child to explain what that means. Other types of comments might be, "100% of us are here tonight," or "2/5 of us want to see that movie--that's 40%."
• Use money to help with percent. You can use coins to help your child remember percents. For example, a quarter is 1/4 or 25% of a dollar, two quarters is 2/4 or 1/2 or 50% of a dollar, and 3 quarters is 75% of a dollar. Also, a dime is 1/10 or 10% of a dollar, and a penny is 1/100 or 1% of a dollar. Relating these amounts to percents of other dollar amounts can follow, for example, 10% of $6 is 6 dimes or $.60.
Go up to Table of Contents
Data and Graphs
• Survey family members. Record how much sleep each family member gets each night to keep track of how your family spends the weekend hours. Your child can collect data about almost any activity that goes on at home and make attractive displays for the refrigerator.
• Find averages. Your child can use some of the data he or she collects to find averages, or you can suggest situations in which averages can be found. For example, you might have your child find the average number of raisins in small boxes that come in packages of four or six. You can count the raisins in each box, find the sum, and divide by the number of boxes. Your child may have other ways, such as moving raisins around until there are equal piles (the aver- age is the
Document: Done
Start
AllAdvantage.com
Parents' Handbo...
Eudora Pro - [Keith_...
Melonie's Thesis Re...
10:07 PM

# REFERENCES


Ayersman, D. (1996). Reviewing the research on hypermedia-based learning. Journal of Research on Computing in Education, 28 (4), 500-525.

Bezuk, N., & Cramer, K. (1989). Teaching about fractions: What, when, and how. In New directions for elementary school mathematics, edited by P.R. Trafton. Reston, VA: National Council of Teachers of Mathematics.

Berge, Z., & Collins, M. (1995, April). Computer-mediated communication and the online classroom in distance learning. Computer-Mediated Communication Magazine, p. 7.

Biehler, R. F., & Snowman, J. (1993). Psychology Applied to Teaching. Boston, MA: Houghton Mifflin Company.

Braxton, S., Bronico, K., & Looms, T. (1997). Instructional Design Methodologies and Techniques. [Online], 6 pages. Available: http://www.seas.gwu.edu/~tlooms/ISD/GIFS/dc_design.gif [2000, August 23].

Bright, G. W., Behr, M. J., Post, T. R., & Wachsmuth, I. (1988). Identifying fractions with number lines. Journal for Research in Mathematics Education, 19, 215-232.

Brown, J., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18 (1), 32-41.

California State Board of Education. (1998). The California mathematics academic content standards. Sacramento, CA: Author.

Chiero, R. T. (1997). Teachers' perspectives on factors that affect computer use. Journal of Research on Computing in Education, 30, (2), 133-146.

Clinton, W. (1996, January 23). President William Jefferson Clinton State of the Union Address, U.S. Capitol [Online], 6 pages. Available: http://www.whitehouse.gov/WH/EOP/edtech/html/edtech_f.html [1998, May 30].

Clinton, W. (2000, January 27). President William Jefferson Clinton State of the Union Address, U.S. Capitol [Online], 17 pages. Available: http://www.whitehouse.gov/WH/EOP/edtech/html/edtech_f.html [2000, May 7].

Davydov, V. V., & Tsvetkovich, Z. (1991). On the objective origin of the concept of fractions. Focus on Learning Problems in Mathematics, 13, 13-61.

Dick, W. (1994, April). So how do you implement constructivism into instructional design? Panel presented at the American Educational Research Association, New Orleans.

Dick, W., & Carey, L. (1990). The systematic design of instruction (3rd ed.). Glenview, IL: Scott, Foresman & Co.

Dusick, D. M. (1998). What social cognitive factors influence faculty members' use of computers for teaching? Journal of Research on Computing in Education, 31, (2), 123-137.

Ellsworth, J. H. (1994). Education on the Internet. Indianapolis: Macmillan Computer Publishing.

