This is to certify that the

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ENCHANTED MATH IN THE GARDEN

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VICTORIA A. SAWYER

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ENCHANTED MATH IN THE GARDEN

By

Victoria A. Sawyer

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ABSTRACT

ENCHANTED MATH IN THE GARDEN

By

Victoria A. Sawyer

This project is to design and develop a set of interactive, web-based games and learning experiences which offer parents/caregivers and preschool teachers tools that children age 3-5 can use to learn to identify the ordinal numbers 1-10, match ordinal numbers 1-10 with words, match ordinal numbers 1-10 with amounts of objects, and to sequence the numbers 1-10 correctly.

It is the MSU 4-H Children's Garden's vision that the 4-H Children's Garden become a leader in how to integrate technology into garden learning experiences. In keeping with this mission and vision, and in cooperation with the curator of the 4-H Children's Garden, Enchanted Math in the Garden uses garden themes to promote mathematical exploration using web-based technology.

To my family, who taught me to love learning and playing.

ACKNOWLEDGMENTS

Thank you to Dr. Carrie Heeter and Dr. Norm Lownds for access to their creativity and their support of this project. Thank you to my co-workers for their technical and moral support. Thank you to Jiatyan Chen for her Flash expertise, to Barbara Beckmeyer for her artistic assistance and to Marcia Witt for her wonderful voices. Thanks to Mike Lownds for his counting tune.

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INTRODUCTION

"Although school attendance is not mandatory in most states until first grade, national surveys of parents of early elementary pupils show that 98 percent of primary school children attended kindergarten before entering first grade (West, Germino-Hausken, Chandler, and Collins 1992). Thus, kindergarten is now the initial year of formal schooling for nearly all children in the United States." [1]

Younger children are needing to know more at an earlier age. For pre-school-K children with computer access, web-based learning tools, which follow national standards, can be of great benefit in assisting caregivers responsible for teaching them basic math skills. Such tools interest and engage children and allow them to gain experience with technology.

The MSU 4-H Children's Garden's mission is to "promote an understanding of plants and the role they play in our daily lives; nurture the wonder in a child's imagination and curiosity; and to provide a place of enrichment and delight for children of all ages." It is also their vision that the 4-H Children's Garden become a leader in how to integrate technology into garden learning experiences. In keeping with this mission and vision, and in cooperation with Dr. Norm Lownds, curator of the 4-H Children's Garden, Enchanted Math in the Garden was

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[1] *Entering Kindergarten: A Portrait of American Children When They Begin School.* Nicholas Zill and Jerry West. Retrieved September, 2002 from the National Center for Education Statistics web site: http://nces.ed.gov/programs/coe/2000/essay/e01.asp

created. It is designed to promote mathematical exploration using web-based technology and to link to the 4-H Children's Garden based on the Enchanted Garden theme area. In this way Enchanted Math in the Garden will show a unique link between a physical place kids can visit and new and fun ways to learn math.

Specifically, this project will be to design and develop a set of interactive, web-based games and learning experiences which offer parents/caregivers and preschool teachers tools that children age 3-5 can use to learn to identify the ordinal numbers 1-10, match ordinal numbers 1-10 with words, match ordinal numbers 1-10 with amounts of objects, and to sequence the numbers 1-10 correctly. It will not address handicapper issues or needs. Web-based games and learning experiences will be developed using the National Council of Teachers of Mathematics Principles and Standards for pre-school - K mathematics. [2]

Research for this project will include observing and interviewing children aged 3-5, who attend an area Head Start program.

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[2] *Principles and Standards for pre-school - K mathematics.* Retrieved September, 2002 from National Council of Teachers of Mathematics Principles and Standards for School Mathematics web site: http://standards.nctm.org/.

After a prototype of the software is developed, 3-5 children in a Head Start classroom will be observed playing with the software. Afterwards, the researcher will ask a small number of informal questions about the experience. This research will help identify any problems with design and be used to refine the tools to best meet the needs of this group of children.

