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Math moments: A parents' multimedia guide for tutoring K-3 students

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MATH MOMENTS:

A PARENTS' MULTIMEDIA GUIDE FOR TUTORING

K-3 STUDENTS

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

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by

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December 1997

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ABSTRACT

Parents have a profound influence on a child's learning. Yet, because most parents work outside the home, it is becoming increasingly difficult for them to find time to spend in educational activities with their children. Due to misconceptions and negative feelings, math has been a subject area where parents find it especially difficult to be of help to their children. This project is a computer-based, interactive tutorial for parents of children in Kindergarten through third grade, designed to assist them in becoming effective math tutors for their children. The tutorial utilizes the multimedia capabilities of the computer to present parents with teaching skills and activities that enable them and their children to become competent mathematicians, capable of solving problems, reasoning, and communicating mathematically.

ACKNOWLEDGMENTS

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CHAPTER ONE

INTRODUCTION

Learning and the Home

Schools are responsible for the education of children, but the educational success of children is influenced by much more than what takes place within the walls of the classroom. Families also have a profound influence on a child's learning. What is done within the confines of the family to enhance a child's education is more important than the educational level of the parents, or the grade level of the children (Robinson, 1995). The basic foundation for successful learning is laid for children from the ages of three to ten. It is during these years that children develop skills in cognition, language, and reasoning, along with other dramatic neurological changes. During this time they also develop greater ability in intellectual problem solving and abstract thinking. Their store of knowledge increases as well as their attention span and their capacity for reflection, and social skills (Carnegie Task Force on Learning in the Primary Grades, 1994). Within families where an environment is created that stimulates learning, and where parents involve themselves in their children's education at home and at school, children are being prepared for a lifetime of successful learning. It has been said that, "Families are the wellspring of learning for children" (Carnegie, 1994, p.15).

However, family life today is far different than it was a generation ago. Many educators are concerned about the home conditions of many students. They suggest that a return to family life as it was twenty-five years ago would do much to improve education. They worry about the drop in participation of parents in school programs and the lack of participation in the direction of their children (Bennett, 1996).

Part of the transformation of the family is due to the change in the basic definition of "family". The family where the father supplies the livelihood and the mother stays home to take on the role of nurturer is almost extinct. Both parents often work outside the home. Most often, one income is no longer sufficient to support the family. Mothers not only work to supplement the family income, but many work because they find it enjoyable and challenging. The definition of "family" has also been altered by the changing demographics in the United States. For example, today fifteen million children are being raised by single mothers (Bennett, 1996). Because parents are having to spread themselves so thin, finding adequate time to prepare children for learning success is increasingly difficult. This makes it all the more imperative that the limited amount of time parents do have with their children is used productively. It should be used to develop within the children positive charter traits and values, to instill a love and curiosity for learning, to assist with homework, and to maintain a working relationship with teachers and schools.

Statement of the Problem

The majority of parents who do get involved in their children's education, do so with the best of intentions, but there are a few factors that may become barriers to making the best use of the time they spend assisting their children with school work. Most parents are not trained educators and so are lacking in basic teaching skills. Many are not knowledgeable in certain subject areas, preventing them from being of benefit to their children.

Mathematics has long been a subject area where many well-intentioned parents feel helpless to be of benefit to their children. The problem is three-fold:

1. Math teachers recognize that parents are often perplexed because they do not understand their children's mathematics, and cannot give them the help they need (Stenmark, 1986).

2. Parents often fail to see that mathematical concepts are applied everywhere in daily life. They need to recognize that everyone needs math. It is needed not only to survive, but it is necessary in occupations, and leisure activities. Some form of math expertise is required in every area of specialty and vocation (Kanter, 1994).

3. Because parents fail to realize this, they do not give themselves credit for the math they do know and use everyday. This is perhaps due to the fact that many parents approach math with old mental blocks, misconceptions, and stereotypes. These attitudes can have an unfavorable impact

on their children's feelings about the subject (Kanter, 1994).

The lack of teaching skills, the lack of understanding and appreciation of the subject matter, and the attitudes and misconceptions about math present a major roadblock to well-meaning parents who desire to make the best use of the limited time they have available to help their children succeed in math.

Significance of the Project

This project, a computer-based tutorial, is an attempt to provide parents with a guideline for developing positive attitudes toward mathematics within themselves and their children. It endeavors to raise parents' comfort level with math, encouraging them to think of themselves and their children as mathematicians who posses the ability to use their reasoning powers to solve problems.

It also supplies parents with teaching suggestions, and a cache of activities designed to assist parents in teaching mathematical concepts to their children. Teaching suggestions such as progressing from the easier uncomplicated tasks to the increasingly more difficult tasks, and using concrete examples and activities to teach abstract concepts are presented. The tutorial also presents examples of good math-learning activities that parents may use in their instruction, and that perhaps furnish them with ideas for their own activities. All of these activities teach mathematical concepts using materials found around the house,

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and using math applications that are part of our daily activities.

Project Overview

This project is presented on a multimedia authoring software with a card and stack format. A card is similar to a page in a book, a stack is a series of cards. This format enables the users to move back and forth through the pages or cards. It is designed to assist parents of students enrolled in kindergarten through third grade. It is also intended to help parents make the best use of the limited time they have available to develop in their children an appreciation for math, and to prepare them for success in school math classes. Thus,it is entitled "Math Moments".

"Math Moments" is a tutorial in four parts. The first part is entitled "Math Is/Is Not..." which introduces math in a new light. Math is introduced as being more than the memorizing of long lists of multiplication facts, or the pages of problems that need answers. Math is interesting and fun. Math is also important and omnipresent.

The second section, "About You", asks parents several questions to assist them in self-evaluation to determine if they harbor ill-feelings or misconceptions about the subject. Next is a short tutorial encouraging parents to consider themselves and their children as mathematicians, capable of reasoning and problem solving. Parents are then presented with a definition of mathematics, and informed of the changes the subject has undergone in recent years. For example,

today the emphasis is no longer on solely finding the right answer to a problem, but more importance is placed on strategy used to arrive at the right answer.

The next part of the tutorial, "Teaching Tips", focuses on suggestions for parents to use when teaching mathematics to their children. These suggestions are both advice and teaching skills that will assist parents in making the most of the teaching time they spend with their children. Concrete examples of each of the suggestions will be presented so parents can see them used. The suggestions are:

1. Pay attention to wrong answers, they hold valuable information.

2. Problems can be solved in various ways although there is usually only one right answer.

3. Children should be encouraged to do math in their heads; the ability to estimate is important in today's technological world.

4. During an activity, children should be encouraged to verbalize why they are doing the activity, and how they arrived at the solution.

5. A concept is taught beginning with easy and uncomplicated tasks, and progressing to tasks that increase in difficulty.

6. Concrete activities and tangible examples help children learn an abstract concept.

The final section of the tutorial, "Homemade Activities", presents parents with a variety of activities that provide concrete examples to aid in teaching teach math

concepts. These activities make use of materials that are readily available in the home, and help children understand the universal nature of math, that it is indeed everywhere.

It is intended that "Math Moments" will give parents concrete activities and skills they need to prepare and implement math-enrichment time most effectively. The objectives of this tutorial are:

1. Parents will be able to use newspapers and execute mathematical activities with their children that will teach children about sorting, comparing, and logical relationships.

2. They will be able to use coins to carry out activities that help children differentiate between a penny, a dime, a nickel and a quarter, and learn their values.

3. They will be able to ask questions that encourage children to practice mental math.

4. They will be able to ask questions that will encourage children to talk about math activities and wrong answers.

"Math Moments" gives parents the tools and ideas they need to become effective math tutors to their children, and spend enjoyable, fruitful moments together.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The Role of Parents as Teachers in the Home

The family unit is different today than it was just a generation ago. Parents have less time to spend with their children, as a result, they face a real struggle to balance the demands of their jobs with the demands of family life. At a time when parents are under this kind of pressure, there is a greater need for them to get involved in the lives of their children, particularly in the field of education (U.S. Department of Education, 1994). McKenzie (1991) explains the importance of the need for parents to be involved:

Parents have a special teaching role to play in their children's educations. As primary caretakers and teachers for only a few children, they can educate their children in powerful ways. The role of parents in preparing their children for the future is critical because many of America's schools labor under worn-out, 1950's style programs. As adults working in the world, parents are often more in tune with changes in the world than schools. With important, but rare exception, the curriculum of today's schools falls short of preparing students for the workplace and society of today, much less the next century. There is a large and growing gap between the lessons learned in the classroom and the skills needed in the workplace, and the gap is widening. Our children must do more than mark time in the nation's

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classrooms. Parents can equip their children to make the most of their school experiences. (p. 4)

Parents are aware of this need. "According to a Newsweek PTA poll, some 40 percent of parents all across the country believe they are not devoting enough time to their children's education" (U.S. Department of Education, 1994, p. 3).

This dilemma can only be corrected through a joint effort on the part of parents, schools, and communities. "Research confirms that, regardless of the economic, racial, or cultural background of the family, when parents are partners in their children's education the results are improved student achievement, better school attendance, reduced dropout rates, and decreased delinquency" (U.S. Department of Education, 1994, p. 5).

After examining all the forces that contribute to children's learning and development, the Carnegie Task Force on Learning (1994) agrees that parents have an important influence on their children's success in school. It was also concluded that the years from three to ten are a crucial time when it is important to lay a firm foundation for lifelong learning. It is during these years that children make enormous progress in cognition, language acquisition, and reasoning. Their capacity for problem solving and abstract thinking are increased. Whether or not children will have success in learning depends to a great extent on what takes place during these years.

The Carnegie Task Force on Learning (1994) advises that children who spend these years in a home environment where the parents encourage learning, and remain involved in their education, earn higher grades than those whose parents are uninvolved. All children are born with curiosity and a will to learn, but if they do not have parents who involve themselves in their development and education during the ages of three to ten, they will lose that natural curiosity and enthusiasm for learning. The Carnegie Task Force on Learning study states:

> Studies show repeatedly that children's academic performance is determined more by the time and effort they devote to learning, and by the time and effort that schools invest in teaching them, than by their inborn abilities. With the right combination of challenge and support form parents, educators, and the community, virtually every child, by the end of the fourth grade, can be reading, writing, and doing math and science at levels now achieved by only a few (p. 10).

There are many things that parents can do on their own to help their children learn. Some parents, however, mistakenly think they can help by constantly nagging in an effort make their children get their school work done. Still others simply do the homework themselves and save the commotion. Parents sometimes feel caught in the middle of a dilemma, either do the work themselves, or let the children take the consequences of undone homework (Dudley, 1996).

There are more successful ways parents can involve themselves in their children's education. They can first provide guidance for their children by determining how their children learn best. Do they work better alone or with someone else, or are they visual, auditory, or tactile learners (Nebraska State Education Association, 1996)? Parents armed with this knowledge will be able to utilize methods and activities that will facilitate the learning process. The most effective teaching takes place when parents are aware of and responsive to the needs, learning patterns, and capabilities of their children (Smith, Cudaback, Goddard, and Meyers-Walls, no year available).

Dodge (1995) emphasizes that parents must also create a home environment conducive to good study habits. Children should have a designated study area, anything from a cleared kitchen table and a portable plastic carrying case used for homework materials, to a desk of their own. Other supplies that may be needed should be made available to the student. Resources such as books, and computers may be available at the library if they are not available at home. Carrington (1996) suggests that children participate in a "jiffy cleanup" where they ruthlessly clear off all extraneous objects from the work surface in record time once a day prior to starting homework. This is important, because the work space needs to be neat and tidy. The more inviting the workspace, the more children will want to begin homework, and the more they will be able to concentrate. A special quiet time should also be set aside for study. It should be a time

when distractions such a television and other disturbing
noises are to be avoided during the appointed study hour.
The entire family should take part in quiet activities during
this time (Office of Educational Research and Improvement,
"Show You Think..." 1995). That appointed hour of study
should also be the time that parents maintain their
availability to help children with their homework (Dudley,
1996).

Dodge (1995) suggests that children should be taught to
make good use of that allotted time. Children can learn to
increase their focus time. This can be done by setting a
timer and challenging them to focus on school work until the
timer rings, then taking a break and trying it again,
gradually increasing the time. Good use of time also
involves having a regular bed time.

Children should also be encouraged to develop
organization skills. They need a way to keep school papers
organized. Two-section homework folders with one side marked
"To Do" and the other marked "Done", where they tuck finished
homework for safe-keeping, eliminates crumpled papers. They
should also keep graphic clues (charts, lists, and schedules)
to help them remember what needs to be done (Dodge, 1995).