Family Education Networks. (1997). Funbrain.com - Quiz Lab. [Online], 4 pages. Available: http://www.funbrain,com/quiz/index.html [2000, August 23].

Gianocavo, G., McLain, T., DiStefano, V., & Noonan-Sturm, C. (1996). Educator's Internet Companion. Lancaster, PA: Wentworth Worlwide Media, Inc.

Gokhale, A. (1995). Collaborative learning enhances critical thinking. Journal of Technology Education, 7, 1-7.

Groff, P. (1994). The future of fractions. International Journal of Mathematics Education in Science and Technology, 25, 549-561.

Houghton Mifflin Company. (1997). Math Parent Handbook. [Online], 5 pages. Available: http://www.eduplace.com/math/res/parentbk/phs2.html#8 [2000, August 23].

Jonassen, D. H. (1986). Hypertext principles for text and courseware design. Educational Psychologist, 21, 269-292.

Jonassen, D. H. (1996). Computers in the Classroom: Mindtools for Critical Thinking. Englewood Cliffs, NJ: Prentice Hall.

Kennedy, L. M., & Tipps, S. (1994). Guiding Children's Learning of Mathematics. Belmont, CA: Wadsworth Publishing Company.

Lanius, C. (1997). No matter what shape your fractions are in. [Online], 7 pages. Available: http://math.rice.edu/~lanius/patterns/ [2000, May 7].

Lieberman, D.A. (1991). Learning to learn revisited: Computers and the development of self-directed learning skills. Journal of Research on Computing in Education, 23, (3), 373-396.

Liao, Y. (1998). Effects of hypermedia versus traditional instruction on students'

achievement: A Meta-analysis. Journal of Research on Computing in Education, 30 (4), 341-360.

National Center for Educational Statistics. (1995). Digest of Educational Statistics. Washington, D.C.: U.S. Department of Educational Research and Improvement

National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics. (1991). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics. (1995). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics. (1998). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics. (1999). Math Forum Conference Within a Conference. [Online], 4 pages. Available: http://forum.swarthmore.edu/workshops/cwac/1999.html [2000, May 7].

National Council of Teachers of Mathematics. (2000). Still moving forward on math goals [Online], 2 pages. Available: http://www.nctm.org/news/articles/2000-02goals.htm [2000, May 7].

Neafsey, P.J. (1997). Computer-assisted instruction for home study. A new venture for continuing education programs in nursing. The Journal of Continuing Education in Nursing, 28, 164-172.

Ryder, R. J., & Hughes, T. (1997). Internet for Educators, Columbus, Ohio: Prentice-Hall.

Schuler, D., & Namioka, A. (1993). Participatory design: Principles and practices. Hillsdale, NJ: Lawrence Erlbaum Associates.

Schultz, C. W., & Higginbotham-Wheat, N. (1991). Practitioners' perspectives of computers in the classroom. In T. M. Shlechter (Ed.), Problems and promises of computer-based training (pp. 199-214). Norwood, NJ: Ablex.

Sedbrook, T. (1996). Developing hypermedia courseware through partnerships of students and instructors. Journal of Education for Business [Online], 71 (4), 5 pages. Available: http://www.epnet.com/cgi-bin/epwbird/page [1998 October, 12].

Silva, M., & Breuleux, A. (1994). Interpersonal computing and technology: An electronic journal for the 21st century. Interpersonal Computing and Technology [Online], 2 (3), 17 pages. Available: http://www.quest.arc.nasa.gov/misc/ipct.html [1998 May, 30].

Tripp, S. (1994, February). Reverse engineering the "Stone Canoe" (learning from designs). Paper presented at the meeting of the Association for Educational Communications and Technology, Nashville TN.

Turner, S., & Dipinto, V. (1997). Peer collaboration in a hypermedia learning environment. Journal of Research on Computing in Education, 29 (4), 392-402.

Villamil-Casanova, J., & Molina, L. (1996). An Interactive Guide to Multimedia. Indianapolis IN: Macmillan Computer Publishing.