CHAPTER 1
THE NEED

There is a need to:

- create interactive web-based tools that children aged 3-5 can use to learn math concepts
- create learning tools which are fun for children
- create web-based tools which are attractive to children aged 3-5
- support caregivers in providing standards-based tools to teach children aged 3-5 appropriate math concepts
- support the 4-H Children's Garden vision of integrating technology into learning experiences.

Many children are exposed to learning through computers, games, television, pre-school or parental support before they attend Kindergarten. "The foundation for children's mathematical development is established in the earliest years. "[3] It is essential that caregivers, parents and pre-school teachers have access to tools to assist them in teaching children early math skills.

It is important that these tools interest, challenge and entertain the child as well as follow national standards to teach appropriate math concepts. "The National Council of Teachers of Mathematics (NCTM) feels counting is a foundation for

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[3] *Standards for Grades Pre-K-2,* Retrieved September, 2002 from National Council of Teachers of Mathematics Principles and Standards for School Mathematics web site: http://standards.nctm.org/document/chapter4/index.htm

students' early work with numbers. "[4] Learning to count in a fun and engaging way will provide a good foundation for later math experiences.

Technology provides an opportunity to create interactive multimedia software to assist in the teaching of early counting and number recognition skills. Integrating technology into the learning experience prepares the child for today's learning techniques. Integrating technology also supports the vision of the 4-H Children's Garden to nurture a child's imagination and curiosity through the integration of technology.

Standards

The NCTM has developed standards which address several expectations of the pre-school -K-2 group. This project will address the following subset of those expectations. Students will:

- "count with understanding and recognize "how many" in sets of objects
- connect number words and numerals to the quantities they represent, using various physical models and representations" [5]

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[4] *Number Operations and Standards for Grades Pre-K-2*. Retrieved September, 2002 from National Council of Teachers of Mathematics Principles and Standards for School Mathematics web site: http://standards.nctm.org/document/chapter4/numb.htm

[5] *Understand numbers, ways of representing numbers, relationships among numbers, and number systems.* Retrieved September, 2002 from National Council of Teachers of Mathematics Principles and Standards for School

Pre-school - K Children and Computers

Today's children are increasingly exposed to computers in their everyday lives. While not all children have the same advantages, many have been exposed to a computer. Computers are now found in many homes, libraries and in pre-schools.

Children aged 3-5 are comfortable clicking a mouse, using a mouse to move the cursor around the screen, and already associate clicking on objects with a response by the computer. Children aged 3-5 like repetition. "The computer allows endless experimentation and permits them to watch the same thing over and over again, as many times as they choose." [6] Software designed to take advantage of repetition will compliment this tendency and enhance learning.

Children who use learning software have an advantage over those who do not. Good computer-based learning software provides stimulus, content, fun and the ability to be played again and again. "Research has shown that 3 and 4 year old children who use computers with supporting activities that reinforce the major

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Mathematics web site:
http://standards.nctm.org/document/chapter4/numb.htm#bp1

[6] *Why children love computers.* Warren Buckleitner, Scholastic Parent & Child, New York; Apr/May 1999; Vol. 6, Iss. 5; pg. 38, 5 pgs Retrieved September 2002 from Proquest web site:
http://proquest.umi.com/pqdweb?Did=000000040194638&Fmt=4&Deli=1&Mtd=1&Idx=2&Sid=1&RQT=309

objectives of the programs have significantly greater developmental gains when compared to children without computer experiences." [7]

Other attributes are required to make learning software successful. "A well-designed, easy to use program with interesting content that also shows awareness of children's love for the ridiculous, the repetitious, or the surprising is a find." [8] Appropriate graphics, color and sound are important features. Bright colors will attract the child's eye and attention. Sound can be used to encourage, discourage or signal the child to do something.

Tasks must be appropriate for the child's age. It's O.K. for a child to ask for help to get started, but not fun if adult supervision is required. Tasks can be challenging, but must be fun or rewarding in some way. Interactivity is crucial. The child must be included in the learning process. Interesting themes provide cohesion for the learning process and often a "goal" or reason for the child to perform tasks. The theme must interest the child and make them want to play the game. It is important that the user interface be consistent throughout the product.