Parents can show children how to break assignments down
into workable parts and set target dates for their
completion. Reports should be broken into the following
logical steps: (a) selecting a topic, (b) doing the
research, (c) selecting the questions to be discussed, (d)
drafting an outline, (e) writing a rough draft, and (f)

completing the final draft (Office of Educational Research and Improvement [OERI], "Provide Guidance," 1995).

If it is necessary for children to use the library to complete and assignment, they should be encouraged to ask suggestions of the librarian, and learn to use the library correctly. If research is being done on computer, parents must make sure children are getting the help needed to do it properly (OERI, "Provide Guidance," 1995).

The Office of Educational Research and Improvement in the publication, "How to Help: Provide Guidance" (1995) suggests that when discussing assignments with children, parents must assess whether students have the information and supplies they need to complete it. They also need to determine whether they are having trouble completing the assignment. If so, the children should be asked whether they have ever done similar problems, and use that as a base to guide them to the correct answer.

Test-taking is a very important learning skill, one that is seldom taught in schools. Parents can help children to be successful test-takers. Skills needed in test-taking such as keeping track of the time, being careful not to spend too much time on one question, and reading the questions carefully should be taught. Parents can help children work out a schedule of study to avoid last-minute cramming, and they can make up and give children practice tests to assist them in their preparation (OERI, "Provide Guidance," 1995).

Dodge (1995) suggests other test-preparation and study strategies. Parents can teach children how to study

effectively by reciting, describing, explaining aloud the
concept in their own words. They can draw, label a diagram
or map, or sketch a chart from memory. Children can also
imagine questions that they think will be on a test, and then
answer them. Listing concepts, making flash cards, and
visualizing anything they need to learn are all effective
study strategies.

Parents and older siblings should read to children and
let children see them read. Children should get library
cards of their own, and be taken to the library often where
they can find books that interest them. Reading to children
or listening to them read regularly, encourages them to read.
This is crucial to becoming successful learners (U.S.
Department of Education, 1994).

Communication between parents and children is very
important. Helping Your Child Succeed in School, by The
Office of Educational Research and Improvement (1992)
states:

> Communicating. This is probably the most important
> activity we can do in our home, and it doesn't cost
> anything. Ask questions, listen for answers. These are
> no-cost, high-value things to do.
>
> Think of conversation as a tennis game with talk,
> instead of a ball, bouncing back and forth,
> communication can happen any time, any place--in the
> car, on a bus, at mealtime, at bedtime.
>
> When our children enter and continue school with
> good habits of communication, they are in a position to

succeed--to learn all that has to be learned, and to become confident students. (p. 1)

Often just talking to children, and thinking through an assignment verbally will help children break it down into small, and workable parts. Talking about an assignment will disclose any misunderstanding children may have about what is expected. Praise is a very important part of communication. Children need encouragement from the people who mean the most to them, their parents (OERD, "Provide Guidance," 1995).

Parents should provide children with opportunities to learn. Children of all ages are more likely to become skilled and motivated learners if they are provided with a variety of leaning experiences which stimulate sensory, physical and intellectual learning. It is important to encourage exploration and interaction with the environment, then give children feedback that is responsive, warm and supportive (Smith, et al., no year available).

Robinson (1995) states that the role families play in children's educational success is vital. What families do to participate in a child's education is more important to that child's success than their social standing, educational level, or the child's age or grade level in school. Assisting children with homework helps parents learn about their children's education, promotes communication with the schools, and encourages a life-long love of learning. Parents' interest can also spark enthusiasm in children and help teach them that learning really can be fun.

Theodore Sizer as cited by Sharp (1997) suggests that America would best be served by making every home a "quasi-school" where parents supplement what their children learn elsewhere. "We shouldn't think that schools do everything about intellectual training any more than homes do" (p. 6).

The importance of the parents role is summed up by the Office of Educational Research and Improvement (1992) which states:

What counts most is what we say and do at home, not how rich or poor we are or how many years of school we have finished. When children can count on getting attention at home, they have a greater sense of security and self-worth. This will help them do better not only in school, but also when they grow up.

If you think about it, school, while very important, does not really take up very much time....So, the hours and days a child is not in school are important for learning, too. (p. 1)

Skills for Teaching Math

In the introduction to the Handbook for Planning an Effective Mathematics Program, published by California State Department of Education (1982), the following statement is made:

Mathematics is not just a tool for solving problems related to science and daily living; mathematics is a science in its own right. It is also one of the humanities--one which has captured and stimulated the

most creative minds all through the ages; it is the most precise of languages—one that is continually growing in order to accommodate new ideas and solve new problems; and it is a form of mental recreation that completely fascinates and absorbs the mind. (p.1)

Those who are responsible for teaching math to children must instill in those children this broad spectrum of mathematics. The computerization of society has made this understanding of math a necessity because computer technology draws upon the full spectrum of math (California State Department of Education [CSDE], 1982).

A generation ago, this broad concept of math was not taught in schools. Math students were expected to do row after row problems, and do them perfectly. They were taught that there was only one way to arrive at the correct answer, and the best way to improve math skills way to do more problems and to do them faster. In contrast, today's students are learning to understand the concepts and apply thinking skills in order to arrive at an answer, rather than merely completing rows of problems by rote (Kanter, 1994).

Because most parents were schooled in the old methods, and may not have an appreciation for the broad spectrum of math, Kanter (1994) suggests they need to ask themselves how they feel about math before they can be effective tutors. The feelings parents have, either positive or negative, will have an impact on how their children feel about mathematics, and how they feel about themselves as mathematicians. If parents determine that they feel uncomfortable, they need to

understand that it is important for them to encourage their children to think of themselves as mathematicians who have the ability to reason, and solve problems. Kanter emphasizes that math is a subject for everyone, and that males and females have an equally strong potential in math.

Burns (1996) suggests that successful teaching of math requires that children be given choices of what they want to explore. This allows them to invest in their education. Burns also states that it is more beneficial to assign students to teach someone at home what they learned, or collect data, or solve a problem with an adult, than to send a practice sheet home for homework. Having children memorize mathematical facts by rote is counter productive. It serves to treat such facts as individual bits of data rather than helping children understand the underlying mathematical concept that connects them, and sends the message that memorization is important to mathematics, more important than thinking and reasoning.

However, the California State Department of Education (1982) in Handbook for Planning an Effective Mathematics Program, expresses that what seems to be the consensus of the literature, that the teaching of computing skills are necessary because they are essential in daily life. Daily life requires a person to have a thorough understanding of whole numbers, fractions and decimals as well as accuracy in adding, subtracting, multiplying and dividing of those numbers. These skills must be presented as enjoyable, challenging, and important. When students learn new skills,

these skills must be reinforced through the use of practice drills that are closely related to, but different from the way the skills were presented originally. The drills should be short and given often, and can be in the form of practical problem solving, purposeful games, informal timed tests, and the use of mechanical and electronic calculators. Practice drills should also be given in which students must use the skills of estimation and mental computation. Because of the growing use of calculators and computers, it is important that students are taught strategies for estimating at all levels of mathematics, so they may determine whether an answer is reasonable.

The use of calculators and computers makes it mandatory for people to learn to estimate answers in their heads so they will know if the answer arrived at on the calculator is reasonable. Parents can help children by having them do math problems in their heads using small numbers. They can ask, "If I need 12 drinks for the class, how many packages of 3 drinks will I need?" Children should be taught estimating skills and use them to make calculation easier. "For example, when figuring 18 plus 29, an easy way to get a 'close' answer is to think about 20 + 30, or 50." Parents should ask often, "Is your answer reasonable? Is it reasonable that I added 17 and 35 and got 367? Why?" (Kanter, 1994)

Kanter (1994) also encourages parents to take a look at wrong answers. A wrong answer is a signal telling parents to look further. Parents should ask questions to discover what

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the wrong answer is saying about children's understanding of the concept. Children should always be asked how they solved the problem. The wrong answer may have been the result of miscalculation, incorrect procedures, or the wrong concept being applied. Or perhaps a child may think the problem is asking for another answer. Children should be encouraged to examine their wrong answers, and be assured that the right answers will come with proper understanding.

It is important for a teacher to remember that there are many ways that a mathematical problem can be solved. Children should be asked to verbalize how they arrived at the answer. Their means of arriving at the correct answer may be different than that of the parents, but if the answer is right and their strategy worked, it is an acceptable alternative. Children should be encouraged to talk about what they are thinking, it strengthens their skills and reasoning abilities (Kanter, 1994).

A teacher should always probe children for further ideas and ways of reasoning, give them time to answer, and give them ample opportunities to verbalize their thinking. When they have put their thoughts into words it is important to model how to put their words into mathematical symbols. "In the discussion of '6 + 7,' Leslie offered, 'You start with the double, and 6 plus 6 is 12 and 1 more is 13.' I wrote 6 + 6 = 12, 12 + 1 = 13 on the chalkboard" (Burns, 1996).

After the children verbalize, they need to write down their mathematical thoughts. Burns (1996) states:

I have long been convinced by Zinsser's (1988) statement
'Writing is a way to work yourself into a subject and
make it your own,' and I have seen evidence of how
writing has pushed children to organize and clarify
their thoughts. (p. 125)

But writing should only come after children have talked about
their ideas. Verbalizing an idea is easier than writing about
it, and lays the groundwork for their writing. Writing
should be revised when it gives incomplete information, or
lacks detailed information about their thinking.

A good knowledge of the language of mathematics is
essential for students so they may successfully apply their
mathematical skills in other settings, and communicate with
others mathematically. Appropriate terminology should always
be used. And students must also be involved in activities
that help students to learn to communicate with with
mathematical expressions. Students can participate in games,
invent mathematical puzzles, and give oral reports. A
student might be asked to describe a geometric shape to
others who must draw the shape as it is described (CSDE,
1982).

Samples (1994) recommends that teachers must teach
students the art of deciphering test questions. He teaches
his students a problem-solving method that enables them to
understand, apply, analyze, and synthesize problems on a
test. The students are directed to read the problem slowly,
then stop and draw a diagram, keep a list of knowns as they
arise, and write the appropriate equations. He encourages

them to talk to themselves as they reason out problems. The
students are urged to stay away from numbers as they do their
reasoning, because numbers add to the confusion and block the
solution. Then, as a reward, students are told to add this
new-found knowledge to a mental list of conquered knowledge .

Crucial to daily life are problem-solving skills.
Problems found outside the classroom are not usually written
nicely in textbook terms, making it necessary for students to
ask questions and determine what information is needed. Then
they must learn to analyze the problem by identifying the
parts of the problem and planning a strategy that might work.
Then the problem needs to be translated into mathematical
symbols for solving. Finding a solution requires a mastery
of the computing skills mentioned above. Finally, students
must be able to make correct generalizations from their
results and be able to apply the results to more complex
problems (CSDE, 1982).

Mathematics instruction is only as good as the
instructor. The teacher is responsible to see that each
student is presented the material in an exciting manner and
that the student has successful experiences in mathematics.
All students are different, and come to the learning
experience with a different set of experiences. Hatten
(1993) states:

> Tabula rasa is dead; long live typeover. Whether we call
> them slates or monitors, students are not blank screens
> on which we enter content. They are more like unedited
> rough drafts that were ghost-written by their

experience, their reading, their impressions, their emotions. (p. 7)

Because students are all different, no one method works for all students, therefore the teacher must make use of a full range of strategies so that each students' learning needs will be met. Activities could include: discussions, experiments using manipulative, activities that involve data collection, making graphs, the use of audiovisual materials, games, and outdoor experiments. In addition, students should learn how to use available resources to extend their knowledge on the subject. All this serves to build that bridge connecting what students already know to what they should learn, that is, from the familiar to the unknown (CSDE, 1982).

According to It's Elementary!, a book published by the California Department of Education (1992), "Mathematics as commonly presented in today's elementary schools has been described as a 'curriculum out of balance'"(p.7). This is attributed to the fact that many elementary schools in the United States emphasize rote mastery of computational skills, and yet give scant attention to creatively exploring mathematical concepts derived from a child's everyday experiences. Mathematics should be presented to children as a way of looking at the world around them. How is a plate of cookies shared fairly? How can the best buy be determined? Students should have the opportunity to use manipulative, calculators, and other tools. They should be encouraged to work frequently together, and share their ideas. Students

should also verbalize and write their mathematical thinking to solidify the concepts that were learned (California Department of Education, 1992).

Beidler (1997) sums up the characteristics common to good teachers. Among those characteristics are a desire to be a good teacher, a willingness to take risks and to try something new, and a positive attitude. Good teachers also make an effort to give students confidence, and lend a listening ear when students speak.

The first, and most important teachers children have are their parents. For that reason, the above characteristics must also apply to parents. Probably the best advise for parents is offered by Lamar Alexander as quoted by Ravitch (1992), "The first teachers are the parents, both by example and conversation. But don't think of it as teaching. Think of it as fun" (p. 2).

Activities that Build Skills

According to Kanter (1994) the home is a rich resource for learning math. Parents are encouraged to "talk math" with their children, and to involve them in math activities using objects found around the house.

Stenmark, Thompson, and Cossey (1986) compiled a book of math activities, Family Math, for parents to do at home with their children. The introduction reads:

Many of the teachers who came to the program asked us to give them ideas and materials for parents to use at home to help their children in mathematics. They told us that

parents were frustrated in not knowing enough about their children's math program to help them or in not understanding the mathematics their children were studying. (p. xi)

The activities in the book, Family Math, give parents and children opportunities to develop problem-solving skills, and create an understanding of mathematics using everyday, hands-on materials.

Problem-solving skills are defined, in Family Math as a way in which people think out a problem using various strategies. Some strategy possibilities are: looking for patterns, drawing a diagram, working backwards, working with someone else, and eliminating possibilities that will not work. The more strategies children know, the more ways they have to start looking at a problem. The more strategies they have, the more confident they are in tackling new problems, and the better problem solvers they become.

Hands-on material used in the activities are concrete, everyday objects such a beans, pennies, and toothpicks. These are used to help children gain a better understanding of number and space. The activities are rated as to the appropriateness of the activity to primary, elementary, and middle school grade levels (Stenmark et al., 1986).

Parents know that in order to help children enjoy reading, they can take them to the library, and read to them; but what do they know about helping children enjoy mathematics? Family Math contains activities which help parents, and children alike, enjoy mathematics. The

activities are designed to be fun, "...because mathematics is beautiful, fascinating, and exciting and meant to be enjoyed" (Stenmark et al., 1986, p.18).

Parents are given some pointers for doing mathematics at home. They are advised to let their children know that they can succeed. When talking to their children about mathematics, they need to listen to what the children are saying. It is important for parents to remember that processes of doing mathematics are more important than getting the correct answer, and that children should not be told how to solve a problem or their thinking will stop. Finally, parents should encourage children to practice estimation skills whenever possible (Stenmark et al., 1986).

Some of the activities in the Family Math involve word problems which can be a source of frustration to children and parents alike. These activities encourage the use of many techniques to solve word problems, such as manipulatives, drawing pictures and diagrams, breaking the problem into parts, guessing the answer, or changing the numbers in the problem to smaller ones.

According to Stenmark et al. (1986), a natural extension of word problems is logical reasoning. Logical reasoning is merely making good sense out of something in an organized way. It involves sorting things by some common characteristic, or thinking what the result of a certain action might be. Logical thinking can only be learned by experimentation. Getting children to talk about their strategies strengthens their reasoning abilities. Talking

also helps children to become aware of their strategies, making that strategy transferable, or usable in other situations. Awareness of strategies also encourages children to become actively involved in searching for strategies when they are faced with problems to be solved. They learn that, "...the abstract and concrete worlds can be played with, jiggled, turned upside down, explored, and comprehended" (p. 56).

Other activities in the Family Math involve measurement; numbers and operations; probability and statistics; time and money; geometry and spatial thinking; patterns and number charts; estimation calculators, and microcomputers; and careers in mathematics. The activities are not meant to be done in any particular order. Parents are encouraged to look for activities on topics that their children are interested in, or working on at school, or to open the book at random and try whatever they find.

Kanter (1994), in "Helping Your Children Learn Math", provides parents and children with activities that can be done in the home, at the grocery store, and while traveling. The activities are arranged in order of increasing difficulty, beginning with activities appropriate for kindergarten through first grades, then second and third grades, and finally, fourth through eighth grades. Materials and manipulatives used in these activities are objects that are found around the house such as playing cards, measuring cups and spoons, coins, empty food containers, beans, popcorn, dice, coupons, and newspapers. It is evident that

mathematics doesn't have to be learned only in the classroom, the home is an environment rich in mathematical possibilities. Kanter emphasizes that math is not just in the classroom by stating:

Math is everywhere and yet, we may not recognize it, because it doesn't look like it did in school. Math in the world around us sometimes seems invisible. But math is present in our world all the time--in the workplace, in our home, and in life in general. (p. 1)

Tips for Parents! (n. d.) is a booklet published by the Desert Sands Unified School District. It encourages parents to take an active role in their students education by doing activities at home with them. It states: "Helping your child at home will help your child at school. Home habits are mirrored at school....Help your child to develop reading and math skills" (p. 1-2).

Tips for Parents! (n. d.), like Family Math, has many activities that parents can use to keep their children busy during the summer months. The activities include, making paper clocks to practice telling time, giving children various amounts of change to count, practice dividing their food into fractional parts such as halves and fourths before eating, and many others that take little preparation, and can be done on the spur of the moment.

McKenzie (1991) feels that is important for children to develop a systems approach to strategy making, going from interpreting the data through the evaluation of the data and implementing the plans. He suggests that parents can teach

this by stringing beads with children. Children should be given a variety of beads to string and challenged to string them in a specific pattern given them by the parents. The pattern is hidden and the children have a minute to string the beads from memory. McKenzie also encourages play with blocks and placing them in special patterns, he states: "Frank Lloyd Wright attributes some of his inventive thinking to the time he spent playing with blocks with the thoughtful support and encouragement of his mother during his early years" (p. 3). Being able to recognize patterns is an important mathematical skill.

According to the publication Math and Your Child, by Houghton Mifflin (1995), it is possible for a child to have mathematical experiences all day long. When children awaken they can be asked to tell the time. Questions of how many eggs will be left after eating can be asked at breakfast. Children can count and sort silverware, cans of food, laundry and anything around the house. The list of possible mathematical activities is seemingly endless. All the activities are geared to children from Kindergarten through sixth grades. Beside activities, there are quick and easy games, and suggestions for activities called "Math on the Go". It ends with a section entitled "Refrigerator Math" which furnishes number puzzles to be displayed on the refrigerator for all the family to see and try.

Parents can take advantage of such activities which cost little and use materials around the home to surround their children with math-rich environments, and put them on the

road to becoming successful competent math students and successful problem-solving adults.

The Role of Computers as Teachers

Alexander the Great was fortunate to have king Philip of Macedon as a father. Philip was concerned about Alexander's education, and so used his power and fortune to recruit the brightest person in the known world as a private tutor for his son. Aristotle was chosen, and it is not known how much effect he had on Alexander's success, but as his instructor, he laid a firm foundation upon which Alexander could build his life (Bennett, 1996).

If parents could choose a perfect tutor, for their child, they would most likely want one who was knowledgeable in all subjects, who could tailor the courses to the individual needs of the child, who had the time to give to the pupil, who would never fall behind because of illness, one who would be flexible and patient enough to work with a child who was having a difficulty with a concept, and one who was eager to praise and hesitant to find fault.

Very few parents are kings, and most do not have the power and resources of Philip of Macedon, but they can have access to tutors with vastly more knowledge than that of Aristotle, and with the desirable characteristics listed above. Computers are such tutors. Bennett (1996) suggests, "All these powerful characteristics we would choose for our child's private tutor are those that make a non-critical and

eminently patient computer, endowed with almost unlimited knowledge, the ideal instructor" (p. 9).

Computer-assisted instruction, or CAI, is the application of computers as instructors. The multimedia, or color, sound and movement capability of computers makes learning more interesting and effective. This entertaining feature of computers entails the use of CD-ROMs, laser videodisks, huge hard disk drives, color monitors, and speakers, enabling them to compete successfully for the students' attention with other forms of entertainment (Smith, R.A., 1995). Computers have the ability of taking established multimedia, or audio-visual, as it is called, a step further, because they have the added ability to individualize instruction, and provide interaction with the individual student. These features will be discussed further. The general categories of computer-based instruction are: drill and practice, tutorial, simulation, problem-solving, and games.

When a computer is used for drill and practice, it utilizes software designed to help students memorize and give appropriate responses. Such software emphasizes accuracy in response, speed, self-pacing, and progressive question-answering abilities. It emphasizes accuracy, but it is unceasingly patient. Jensen (1993) states, "Computers have infinite patience in teaching that involves drill and repetition, especially among students with differing skills and aptitudes" (p. 10). Drill and practice sessions usually do not include instruction on how to perform a task, such

instruction usually takes place before the drill and practice
(Brock, 1994).

Drill and practice is considered by some to be a trivial
and ill-adapted use of the computer. According to Brock
(1994), "Colloquially referred to pejoratively as 'drill and
kill,' this type of CAI earned its nickname because of the
dull, repetitive presentation which some of the first-
marketed commercial drill and practice software contained"
(p. 156). However, there are some mental skills, such as the
remembering of lists, and multiplication tables, that must be
mastered by rote. In these cases drill and practice is the
appropriate method for learning. Poole (1995) states:

> As long as one remains versed in a discipline, the need
> for rote learning recedes. But [those] becoming versed
> can benefit significantly from the kind of rote learning
> provided by drill and practice. (p. 270)

Unlike drill and practice which drills students on
previously learned concepts, the second category of computer-
assisted instruction, tutorial, introduces new concepts to
the student. A small piece of information is presented, and
the student is asked to respond to a question about the new
information, then the appropriate feedback is given. It is
sequenced, interactive, and paced by the student. Branching
in the program allows more choices for the student. This
branching is used for remediation loops. A remediation loop
allows the student to go back to a concept for review, or
further tutoring. Conversely, students who have a firm grasp
of the concept, may choose to skip extra examples, and

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practice items, thus personalizing the instruction (Brock, 1994).

Alexander the Great, as Aristotle's only student, enjoyed an ideal learning situation by having Aristotle's undivided attention. The cost for such a privilege would be prohibitive. Tutorial applications put the computer in the role of tutor, giving students their undivided attention. Tutorial applications take on the complete task of instructing students, and bringing them to the point of achieving specific objectives. Other applications of computer-assisted instruction, such as drill and practice and simulation only carry a small part of the instructional task. They depend on other applications or human intervention to carry the major burden of instruction (Schwer and Misanchuk, 1993).

Since tutorial programs are so extensive, they are more complex, more difficult to design, and more costly. Because they are so complex, there seem to be more poorly written tutorial programs than good ones (Merrill et al., 1995).

Simulation software programs are simulations of real-life situations in which the student is required to make a decision and act on it (Brock, 1994). They allow students to participate in certain events without risk, and with less cost. Through simulation medical students can interact with a patient, and diagnose and prescribe without risk to the patient. By their nature they are highly interactive, but they are not computer games. Simulations present facts and problem-solving situations, but there is not, of necessity a

winner or looser. They can be used for science experiments, and you-are-there historic adventures. Simulations are often used to train drivers, pilots, and even astronauts (Newby, Stepich, Lehman, and Russell, 1996).

Problem-solving computer assisted instruction is for the purpose of increasing logical skills, or visual-spacial skills, and is often similar to logic problems found on I.Q. tests (Brock, 1994). They may or may not simulate real-life situations, but students are given problems to solve using reasoning skills. They allow students to practice decision-making strategies. In the past, teachers used tools such as role-playing, and board games for simulation (Forcier, 1996).

Computer-assisted instruction often makes use of game applications to build interest and motivation to a learning situation. Games add an element of fun to CAI. They can involve competitive play between a student and one or more opponents, or can involve the student alone. Each of the other applications described above can include elements of gaming. One of the biggest concerns about educational computer games is that education becomes secondary in importance to the game. It is important to take care when using games for educational purposes (Newby et al., 1996).

The computer-assisted instruction programs discussed above do not utilize the full potential of technology. There are additional educational uses of technology that take advantage of its vast resources, multimedia capabilities and interactive ability in other ways.

Thornburg (1994) asserts that while drill and practice exercises may be effective in increasing test scores, this use of computers does not prepare children to live as competent adults in this information age, where technology has permeated every aspect of life. He states: "Why waste powerful technology helping millions of children master trivia when these same computers can be used in truly productive endeavors by the students themselves" (p. 25)?

New technologies are creating the demand for new skills. This is the information age, and students of today are going to need to know how to retrieve information, how to manage it, manipulate it, and how to present it (Schurman 1994). Geoffrion, as quoted by Reinhardt (1995) states, "Knowledge of network-based communications and on-line resources, how to use them, and the cooperative society of the Net all [improve] the creativity, productivity, quality, and quick responsiveness of professional work" (p. 56). In addition, students of today will need to know how to identify and solve problems, and broker situations, they will need the basic skills of experimentation and collaboration (Goldberg and Richards, 1995).