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[7] *Computers and Yong Children. ERIC Digest.* Susan W. Haugland. March 2000. Condensed from "What Role Should Technology Play in Young Children's Learning?" by Susan Haugland. Retrieved September, 2002 from ERIC Clearinghouse on Elementary and Early Childhood Education Champaign Il. Web site: http://www.ed.gov/databases/ERIC_Digests/ed438926.html

[8] Choosing Software for Children. Mima Spencer. 1986. Retrieved September, 2002 from ERIC Clearinghouse on Elementary and Early Childhood Education Champaign Il. Web site: http://www.ed.gov/databases/ERIC_Digests/ed267914.html

A button should always be in the same location, look the same and do the same thing in all screens. Features should always work the same way.

Existing Products

Keeping these criteria in mind, I reviewed existing software which met the specific needs of pre-school children, aged 3-5, to learn number recognition, number matching and sequencing.

Most of the products used a game metaphor of some sort and most included a challenge such as "solve all the problems and win a ticket for a prize" or "solve problems to progress through a maze" and so on. Games that were marketed toward younger children used recognizable characters, such as Pooh, or familiar and entertaining themes such as a circus or magical world.

There are quite a few products for advanced math concepts, but fewer for the basic concepts. Most of the products I found were targeted towards children 6 years and older. Many were too complicated for 3-5 year olds. Some products included number recognition, number matching and sequencing skills, but typically included more difficult skills such as problem solving, shape recognition or addition and subtraction as well. I was looking for products with a narrower content focus, targeted at 3-5 year olds.

I went to my local library and selected all products on CD-ROM that related to math skills for children age 3-5. I played the games and reviewed the look and feel, the interface and navigation tools, the games techniques and content. Two addressed more advanced skills. Two included one simple math game but were too limited in scope. One product met my project criteria - Disney's Ready for Math with Pooh. Next, I reviewed products on the Internet. While I did not test the user interface, their product reviews described content which related to my project's criteria. Following is a selection of products that address mathematics skills for similar age groups and addressed number recognition, number matching and sequencing skills.

The Learning Company's Math Rabbit Deluxe

Ages 4-7

This product uses four games in a circus setting. Games involve counting and number matching which meet project needs, but additionally include adding, subtracting and problem solving. Calliope Country lets children create music by counting out notes. Tightrope Show has children match a number with one held by the rabbit. Sea Lion and Bear Matching are adding and subtracting and concentration games. Each game has four levels of difficulty. Some instructions are written rather than spoken, so non-reading children need adult help. "The game uses positive reinforcement by having the rabbit say "nice try" and "good job" and using prizes. By correctly solving all the problems in a game set, the child gets a ticket he/she can apply toward the purchase of a toy at the prize

center." [9] There are limited hints for incorrect answers. One review notes that "your child should already be able to count and recognize numbers before using this program." [10]

Disney's Ready for Math with Pooh

Ages 3-6

"In Pooh's interactive "mathemagical" garden, children are guided through seven multi-level, self-paced math activities." [11] This game offers children their favorite Disney characters as incentive. It includes number recognition and sequencing but also includes addition, subtraction and pattern recognition. The games cover the numbers 1-30. Animations and characters are cute and the music is age appropriate and songs can be played again. The games include finding surprises, hidden animations and music to attract and delight children. The hidden animations differ each time they are clicked on. Kids earn a seed for their own garden after completing an activity and water their garden by dragging a watering can over it. Directional arrows point the child along Pooh's garden path where they find games to be played. A Honey Pot icon provides hints for any

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[9] The Learning Company's *Math Rabbit Deluxe*. Retrieved September, 2002 from SuperKids ™ Educational Software Review web site: http://www.superkids.com/aweb/pages/reviews/math1/mrabbit/merge.shtml)

[10] *Math Software: The Big Picture*. Retrieved September, 2002 from SuperKids ™ Educational Software Review web site: http://www.superkids.com/aweb/pages/reviews/math1/sw_sum1.shtml