Computers can play a vital role in teaching of these important skills by supporting "...contextual, interdisciplinary instruction. [and] It allows you to learn in the context of real-life skills" (Sue Kamp, as quoted by Mageau, & Chion-Kenney, 1994, p. 39). Formerly, students were passive learners, attending classes where information flowed from teacher or computer to student. Student's were

encouraged to work alone, always being told to keep their eyes on their own work. But when they begin to work in a corporate setting, team work and cooperation are encouraged. By using technology to research, create, and present their work, students become participators, discoverers, creators, problem-solvers, and team players. Jeanne Hayes, as quoted by Reinhardt (1995) says, "The old pattern of kids left in the corner to do flash cards on an Apple II is over" (p. 50).

In an endeavor to improve the productivity of computer based instruction, schools began to connect computers to form "intranets". Schools find that networking computers within laboratories, within the school, and the district enable the students to share software, ideas and their finest work with teachers and other students (Smith, R.A., 1995).

Weinstein (1996) states that the name "intranet" was coined by vendors of networking products, and refers to: "private computer network based on the data communication standards of the public Internet" (p. 51). An intranet allows members of the school community not only to access files created locally, but also allow them to access the Internet. But public Internet users are prevented from accessing the local intranet for security reasons. "It offers relief for parents who want their children to publish and be present on a network, but don't want their children's pictures and names distributed freely around the world" (p. 51).

A private intranet can have many educational uses. Classes can have class homepages, creating a sense of class

unity. Students' art work and writing can be viewed from any class at any time by publishing them online. Teachers can share lesson plans, and ideas, and classes across the district from one another can do collaborative projects over the intranet. In addition, it can provide hot links to useful resources on the Internet (Weinstein, 1996).

Access to the Internet takes students out of the classroom and gives them access to the world. "Teachers have discovered that the Web makes possible new levels of individualization, and encourages collaborations that take students far beyond the classroom" (Dyrli, 1996, p. 44).

According to Mather (1996), the Internet gives new meaning to the idea of collaboration. She states, "A single good idea strategically placed in the Net, can attract thousands of enthusiastic participants from all over the world" (p. 12).

One such idea called "Read In" has become a strong presence on the World Wide Web. The project involves participation in a read-a-thon, letters of encouragement from celebrities, and communication among participating classes. The students read the communications, study geographic locations on maps, measure distances, study climates, discuss time zones, and develop local activities such as poster contests and sleepovers (Mather, 1996).

George Cassuto, a ninth grade government teacher involves his class in a project called Prejudice Reduction Through Global Telecommunications. The project covers a wide range of interesting topics. His class publishes their

writing on these subjects and posts them on a Web site where they get responses and feed back from scholars and other students all over the world. Cassuto as quoted by Quesada (1996) said, "Students have become enlightened and aware of the global village in which they live....reducing ignorance and prejudice regarding their fellow human beings" (p. 29).

Beside collaborative experiences, access to the Internet allows educators and students access to vast amounts of information stored in electronic libraries around the world (Smith, R. A., 1995). Armed with search skills, and an understanding of databases and their various limitations, students can research any topic from behind a computer. However, students should not limit research to what can be found on the Internet, but should supplement their findings with book research. Polyson, Saltzberg, & Goodwin-Jones (1996) remind us, "We are not yet (and probably never will be) at the point at which a study in any field can rely solely on the Web as a research source..." (p. 16). Not all information worth having has been digitalized and indexed and can be accessed by the Internet. To ignore book research is to risk what Isaac Asimov, as paraphrased by Wehmeyer (1996), states: "... that all information prior to some point in time is lost because it has not been computerized" (p. 56).

As the role of computers in education becomes increasingly dominant, other roles will also need to change. The changes in a student's role were previously mentioned. It is of necessity that a teacher's role also changes. Teachers will become facilitators, and resource providers.

They will no longer be responsible for knowing all information and delivering it, but rather for knowing how to access it (Siegel and Sousa, 1994). There are those that believe there may also be changes in physical components of education.

Seigal and Sousa (1994) assert that the era of the printed textbook is, in fact, ending. Since 1657, when Morovian educator, John Amos Comenius, issued Orbis Sensualium Pictus, a Latin textbook, the textbook has been the main educational tool in the classroom. The textbook determines the content and direction of the class, and proceeds through a discipline in a linear fashion. This is inherent in the fact that a textbook is static and passive, making it difficult to connect to new concepts and to ideas from other disciplines. Siegel and Sousa state:

> ...computers are better than books in almost every way. They are able to present not only text and pictures, but also animation, video, and sound. Their interactive capability, their ability to withhold, reorganize, and search information contained in vast, decentralized, world-wide digital libraries, and their ability to deliver feedback contingent upon student response make them more effective than print alone. (p. 49)

Carroll (1997) agrees, insisting that money could be saved by replacing traditional textbooks with inexpensive CD's that would contain everything a text would contain, as well as integrated word processing, spreadsheet, graphics,

database, and other important tools. Just one disk could serve a student for many years of school.

In addition to replacing the printed textbook, technology, used to it's fullest in education, would change the school building. Carroll (1997) notes that new schools would be designed with few classrooms, but more open study areas, seminar rooms, and large and small presentation areas. In addition, virtual reality technology may eliminate the need for laboratories and shops. Carroll states:

> Using virtual-reality technology, students could walk down the street in Berlin or Beijing, stopping to chat with the locals. They could engage in complex laboratory dissections or experimentation, visit the British Museum, and stand on the battlefield at Gettysburg, or explore the depths of the ocean or the surface of Mars. (p.71)

According to The New Lexicon Webster's Dictionary of the English Language, edited by Cayne et al. (1991), teachers are those who give others knowledge or skills which they themselves possess. Using this as a definition, computers, no matter how indispensable to education, cannot be considered teachers. They, in and of themselves, possess no knowledge or skills as a teacher does, and they decidedly lack the human touch. They can never replace the human element in education, but as Schurman states, "Technology holds the key to an American educational rebirth" (p. 32).

Characteristics of Effective CAI

Before a bridge can be built, the builders must know
something about bridges. They need to have an understanding
of the purpose of bridges, and the best materials to use in
the construction of bridges. They need, also, to understand
the area the bridge will span and the climatic conditions the
bridge will have to endure, and they need to know the type
and amount of traffic that will be crossing the bridge.
Likewise, when effective computer-assisted instruction, or
CAI, is to be produced, the producer needs to understand
something about effective CAI. There needs to be an
understanding of the purpose of the CAI, those who will use
it, and the conditions under which it will be used.

Instructional Design Issues. As in building a bridge,
before one can begin to build effective CAI, the
instructional problem ahead must be understood. This process
of analyzing the learning task consists of four steps.

1. The educational goals must be stated.

2. The task must be described.

3. Enabling skills and knowledge must be listed.

4. The skills to be taught must be differentiated from
the skills that are to be assumed (Gagne, 1979).

Educational goals are nothing more than a general
statement of what is to be learned. An example of such a
goal is: "Learning about computers." These goals are in
very general terms and are not detailed enough to guide the
production of effective CAI, but are used as a starting point
(Hannafin and Peck, 1988).

Describing the tasks results in a list of all the activities, both visible and cognitive, that the student must do in performing the desired behavior. For instance the task description for starting a computer would be:

Step 1. Insert the operating system diskette into drive A.

Step 2. Turn the computer's power switch to "on".

Step 3. Turn the monitor' power switch to "on".

Step 4. Respond to date and time prompts displayed.

A list of the enabling skills and knowledge will come about as an analysis of each of the tasks identified in the task description. This is done by first identifying all of the subtasks implied in each tasks, then considering all the subtasks implied in each subtask. This is to be done until all identified tasks or subtasks can be identified a part of the audience's prior knowledge (Hannafin and Peck, 1988). Step four could be broken down as follows:

Step 4.   Respond to the date and time prompts as they appear.

a. Learn to respond to the date prompt.

(1) Recognize the date prompt.

b. Learn to respond to the time prompt.

(1) Recognize the time prompt.

Once this list of skills and knowledge has been compiled, a diagram of the list is made to illustrate the hierarchy of task and subtasks (Gagne, 1979).

The final step in instructional task analysis is to determine what will be presented to the students during the lesson. This is done by inspecting the expanded task diagram,

and deciding which tasks all learners would know, which tasks some learners would know, and which tasks possibly a few would know. Cross out the tasks all learners would know and set this list aside for further use. Put a circle around the tasks some would know. Instruction on these might be optional, using pretests to direct the learners to task instruction, and the tasks not crossed out or circled become the lesson modules (Gagne, 1979).

Task analysis is important in order to generate the objectives of the lesson. The best way to determine the success of the task analysis is to look at the success of the instructional unit when it is completed (Gagne, 1979).

In order for CAI to be effective it must be based on instructional objectives. Sponder and Hilgenfeld (1994) state:

> If teacher-made applications are to have a significant impact on students' basic skills, they must work in ways that take advantage of the unique capabilities of computer technology. Furthermore, these homespun products should be based upon solid educational objectives that provide guidance for both creating and using instructional multimedia. (p. 10)

Instructional objectives are simply the intent of the CAI. Describing the intent of a lesson is helpful in many ways, they (a) guide the development of the lesson, (b) help possible users decide the appropriateness of the lesson, (c) allow the student to focus on the important learning tasks,

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(d) define the evaluation of student performance, and (e) define the success of the lesson (Hannafin and Peck, 1988).

According to Woolfolk (1995), every well-written behavorial objective has three parts. The first of these is an observable behavior. These must be behaviors that the student will actually be able to exhibit. In writing this behavior, care must be taken to use verbs that show an action that is observable. Verbs such as, understand, feel, appreciate, believe do not show observable behavior and cannot be measured. An example of an objective which is not observable is: "The student will understand how various drugs effect the human body." It is better to say: "The student will be able to list at least five drugs that have harmful effect on the human body."

The next component of a well-written objective is a statement of the conditions under which performance is to take place (Woolfolk, 1995). Is it to be performed alone or in a group? With or without the use of notes or textbooks? Within a certain time limit? An example of an objective with this component is: "Given an article from a newspaper, the student will be able to mark statements in the article with an 'F' for fact and an 'O' for opinion."

The third component of an effective objective is a statement of the standards against which performance will be judged. Specification of standards is particularly important in writing objectives for CAI, because, unlike conventional instruction, CAI instruction usually continues until the objectives are met. Well-written, appropriate objectives

assure that the learning goals are met without spending any more time or effort than necessary. Standards are usually based on the quality of the response or time limit in which response must occur. An example of an objective with all three components would be: "Given an article from a newspaper, the student will be able to mark statements in the article with an 'F' for fact and an 'O' for opinion with 75% accuracy" (Woolfolk, 1995).

Instructional objectives are meant for three different audiences. "By writing objectives that include these three components, designers know what the lesson must achieve, developers know what to build, and evaluators can determine whether or not the lesson was successful" (Hannafin and Peck, 1988, p. 101). Care must be taken to write and rewrite the objective to be understandable to each audience.

As stated earlier in this chapter, there are five general categories of computer-based instruction, they are, drill and practice, tutorial, simulation, and problem-solving, and games. Most applications use some combination of these. The most effective use of each of these will be discussed.

Although drill and practice is considered by some to be an inappropriate use of computers. Computers make it possible to put into operation a more elaborate drill and practice strategy, that, even though more complex, is simple from the students' stand point. There are several ways drill and practice can be effective.

Hannafin and Peck (1988) state that effective drill and practice should be clear. It should give clear directions for the use of the program, so the student will know how to respond. The response required should be brief and quickly producible. It should give clear feedback that is appropriate to the response offered by the student. Good drill and practice accomplishes clarity by also minimizing unnecessary narrative, and keeping the procedure simple.

Further simplification can be accomplished by giving the student a small subset of items to learn. According to Merrill et al. (1995), This subset, called a working pool, and consists of items to be practiced during the drill and practice session. The working pool is individualized for each child. Ideally, an item that is learned will be removed from the working pool and put back in to the pool periodically for review. New items, and items to be reviewed replace learned items as they are removed from the pool. Of course, if this a drill and practice method is to be effective, it must have the capability of being modified by the teacher to insure that the items drilled are items that are needed by the students.

Tutorial applications bear the burden of instructing students, and introducing new concepts. By their nature they are very complex. In order for a program to carry the full burden of instruction, it must adopt an organizational template. A template is a sequence of steps or features found consistently across lessons. A useful template was devised by Gagne, and it incorporates nine events of

instruction necessary for learning. These nine events of instruction need to be included in most tutorial applications, and they are: gaining attention, presenting objectives, recalling prerequisite learning, presenting stimuli, providing guidance, eliciting performance, providing feedback, assessing performance, and enhancing retention and transfer (Hannafin and Peck, 1988).

Not every tutorial needs to contain all these events, nor does every tutorial need them in this order, but it should include most of them in approximately the same order. Gaining attention, the first event, can be accomplished by the use of color, graphics, sound, animation, humor, or unexpected elements. However, care must be taken to not allow these things to detract from the instructional content. The attention of motivated students can be gained by presenting them with a short description of the purpose and value of the lesson to be learned (Merrill et al., 1995). A tutorial program should present the learner with the goal, or a description of the learning outcomes expected after going through the instruction (Poole, 1995).

So often when new concepts are to be learned, it is necessary for students to have previously obtained skills that will be needed to learn the new material. A good tutorial program will assist the students in recalling the previously learned information at the appropriate time. For example, for a student to learn how to add integers of a different sign, they would have to be reminded of the previously learned definition of integer and the number line,

with zero in the center, positive integers to the right, and negative integers to the left. Tutorials can accomplish this through examples, questions, or definitions (Merrill et al., 1995).

The major part of a tutorial program consists of stimuli, and guidance to expedite the learning process. The stimuli usually consists of examples, explanations, definitions, instructions, and illustrations. Guidance is given in the form of prompts, cues, or directions. Guidance can also be achieved with a series of questions designed to assist the student in discovering concept (Merrill et al., 1995).

Interaction is accomplished with a tutorial program by eliciting response and providing feedback. Response is elicited by asking the student to practice the skill to be learned. The program analyzes the students response and provides feedback informing the student of the correctness of the response, and perhaps, possible reasons for the incorrect response (Schwer and Misanchuk, 1993).

Assessment of performance is another event of instruction often found in tutorial programs, and it is usually in the form of a test. In addition to delivering the test, the program needs to store, summarize and report the results of the test (Merrill et al., 1995).

Enhancing is accomplished by periodic reviews and practices. The most effective way to enhance is to continue building on past skills by requiring that they be used in future learning activities. Transfer of skills to new

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situations is done by presenting the user with varied practices and examples (Merrill et al., 1995).

Problem-solving, simulation, and games, the three remaining categories of computer-based instruction, have much in common. In fact, they are not, by any means mutually exclusive of one another. Problem-solving software presents situations that are designed to stimulate analytical thinking, and exhorts the learner to find a solution through a process of logic, synthesis, and implementation. On the other hand, simulation software offers highly realistic practice at solving real problems unhampered by danger, distance, time, or cost. Finally, the dominant characteristic of an educational game is a set of rules and a clear contest (Forcier, 1996).

Many people think of problem solving as being associated with math, but problem-solving activities are part of everyday life. This means that problem solving is an essential skill that must be developed in students. Forcier (1996) states:

> The constructivist point of view (Bagley & Hunter, 1992) holds that students interact with the real-life experiences that surround them and construct mental structures that provide an understanding of their environment. If students are to build these mental structures, they must refine skills needed to solve problems they will encounter whether they are working individually or in cooperative learning groups. (p. 110)

For this reason, problem-solving software is a valuable educational tool. Computers, using problem-solving software, can provide an abundance of experiences and possible solutions to the learner. The first requirement in problem-solving software is to impart a desire to find a solution. The more the users are motivated, the more self-directed they feel. As a person's confidence level with problem solving increases, so does the confidence to be able to handle any situation that arises (Merrill et al., 1995).

A computer simulation provides a student with a realistic environment, which requires the student to interact with the situation, or even with other students. Then the student must make decisions, and take action based on the previous information and subsequent feedback presented by the computer. Feedback is often in the form of a change in the environment or new material (Forcier, 1996).

Simulations are valuable instructional tools for several reasons. Simulations are less risky than reality. They save in training costs, and are more convenient than real-life situations. Much can be accomplished in less time. Simulation software can focus on specific aspects of the phenomenon, emphasizing more important aspects and minimalizing extraneous aspects. This helps students learn the critical information. Finally, simulation software is able to repeat a phenomenon over and over until the users reactions becomes automatic (Merrill et al., 1995).

Games must have a definite set of rules pertaining to allowed actions, how rewards are earned, and what constitutes

winning. They must also have components of competition on different levels of difficulty. The competition can be between students or against the computer or another standard. Gaming programs have a challenge to make sure that the materials that are presented must be done so that students will find the game interesting enough to stay involved in play (Forcier, 1996).

Screen Design Issues. Good screen design makes the students' experience with CAI as pleasant as possible. In order to do this, care must be taken to make the best use of the screen space. This can be accomplished by applying a few basic principles of good design, simplicity, consistency, clarity, balance, harmony, and unity.

Simplicity demands that the author take a minimalist approach. The message and only the message should be presented, not to be confounded with too many graphics animations and other distractions (Schwer and Misanchuk, 1993).

Schwer and Misanchuk (1993) advise that people have expectations and the unexpected can upset them. This makes consistency an important consideration in screen design. There should be consistency in style, placement of items on the screen, color, titles, cues, screen density, terminology, names of commands, and interactive behavior required.

Clarity requires that text is easy to read and kept to a minimum. Within the text, abbreviations, cryptic codes, stereotyping, and negative messages should be avoided ("The Right Stuff", 1995). The feeling presented by the text

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should be positive and non-threatening.

The aesthetic considerations, balance, harmony and unity are concepts that apply equally to all forms of artistic expression. Balance means that for every graphic object on the screen, blocks of text included, there will be one or more visually complementary objects. Harmony is achieved by consistency, repetition, and using similar and appropriate graphics and fonts across successive screen displays. When a screen display looks as though all the elements forming it belong together, unity is achieved. There should be a focal point, but no one element should stand out too much (Schwer and Misanchuk, 1993).

Although the employment of graphics, animated or not, does not automatically increase the instructional effectiveness of CAI, it does serve to keep the attention and interest of students. Graphics should be only be used when they support learning, otherwise they can be confusing and distracting. Pictorial graphics can be especially helpful, when learners are presented with new concepts for which they have no corresponding visual images such as the concept of an atom (Merrill and Bunderson, 1981).

Sound and color may also be used to hold interest, but care should be taken to not over use them to avoid confusion and annoyance. A loud buzz each time a button is clicked will become an annoyance after a time. Color, again, is of no value in increasing learning, but according to Pett (1996), color "...is preferred and does add interest. Purchasers of instructional materials buy colored materials

even when black-and-white materials are more economical. Therefore, it is important for media designers to use color in as effective a manner as possible" (p. 25). Color choices should be consistent throughout the application.

Usability Issues. A well-designed CAI should be user-friendly, that is, easy to use. Even students who have a minimum amount of computer knowledge should be able to maneuver around within the program. The lesson and any directions presented to the student should be easy to understand and be free from vague, difficult to understand text ("The Right Stuff", 1995).

Students should be able to easily move forward and backward, review, and get out of the program at any time using mnemonic key strokes, buttons or other devices, and get out at any time (Schwer and Misanchuk, 1993).

Authoring Programs. One way that educators can insure that computer-assisted instruction programs contain all the key components of successful teaching is to write their own programs using an authoring program (Traynor, 1996).

An authoring program is any program that is used to develop instruction. There are two main categories of authoring programs available: programming languages and authoring tools (Schwer and Misanchuk, 1993). Authoring tools are easier to use and require less skill in programming. There are authoring tools available that combine a form of computer programing with other basic computer skills. This enables an educator to write a simple program with just basic computer skills, but as programs

become more sophisticated, more detailed knowledge of the language is required. Hyperstudio is an example of such a program (Traynor, 1996).

The first step in creating a successful program is to follow a good model for effective instruction. One such model is the Instructional Theory Into Practice Model or ITIP. The ITIP consists of five stages (Traynor, 1996):

1. The Anticipatory Set Stage is the attention-focusing phase, it also states the objectives and establishes the purpose for the lesson.

2. The Instruction Stage provides the information by explaining the concept, stating definitions, identifying attributes, providing examples, and providing a model. This stage also checks for understanding, by posing key questions, asking for explanations, definitions or attributes. Students may be asked to discriminate between examples and non examples, and may be encouraged to use their own examples. Active participation devices are also provided at this stage.

3. The Guided Practice Stage initiates activities under teacher supervision, and elicits response that demonstrates behavioral objectives. It monitors, checks for understanding, and provides specific knowledge of results.

4. The Closure Stage makes final assessment to determine if the objectives have been met, and it has students perform specific behaviors on their own.

5. The Independent Practice Stage has students continue to practice on their own, and provides them with knowledge of the results.

It isn't necessary to write complex programs to incorporate all of the stages of instruction listed above. Traynor (1996) states: "Programs can be very short—perhaps only one card—to illustrate a certain concept that would otherwise be difficult to convey verbally or on the chalkboard" (p. 58). This is due to the fact that students seem to pay more attention during instruction if they have stimulating visual material.

Teachers are bridge builders, they must attempt to build a bridge of understanding and knowledge across the gap between them and their students. Well-made computer-assisted instruction, can go along way to assist teachers in bridging the gap.

Conclusion

There is a dilemma facing parents of school-age children. They have less time to spend with their children, yet there is a greater need for them to get involved in the lives of their children, especially in their children's education. Parents have a very important influence on their children's success in school. The ages from three to ten are especially crucial years when children progress rapidly in cognition, language, reasoning, problem-solving, and abstract thinking. What takes place during these years has much to do with whether or not children will have success in learning.

Much can be done on the part of parents to involve themselves in their children's education. They can determine how their children learn best. They can create a home

environment conducive to good study habits by setting aside quite time, and providing a study area and proper supplies. Children can be taught to make good use of time, and to develop organizational skills. In addition, they can be taught how to approach assignments, study for and take tests, and use a library. Parents can set an example by reading to and reading in front of children, and they can stimulate children by providing a variety of opportunities to learn, and explore.

"Math Moments" is an attempt to help parents facing such a dilemma by giving them information that will enable them to make the most of those few moments, and offering stimulating and fun activities that will teach math concepts.

Communication between parents and children is important, but it is especially important when it comes to children's education. Parents should communicate with their children, by asking questions and listening as children answer questions about assignments or about a concept being considered, taking care to use the correct terminology. Ongoing, sincere praise and encouragement for children is also very important. "Math Moments" emphasizes the importance of parents encouraging children to verbalize as they are doing the activities, and talking about how wrong answers were derived so that the reason for the errors can be determined.

Mathematics is not just a tool for calculating or solving problems, but it is a precise language that is growing in order to accommodate new ideas and solve new

problems, it is also a form of fascinating and absorbing mental recreation. The computerization of society made this understanding of math a necessity because technology draws upon the full spectrum of math.

A generation ago this definition of math was not taught. Students were shown how to do math problems one way, then expected to do rows of problems and arrive at the right answers. Today's students are learning to understand concepts and apply thinking skills to get their answers. They are taught that there is more than one right way to get the correct answer. This dissimilarity in generations may cause negative feelings about math on the part of parents which can influence children. Parents need to determine how they feel about math so they can avoid negatively influencing their children. It important for parents to instill in their children the importance of thinking of themselves as mathematicians who can reason, solve problems and use math with confidence throughout their lives.

Parents who go through "Math Moments" are presented with a self-assessing list of questions to determine how they feel about math, and to encourage them toward a more positive outlook. They are exposed to the concept that there are many correct ways a child can do the same problem, encouraged to discuss with their children the methods they use, and even brainstorm to find other ways. They are also presented with the above definition of "mathematician" and encouraged to think of themselves and their children as mathematicians.

Although the old methods of rote are not the methods of
choice today, some use of them is necessary. When children
learn a new concept, the computational skill must be
reinforced through short, but frequent practice drills which
should be presented in interesting ways. Drills should be
given which reinforce estimation, and mental computation.
The growing use of calculators and computers demand that the
user has mastered these skills.

This tutorial presents to parents the notion that they
need to give their children opportunities to practice
estimations and mental math skills, emphasizing that mental
math is something people need to use every day.

Because all students are different and all of them bring
different experiences to the learning situation, activities
and teaching methods should be varied. Parents using "Math
Moments" have a choice of a range of activities to chose from
that involve discussion, art, writing, manipulatives, graphs,
and data collection.

The idea that the first and most important teachers that
children have are their parents, and that this
responsibility, although a great one, can be fun is
emphasized throughout "Math Moments".

The recognition that math is everywhere and everyone
uses math everyday is one the the main points stressed in the
tutorial. This idea can be reinforced with children every
time they do activities using objects around the house,
during travel or at the store.

Using tangible objects, or manipulatives, also helps children understand intangible concepts. Parents are encouraged in "Math Moments" to use manipulatives. It is demonstrated within the tutorial how a child can learn the concepts of odd and even by lining up a number of objects, or manipulatives, in pairs. If there is one left over the number of objects is odd, if not it is even.

Computer-based instruction, or CAI is the application of computers as instructors. The multimedia capability of computers make learning more interesting and effective. This is made possible by CD-ROMs, color monitors, speakers, and other hardware. "Math Moments" is a software on CD-ROM that makes use of the computer's multimedia capabilities. It involves sound, color, and animation.

The general categories of computer-based instruction are drill and practice, tutorial, simulation, and problem-solving. Drill and practice drills students on previously learned facts. To be effective, the drill and practice sessions need to be individualized for each student, and the time spent should not go beyond his or her attention span.

"Math Moments" is a tutorial application. Tutorial applications, unlike drill and practice, problem-solving, and simulation, bear the burden of instruction and introducing new concepts. In order to be effective, they need to include as many of the nine events of instruction as possible. These events are, gaining attention, presenting objectives, recalling prerequisite learning, presenting stimuli, providing guidance, eliciting performance, providing

feedback, assessing performance, and enhancing attention and transfer. This tutorial includes, all of the events except, eliciting performance, and assessment of performance.

Problem-solving presents the user with situations that are designed to stimulate thinking, and reliance upon previously obtained knowledge. It adds to the users stash of possible solutions.

Simulation software can imitate anything, requiring imagination of the user. They are valuable because they are less risky, lower in cost than reality, use less time, and can be repeated.

Games must have rules to determine what is allowed, what constitutes winning, and rewards that are given. They need to give the user a feel of control, provide competition, and recognition.

Computers can assist instruction in many other ways than applications listed above. Computers within a school can be connected in an intranet to enable students to share software, ideas and work with other students, as well as allowing access to the Internet, without sacrificing security.

Computers can aid learning by providing access to the Internet, giving students a highway to the world. Students can participate in collaborative projects that involve them with students and scholars all over the world. The Internet also puts at their disposal vast amounts of knowledge which can supplement book research.

The use of computers to aid instruction has brought about, and will yet bring about, changes in education as we see it to day. The teacher will become more of a facilitator than an instructor. The school building may need fewer classrooms and more seminar rooms and presentation areas. Textbooks may take a second seat to CD-ROMs. However, in spite of all the advantages of computer-aided learning, computers lack the human touch and will never replace the teacher.

Before an effective CAI can be created, the learning task must be analyzed. There are four steps to this process. 1. The educational goals must be stated. 2. The task must be described. 3. Enabling skills and knowledge must be listed. 4. The skills that must be taught must be differentiated from the skills that are to be assumed.

It is very important that computer-assisted instruction is based on sound instructional objectives. Well-written objectives describe an observable behavior, a statement of conditions under which the behavior is to be performed, and a statement of the standards with which it will be judged.

Good screen design can be accomplished by applying a few basic principles of good design, simplicity, consistency, clarity, balance, harmony, and unity.

Graphics, sound and color serve to keep the attention and interest of students, but should not be over used, and should only be used to support learning.

A well-designed CAI is user-friendly even for a user with a minimum amount of computer knowledge. Users should be

able to easily move forward and backward, review, and get out
of the program at any time. The lesson and any directions
presented to the student should be easy to understand and be
free from vague text.

"Math Moments" is written for the parents of students in
Kindergarten through the third grade. Of necessity, a well-
thought-out objective, good screen design, the application of
graphics, and ease of use were all taken into consideration
to ensure that the tutorial would be "user friendly" and that
the information, and samples presented are understandable and
usable to the greatest majority.

An authoring program is any program that is used to
develop instruction. There are two main categories of
authoring programs available, programming languages, and
authoring tools. Authoring tools are easier to use and
require less skill in programming. They enable an educator
to write a program with basic computer skills, but as
programs become more sophisticated, more detailed knowledge
of the language is required. Hyperstudio is an example of
such a program, and was the selected software for "Math
Moments".

The Instructional Theory Into Practice Model is a good
model for the authoring of good CAI. There are five stages
to this model, the Anticipatory Set Stage, the Instruction
Stage, the Guided Practice Stage, the Closure Stage, and the
Independent Practice Stage. Of necessity, "Math Moments"
incorporates all but two of the stages. There is no Guided
Practice Stage which under teacher supervision elicits

response, checks for understanding, and provides results. And there is no Closure Stage that makes final assessment to determine if the objectives have been met.

It is the purpose of "Math Moments" to use the tutorial capabilities of the computer, by incorporating principles important to the creation of effective CAI to assist parents in bridging the gap of time constraints, attitudes, and lack of knowledge of math to be effective and competent math tutors to their children.

CHAPTER THREE

STATEMENT OF OBJECTIVES

Project Objective

The objective of this project is to design and develop a computer-based tutorial for home instruction. The tutorial entitled "Math Moments" is designed for parents of students in Kindergarten through the third grades. It is an effort to assist them in tutoring their children in mathematics. It is also an effort to overcome some barriers parents face when attempting to assist their children in math. Most parents (a) are not trained teachers, (b) usually have insufficient time to spend tutoring their children, and (c) feel intimidated by mathematics. Each of these problems is addressed within the tutorial.

In an attempt to rectify the lack of teacher training, the tutorial presents parents with six teaching techniques and suggestions that can be used when doing math activities with their children. Parents' lack of time is allayed by the teaching suggestions and activity ideas that make the best use of the time they do have to spend teaching their children. Finally, parents' negative feelings toward math are tackled by presenting them with a self-assessing set of questions, and clarifications about the new, more positive approach educators are taking toward math today.

Objectives of the Tutorial

Armed with the knowledge and suggestions provided in the tutorial parents should be able to perform the following behavioral objectives:

1. Parents will be able to use newspapers and execute mathematical activities with their children that will teach children about sorting, comparing, and logical relationships.

2. They will be able to use coins to carry out activities that help children differentiate between a penny, a dime, a nickel and a quarter, and learn their values.

3. They will be able to ask questions that encourage children to practice mental math.

4. They will be able to ask questions that will encourage children to talk about math activities and wrong answers.

It is hoped that this tutorial will serve as a launching point from which parents will be able to design further activities using objects around the house. It is also hoped that they will be observant of their surroundings, become sensitive to the math that is all around them each day, and discuss what they observe with their children.

CHAPTER FOUR

DESIGN AND DEVELOPMENT OF THE PROJECT

Description of the Project

"Math Moments" is a computer-based tutorial designed to assist parents of children attending Kindergarten through third grade in overcoming negative biases, lack of knowledge, and their past experience with math to become effective math tutors to their children. The CD containing this project is found in Appendix A.

The tutorial is in four parts (See Figure 1) beginning with a section entitled "Math Is/Is Not...". It aims to dispell the commonly held myths that math is something that is only done in school, that it is row after row of computations, that it is the tedious memorizing of multiplication facts, and that it is a dead subject because we now have access to calculators and computers. Math is defined as a way of interpreting the world around us by observing shapes, patterns, numbers, estimations, measurements and the concepts that relate to them. In addition, it is defined as a way to explore and control real-world situations.

Because parents' attitudes can have an effect on children, the second section entitled, "About You" is a self-assessing set of six questions designed to assist parents in examining their attitudes and biases about math, and to present math to them in a more positive light. The questions posed in this section are:

Figure 1. Flow chart of "Math Moments". The program is non linear, and divided into four distinct sections.
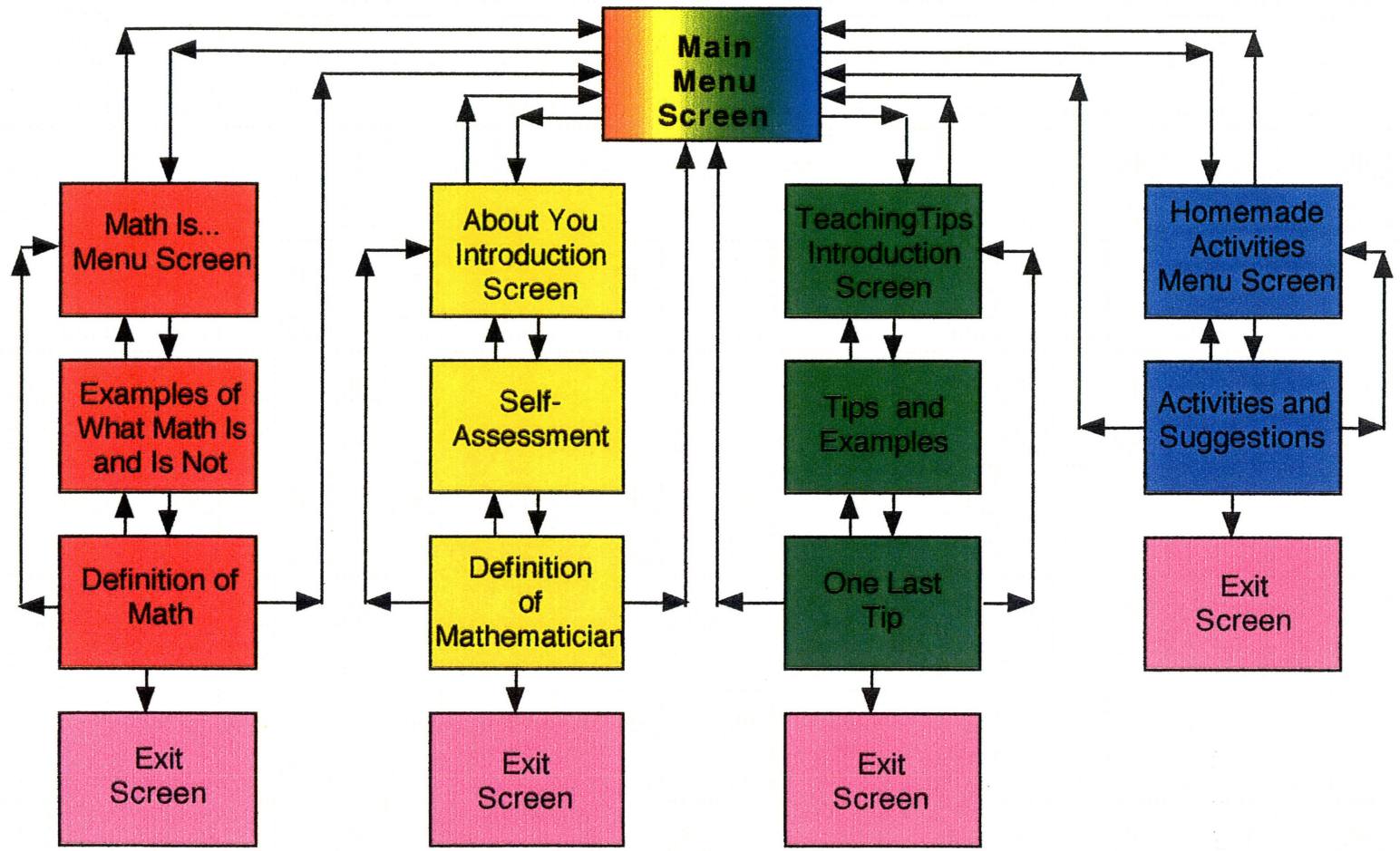
1. Did you like school?

2. Did you like math in school?

3. Can anyone do well in math?

4. Do you feel competent when helping your child with math?

5. Do you use math every day?

6. Do you feel most jobs require math?

After answering the six questions, they are informed that their attitudes about school and math really do matter because their feelings do have an influence on their children. However, that it is not too late, with the help of "Math Moments", they can come to see math in a different light and enjoy doing math with their children. They are also informed that anyone young or old, male or female has the potential to become competent mathematicians (to be defined later). They are informed that, yes, they use math every day and that all vocations and skills require some knowledge of math. The gardener needs to know how to calculate the amount of seed needed to cover a lawn, the truck driver needs to keep track of weight and miles, and the housewife uses math when she cooks and shops.

The tutorial informs parents that they should think of themselves and their children as competent mathematicians who are capable of solving problems, communicating mathematically, and reasoning.

A problem solver is defined as one who is able to stay with a problem to find the solution, ask questions, use many different strategies to arrive at a variety of possible

solutions, and apply math successfully to everyday situations.

To communicate mathematically is presented to the parents as the ability to use words, mathematical symbols, or pictures to explain real-life situations, explain how an answer was obtained, and write about math.

Reasoning is defined in the tutorial as the ability to think logically, and justify ones own thinking about math. It also includes the ability to explain the similarities, differences, and other relationships between things, then make choices based on those differences.

Armed with the knowledge that they can do it, parents are ready to move on to the third section entitled "Teaching Tips". They are reminded that they are their children's first and most important teacher and that this section will help them teach math. "Teaching Tips" presents six simple, but very effective tips and suggestions that will enable parents to assist their children in learning math.

The first tip points out that parents should pay attention to wrong answers, because wrong answers can be very helpful. Children with wrong answers should not be given the "dunce" treatment, but should be assured that wrong answers are to be expected when they are learning a new concept. The cause of a wrong answer should be investigated by asking the child how he or she arrived at that answer. This will let the parent know if the problem is with the procedure, the number facts, or with the math concept.

For example, if a child is given a problem like 3 + ___ = 7, he or she could read it as 3 + 7 = ___, and give the answer 10. The parent might ask the child questions like: "I see your got the answer 10, could you show me how you got that answer, please?" "What is that problem telling you to do to get the answer?" "You got a different answer than I did, you show me how you got your answer and I will show you how I got mine." "Let's take a look at the problem, what does it say?"

The next teaching tip for parents is that abstract concepts can be taught by using concrete objects and examples. These concrete objects, called manipulatives, can be used to help children understand about numbers and their characteristics. They can teach about patterns, spacial relationships and they can aid in solving problems. Manipulatives can be easily made from items found around the house such as beans, buttons, blocks, toothpicks and a host of other things. Parents should keep their eyes open for more ideas.

Objects can be use to teach the concept of odd and even. Objects of a known number could be arranged into pairs. If there are no extra objects after the pairing, the number is even. If there is one object left over, the number is odd. Six apples arranged in pairs illustrate even, and five arranged in pairs with one left over illustrate the concept of odd.

The third tip provided to the parents is that a concept must be taught beginning with easy tasks, then progressing to

more complicated tasks. Each mathematical skill serves as a building block for other more complex skills. Just as a child needs to learn the alphabet and the sounds they make before learning to read, she or he also needs to learn about numbers and their characteristics before moving to higher level math skills. Many math skills, like long division and multiplication are a combination of simpler skills that have to be learned first.

The example for this tip is a demonstration of the concept that multiplication is a quick way to add the same number to itself a given number of times. That is: If 2 + 2 = 4 and 2 + 4 = 6, and 2 + 6 = 8, that means 2 + 2 + 2 + 2 = 8. So 2 x 4 = 8 means "two taken four times is eight". Thus a child needs to master the simpler skill of addition, before he or she can master mulitplication.

The next tip, number four, informs parents that problems usually have one right answer, but an answer can be arrived at in various ways. When parents were in school, they more than likely were taught that there was one right answer to a problem and one acceptable way to find that answer. Times have changed, and today emphasis is no longer on rote learning, but more on understanding the concepts, and using thinking skills to arrive at an answer. This teaches children to be problem solvers. Children should be encouraged to approach a problem from several different directions and asked to talk about the strategy used to arrive at a solution.

The addition problem 6 + 7 = ___ is used as the example showing how different children may arrive at the correct answer. One child might solve the problem by beginning with the double of 6, 6 + 6 = 12, then adding one more, 12 + 1 = 13. A second child could begin by taking the double of 7, 7 + 7 = 14, then taking one away from the total, 14 - 1 = 13. Still another may take 4 from 7 and add it to the 6 to make 10: 7 - 4 = 3, 4 + 6 = 10, then add the 3 and 10 to get the answer, 3 + 10 = 13. All these are correct ways of thinking about 6 + 7 = ___.

The fifth tip advises parents that they need to encourage their children to do math in their heads. Everyone needs and uses mental math skills everyday. Supermarket shoppers quickly do mental math at the check stand to be sure they have enough money to cover the purchases. A child does mental math when setting the table for dinner to be sure there will be enough napkins for everyone.

Three examples of how parents can encourage mental math practice are given. They can challenge children to do math in their heads using small numbers with questions like: "I have five pencils and I need seven, how many more do I need?" Parents should also encourage children to estimate answers by rounding to numbers that make mental calculation easier. For instance, 21 + 38 = 59 can be estimated by rounding to 20 + 40 = 60. Parents should always ask, "Is that answer reasonable?"

The sixth tip advises parents that children should be encouraged to talk math. Children should be encouraged to

talk during a math activity, using correct terminology. They should explain why they are doing the activity, and how they arrived at the answer. Verbalizing helps children solidify a concept and feel comfortable with the vocabulary of math. Talking about math also encourages them to look at the world mathematically and see evidence of it everywhere. Talking can also help parents know if the child is on the right track, and it can help to narrow down the problem a child may have with a concept. For this reason, it is important for a child to explain a wrong answer.

The example for this tip has a child talking about what is being done during an activity. The child is participating in an activity where the characteristic of hair color is being discussed, and the members of the child's family with a certain hair color are counted. A chart is made by drawing one head for each member of the family with that color side by side. The child and the mother talk about the activity. The mother asks, "You made a chart showing how many members of the family had brown hair, and how many and blond hair. Would you explain it to me?" The child explains, "Each head I drew is one person in the family. There is only one brown head, and that is Mike, so I only drew one brown head. Then I drew three blond heads for the rest of us."

One last tip, in the form of a quote by Education Secretary Lamar Alexander, wraps up this section of the tutorial. He states, "The first teachers are the parents, both by example and conversation. But don't think of it as teaching, think of it as fun" (quoted by Ravitch 1992, p. 2).

"Homemade Activities" is the title of the fourth and final section of "Math Moments". Parents are reminded that these activities are meant to be fun and should not become a drudgery. This section is broken down further into "Kindergarten and First Grade Activity", "Second and Third Grade Activity", and "Suggestions for Further Activities".

The "Kindergarten and First Grade Activity" is entitled "Coin Capers". Children are fascinated with coins, and these activities help them identify coins, learn their values, and develop problem-solving skills. The materials needed are crayons, paper, a dime, a nickel, a penny, and a quarter. The activity is as follows:

1. Look carefully at both sides of each coin with the child and discuss the pictures and the words. Discuss the values of the coins.

2. Have the child draw pictures of both sides of each coin.

3. Put a penny, a dime, a nickel and a quarter in front of the child and tell him or her that you are thinking of a coin.

4. Have the child look at the coins while you give clues such as: "The coin I am thinking of is silver." "The coin I am thinking of has a man on one side and a building on the other." "The coin I am thinking of is the biggest coin."

5. Continue giving clues until the child guesses the coin.

The activity for second and third grade children is "Newspaper Know-how". The newspaper is a wonderful source

for math activities. This activity helps a child understand that there are logical ways to sort things. Children will learn to compare items and see logical relationships. The materials needed are: a newspaper, scissors, glue, paper, and a pencil, or crayons. The steps of the activity are:

1. Introduce the newspaper to the child by explaining that it is organized into sections. Point out that the sections are lettered and the pages are numbered.

2. Go through the grocery store advertisements and compare prices of the different stores.

3. Discuss differences in items on sale, at regular price, and those bought with coupons.

4. Ask what happens when a coupon is used.

5. Go through the grocery advertisements again and look for different geometric shapes such a cylinders, boxes and cubes.

6. Cut them out and group them according to their shapes. Talk about their shapes.

7. Make a picture book by entitled "Geometric Solids" by gluing the cutouts onto the pages of the book, putting like shapes together on the same page, and labeling them. Always be on the watch for more shapes that can be added to the book.

The last part of "Homemade Activities", titled, "Suggestions for Further Activities", offers three activities for each of the age groups.

The suggested activities for children in Kindergarten through first grade are:

1. Go through magazines and newspapers and look for the numbers 1 through 50 and cut out the numbers. Glue them in order on a piece of paper. Have the child say the numbers aloud and count them.

2. Gather buttons, beans, screws and other objects from around the house. Sort and classify the items according to color, size texture or any other criterion. Have the child tell how they items are alike and how the are different.

3. Using the objects above, take a handful of one of the materials, such as the beans, and count how many fit into your hand, then have the child do the same. Do it with other materials, and make a chart of kinds of materials and how many fit into your hand and the child's hand.

The suggested activities for children in the second and third grades are as follows:

1. When traveling, copy down license plates, and practice reading only the numbers on them. Compare license plates to see which has the greater number.

2. Assign each letter a number, A = 1, B = 2, C = 3, etc. Calculate the numerical value of each name of each member of the family.

3. Have your child think of a number within a range of numbers. Try to guess to number by asking a series of "yes" and "no" questions such as: "Is the number between 10 and 40?" "Is it odd or even?" "Is the number more than 20?" Then chose a number and have the child take a turn guessing the number.

"Math Moments" is written to an audience of parents who have children in Kindergarten through third grade. It was written using Hyperstudio with a card and stack format, and has five stacks comprised of 85 cards. The user navigates through the program by clicking on buttons that take the user from card to card and stack to stack. The buttons also enable the user to answer questions, see animation, make text appear, hear sounds, and quit the application if desired.

The tutorial is created on Macintosh format and recorded onto a CD-ROM, therefore the user will need to have a Macintosh system with CD-ROM capabilities. "Math Moments" has with it an application entitled Hyperstudio Player, which is a play-only application enabling the user to utilize it without the need of having Hyperstudio installed in his or her computer.

Instructional Design

Because "Math Moments" is a tutorial, this program bears the burden of instruction. The instructional objectives of "Math Moments" are as follows:

1. Parents will be able to use newspapers and execute mathematical activities with their children that will teach children about sorting, comparing, and logical relationships.

2. They will be able to use coins to carry out activities that help children differentiate between a penny, a dime, a nickel and a quarter, and learn their values.

3. They will be able to ask questions that encourage children to practice mental math.

4. They will be able to ask questions that will encourage children to talk about math activities and the cause of wrong answers.

"Math Moments" approaches instruction by using a system of presentations and demonstrations. This is especially prominent in the section "Teaching Tips". In this section, a teaching tip is explained, then an example of that teaching tip is presented. However, there are graphics, charts and sound bites throughout the tutorial that serve to demonstrate what is being discussed.

The organizational template adopted by "Math Moments" includes eight of the nine events of Gagne described in Chapter Two of this paper. The events included within the tutorial are: gaining attention, presenting objectives, recalling prerequisite learning, presenting stimuli, and enhancing retention and transfer.

Attention is gained with the use of an animated opening sequence, and color. Tutorial objectives are presented immediately thereafter on the "Welcome to Math Moments" screen. This screen is followed by a short explanation of what they will find on the main menu screen and directions for navigation.

Recollection of previous learning experiences takes place during the phase of the tutorial entitled "About You". This phase is an interactive, self-assessing set of questions that help the user recall previous experiences they may have had with math during their years of schooling. The sections "Math Is/Is Not...", and "Teaching Tips" also remind parents

of the methods of math instruction they experienced when they were students. The tutorial then attempts to ease any fears or aversions a parent may have about math by making positive statements about the new methods of teaching math, and the ability of anyone to become a competent mathematician. It also emphasizes that math can be fascinating and fun.

The learning stimuli in "Math Moments" is presented in the form of questions that are answered, and definitions as in "About You". It is presented in "Math Is...", "Teaching Tips", and "Homemade Activities" with illustrations, and explanations, and examples that incorporate both sound and graphics. For example in "Teaching Tips", tip number four explains to the parent that there is more than one right way to get an answer, and all methods are acceptable, and in fact, a child should be encouraged to think of new methods. The illustration used to show this (See Figure 2) is a simple addition problem that is solved by three young people in three different ways. The user can see the method they used, and by pushing a button, they can hear the explanations by the children. Then the parent is encouraged to think of other methods.

Retention and transfer are enhanced by a liberal sprinkling of buttons enabling the user to go back to previous sections, and by presenting users, in the last section of the tutorial entitled "Homemade Activities", with activity ideas that make use of their newly acquired teaching skills and enthusiasm for math.

NoteBook

When asked to explain how he or she solved the addition problem: 6+7=? (click on the arrows)

One child might say: Another might say: And another might say:

I took the double of 6.
    6+6=12
Then I added one more, and got:
    12+1=13.

I used the double of 7.
    7+7=14
Then I took one away.
    14-1=13

I took 4 from 7 and put it on the 6 to make 10.
    7-4=3 and
    4+6=10
    10+3=13

All of these are correct ways of thinking about 6+7. Can you think of any other ways?

Tip #5

Figure 2.   Sample screen from "Math Moments". This screen demonstrates the different ways children may solve the same problem.

The Instructional Theory Into Practice Model discussed by Traynor (1996) serves as a good model for the authoring effective CAI. Of the five stages to this model, the Anticipatory Set Stage, the Instruction Stage, the GuidedPractice Stage, the Closure Stage, and the Independent Practice Stage two are not utilized by "Math Moments".

The Anticipatory Set Stage, the attention-focusing stage, is immediately after the opening screen. Here users are presented with the objective of the tutorial.

During the Instruction Stage, information is provided in many ways: explanations of the concept, definitions, examples, models, and questions posed to make the parent think.

Because of time constraints, and the fact that the tutorial is written for parents to use in the comfort of their home, there is no Guided Practice Stage which elicits response from the user under the supervision of a teacher, checks for understanding, and provides the results. Likewise, there is no closure stage wherein final assessment is made to determine if the objectives have been met.

The Independent Practice Stage is the last section, "Homemade Activities," where parents are given examples of activities that they can do with their children using their newly-found knowledge.

Navigation and Screen Design

"Math Moments" is a menu-driven program, controlled by the user. As indicated in Appendix B, the home page can take

the user to any of four sections. The title of each section begins with one of the letters in the word "MATH". The sections are entitled, "Math Is/Is Not...", "About You", "Teaching Tips", and "Homemade Activities". Within each of the four sections, concepts are presented, and examples given. Parents using the program have full control over its non linear navigation. They can go back to the home page at the beginning and end of each section, travel back and forth within the individual sections, and quit at any time.

Good screen design makes the experience with a tutorial pleasant. The program uses a lot of color; most cards have a black background with a colorful border, text, and graphics. The section, "Teaching Tips" is the exception, it has a white screen that that resembles a page in a spiral notebook, similar to a teacher's notebook, as can be seen in Figure 2.

The buttons are uniform and, where card design allows, most often are found on the same area of each card. The main menu cards throughout the program have "Home" buttons. There is a "Home button at the end of each section. The cards in the sections "Math Is/Is Not...," "About You" and "Homemade Activities" have buttons that go back to the beginning of the section enabling the user to go to another section. "Teaching Tips" on the other hand, has buttons that allow the user to "thumb through" the "book" and go back and see any page or screen.

Each card has a "stop" button which takes the user to an exit card. The exit screen has an eleven-second delay before it quits the program. This time allows the user to

experience both a written and an audio parting message. The
exit screen was duplicated and placed at the end of each of
the five stacks so the user exit card could be quickly found
when the user clicks on the "stop" button.

The text is colorful and free of cryptic codes and
negative messages. There is no automatic scrolling, but
there is, at the beginning of the program and on the exit
screens text that is timed to go to the next card after a few
seconds. Great care was taken to make sure there was ample
time to read the words. The beginning screens have only two
or three words to be read on each timed card, and the exit
screen has text as well as audio so the user does not need to
read the text. The font used throughout the program is
Palatino, with some text in Helvetica where card design
dictates.

There are graphics on almost every card. They are used
to illustrate, to decorate, and as buttons. They include
photographs from Hyperstudio's Photo Gallery, hand-drawn
graphics from Hyperstudio's graphics files, and graphics
drawn using a paint program and imported. There are three
animations where objects that are previously not seen, either
float onto the screen or suddenly appear.

One animated graphic is found in the example for
"Teaching Tip # 2". The graphics demonstrate that an even
number of objects can be paired with no object left.
Whereas, an odd number of objects, in this case apples, will
have one item left when they are paired. The screen opens
with four apples pair off and text that states, "5 is...".

Five seconds after arriving at the screen, an extra apple appears from the top right of the screen and settles in behind the other four apples. As this is taking place, the word "odd." floats in from the bottom right of the screen and settles behind the text to complete the sentence, "5 is...odd."

The navigation buttons such as page-turning, and quit buttons have a soft clicking sound that was imported. It is much softer, and less annoying than the clicking sound provided by Hyperstudio. The menu buttons on the initial page of each section have the sound of a muted bell to differentiate them from the other buttons. There are other buttons that when activated play recorded messages that serve as examples of concepts that are being presented. For example, In the "Teaching Tips" section of the tutorial, there is a discussion of the importance of finding the cause of a wrong answer by questioning the child. On the screen, there are four buttons marked by question marks that when activated by the user, present audio examples of such questions.

Formative Evaluation

"Math Moments" was installed on a computer in a private home. The evaluators were informed of the location and asked to drop in anytime during a two-day span to evaluate the program. There were three mothers, each with children who fall within the age limits of "Math Moments". None of the mothers work outside the home. Upon arrival, they were

presented with two copies of the Consent Form (Appendix B). They were asked to read it over, sign both copies, and return one to the investigator. They were then presented with a copy of the "Software Evaluation Sheet" (Appendix C), and asked read it before going through "Math Moments" so they would know what they needed to look for to complete the evaluation.

After finishing "Math Moments", they completed the evaluation sheet and were asked if they had any further comments on the program, and the comments were noted. Then they were thanked, and they departed.

The comments and evaluations were very beneficial. All evaluators strongly agreed that the program contains beneficial information, that the text is easy to read, and that they would recommend it to other parents. Two strongly agreed and one agreed on each of the following items, that the information is easy to understand and apply, that it is an appropriate way to present the information, that the sound and graphics have instructional value, and that the screens are aesthetic and pleasing to the eye. However when asked whether they agreed that the program is easy to navigate, and that it is free of defects and glitches, two agreed and one disagreed on each item.

Their comments and suggestions were very helpful. They noted that there were no buttons at the end of two sections to take them to the home page. One evaluator had never used a computer and needed instruction on the use of a mouse before continuing. She did not realize that some of the

pictures were buttons. Two evaluators suggested that further
instructions should be included on the example for "Teaching
Tip # 1", because it was not clear that they needed to click
on the question marks to hear the sample questions.

One evaluator, an English teacher, found a few
grammatical errors. Another felt confused with the last, or
exit screen, she did not know what to do after arriving, and
she stated that she would have liked to have experienced more
sound. One evaluator stated that the program held her
interest, and wished there were more information available to
her.

After examining the results, many changes were made to
"Math Moments". Care was taken to make sure every button
would take the user to the intended location. A button
taking the user back to the main menu page is included at the
end of each section. Instructions to click on the question
marks were added to the sample for "Teaching Tip #1", and the
grammatical errors were corrected. The confusion with the
exit screen was corrected by duplicating the page and adding
it at the end of each stack. Then all the "Stop" buttons
were programmed to take the user to the nearest exit screen,
where, after eleven seconds, the program quits. This
eliminates the need for the user to do anything in that last,
or exit screen.

One of the evaluators suggested that the word "spacial"
was misspelled, assuming it to be the word "special". An
attempt was made to find an easier-to-understand replacement
for the word, but the effort was futile. The word "spacial"

remains, but the spelling was changed to "spatial" which is an optional spelling of the same word. This was done to avoid further confusion.

Strengths and Limitations of the Project

Math moments is a well-organized program with a main menu page and four distinct and equally-essential sections. It is easy to navigate using uniform buttons throughout most of the program. It uses a variety of presentation methods to introduce concepts. It it colorful, and uses graphics only to dramatize or demonstrate. The text is easy to read, and understand. The program holds the interest of the user.

The information contained in "Math Moments" is important and beneficial, and is presented in a way that is understandable. The activities can be easily augmented, with supplies the are readily accessible.

"Math Moments" is, by its very nature, self-limiting. Due to time constraints, it had to be limited to parents of children in the early school years. Parents of older children would also benefit from comparable information. Also due to limited time, the program has too few activities available to parents. Because children and parents alike, have different interests and abilities, a greater variety of activities would be more likely to appeal to those varied interests.

A few of the concepts discussed in "Math Moments" could have been presented more effectively using video demonstrations. This would have added to the variety of the

demonstrations and would have given the user an opportunity to visualize the application of a concept. Time constraints, and lack of access to equipment made it difficult to include video. Sound was used in place of video to demonstrate those concepts.

Some of the vocabulary may be difficult to understand. As was indicated earlier, one of the evaluators thought that the word "spacial" was supposed to be the word "special". She indicated in her remarks that she had never before seen the word "spacial", and did not know its meaning.

"Math Moments" provides no assessment of performance, or feedback. It is not the intent of the program to subject parents to a test on the information presented. It is believed that many parents would not appreciate that experience. "Math Moments" presents the information, then presents activities that provide the parents with the opportunity to use the information. However, it is possible that a test, and assessment of that test could be included to keep parents alert.

Recommendations for Future Projects

Because the information contained in "Math Moments" is applicable to parents of children older than those in Kindergarten through third grade, the program should be extended to include them. Such a program would, of necessity, need to include other teaching or tutoring tips in order to accomodate the older children. It could include such tips as how to study for and take tests, or how to

organize a plan of action for a large project. It would also
need to include, of course a different variety of activities.
Such activities could include projects using stock market
quotes, mathematical puzzles, brain-teasers, strategy games,
and conducting a make-believe business.

Further help could be given to the parents by including
a list of websites that could be a source information and
ideas, and cooperative projects in which the children could
participate. Parents may also find suggestions on working
with teachers and schools helpful.

It is the intent of this tutorial to give parents a
positive feeling about math that they will pass along to
their children. It is hoped they will come to a realization
that math can be fascinating and fun, and that it is within
the reach of everyone to be a competent mathematician. Above
all, it is intended that parents and children will have many
enjoyable "Math Moments" together.

APPENDIX A

CD-ROM of "Math Moments"

APPENDIX B

IRB Approval Letter

**CALIFORNIA STATE UNIVERSITY
SAN BERNARDINO**

May 20, 1997

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┌─────────────────────┐
│   APPROVED          │
│                     │
│  Full Board Review  │
│    IRB File #       │
│     I97075          │
│   APPROVED          │
└─────────────────────┘
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*The California
State University*

Zola Signs
c/o Dr. Rowena Santiago
California State University
5500 University Parkway
San Bernardino, California 92407

Dear Ms. Signs:

Your application to use human subjects in research has been reviewed by the Institutional Review Board (IRB). Your application has been approved. Please notify the IRB if any substantive changes are made in your research prospectus and/or any unanticipated risks to subjects arise.
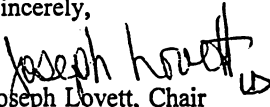
Your informed consent statement should contain a statement that reads, "This research has been reviewed and approved by the Institutional Review Board of California State University, San Bernardino."

If your project lasts longer than one year, you must reapply for approval at the end of each year. You are required to keep copies of the informed consent forms and data for at least three years.

If you have any questions regarding the IRB decision, please contact Lynn Douglass, IRB Secretary. Ms. Douglass can be reached by phone at (909) 880-5027, by fax at (909) 880-7028, or by email at ldouglas@wiley.csusb.edu. Please include your application identification number (above) in all correspondence.

Best of luck with your research.

Sincerely,

Joseph Lovett, Chair
Institutional Review Board

JL/ld
cc: Rowena Santiago, Science, Mathematics and Technology Education

5500 University Parkway, San Bernardino, CA 92407-2397

Consent Form

CONSENT FORM

I, _____, agree to participate in the evaluation of the tutorial entitled *"Math Moments: A Computer-based, Multimedia Guide to Tutoring Math for Parents of Students in Kindergarten Through Third Grades"* which is being conducted by Zola J. Signs. I understand that this participation is entirely voluntary; I can withdraw my consent at any time without penalty and have the results of the participation, to the extent that is can be identified as mine, returned to me, removed from the records, or destroyed.

The following have been explained to me:

1. The reason for the research is to evaluate the effectiveness of the tutorial Math Moments. The benefit I may expect from participating is that I may learn more about how I may more effectively teach my children math.

2. The procedure I will be involved in includes going through the tutorial and answering written and oral questions about the effectiveness of the tutorial and suggested improvements.

3. This participation will involve no risks of any kind.

4. The results of this participation will remain confidential, and will not be released in any individually identifiable form without my prior consent, unless required by law. The only personal information I need to supply the investigator are the ages of my children. Any other information will be given on a voluntary basis.

5. The investigator will answer any further questions about the study either now, or during the course of the investigation.

_____   _____
Signature of Participant   Signature of Investigator

Date: _____

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE, AND RETURN THE OTHER TO THE INVESTIGATOR.

Evaluation Form

Formative Evaluation
of
"Math Moments"

PLEASE CIRCLE THE APPROPRIATE NUMBER

	Strongly Agree	Agree	Disagree	Strongly Disagree
The purpose of this program is apparent.	1	2	3	4
This program contains information that is beneficial.	1	2	3	4
The information is easy to understand and apply.	1	2	3	4
This program is an appropriate way to present this information.	1	2	3	4
It is easy to navigate through the program.	1	2	3	4
The sound, graphics and animation have instructional value.	1	2	3	4
The screens are aesthetic, or pleasing to the eye.	1	2	3	4
The text is easy to read.	1	2	3	4
This program is free of defects, and glitches.	1	2	3	4
I would recommend this program to other parents.	1	2	3	4

Suggestions and Comments:

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