[11] Disney's *Ready for Math with Pooh*. Tina Velgos. Retrieved September, 2002 from The Review Zone web site: http://www.thereviewzone.com/ready4mathpooh.html

activity, allows printing certificates, quitting, repeating songs or changing levels. This directional tool is a bit difficult to use, but is aided by verbal directives. A lot of time is taken for direction given which slows the child's ability to get to play the game. Wrong answers are not accepted and generate "wrong" noises or comments. Right answers are rewarded. At times the program took control away from the child when they would expect to have control. For example, when the child plants their garden, they click on a seed package and a bee plants the seeds. The child should be able to drag the seed packet to plant the seeds. The Honey Pot and Wishing Well match games were well done and good examples of games which met project criteria. They both encouraged number recognition, matching and sequencing.

Knowledge Adventure's JumpStart math for Kindergarteners

Ages 4-6

The theme is loosely based on Jack and the Beanstalk. Riding on a magic beanstalk, Hopsalot, the rabbit, enters CloudTown, home of Guthry the Giant. The child's mission is to prepare a surprise birthday party for Guthry. "The goal is to earn 100 "sparkling" candles for Guthrie's party." [12] Eleven math-related games are located in CloudTown's islands. Children learn to write numbers, count, sequence and also add, subtract, sort, recognize patterns and problem solving. After earning 10 candles, the child can hide presents or hang

[12] *JumpStart Math for Kindergarteners*. Tina Velgos. Retrieved September, 2002 from The Review Zone web site: http://www.thereviewzone.com/jmpstrtmathk.html

decorations for Guthry's party. Sing and learn songs are included as well as printable materials for use away from the computer. The interface was not assessed, but the content meets my criteria. Unfortunately, it goes well beyond my scope.

Great Wave Software's Number Maze

Ages 5-12

The child must correctly solve math problems to navigate through a series of mazes and obstacles and reach the castle at the end of the maze. "The math problems cover seventy skill levels from counting to word problems to long division." [13] This program claims to be useful for K-6. This program tracks the progress of multiple users. Levels of difficulty increase and lessons from previous levels are incorporated. The program focuses on the use of drills. The interface was not assessed. While this program includes targeted skills, it goes well beyond the scope of my project.

[13] Great Wave Software's Number Maze. Retrieved September, 2002 from SuperKids ™ Educational Software Review web site: http://www.superkids.com/aweb/pages/reviews/math1/nmaze/merge.shtml

Edmark's Millie's Math House

Ages Pre K - 2

"Children explore numbers, shapes, patterns, addition and subtraction." [14] While numbers and sequencing are included, shapes, sizes, addition, subtraction and patterns are included as well. By counting critters, making jellybean cookies and creating caterpillars children learn to associate numbers with quantities and shapes with names. Critters pop up and count off when the child selects a number from 0 to 30 in the Number Machine. The child can place from 1-10 rolling eyes, wagging tails and wiggling antennae on a bug or decorate cookies with 0-20 jellybeans. The games provide immediate and positive feedback. It provides spoken and graphic instructions for pre-readers. The product is correlated to State Standards.

[14] Early Learning Mathematics: *Mille's Math House*. Retrieved September, 2002 from Riverdeep web site: http://www.riverdeep.net/products/edmark_house_series/millies_math_house.jhtml

CHAPTER 2
AUDIENCE AND PROJECT SPECIFICATIONS

Target Audience

The primary users will be children between the ages of 3 and 5. However, in order to reach children of those ages with software, the software must first appeal to a secondary target audience, the parents, caretakers, and teachers who serve as gatekeepers for young children's media experiences.

Secondary Target Audience

This media project must be interesting to adults so they will select it for their child's use. The software must also be pleasing to pre-school through kindergarten children so they wish to use it and thus learn from it.

One adult audience will be parents of children in the age range 3-5. These are responsible people who wish to ensure that the website and experiences are positive and safe for their child. They will want their child to have fun, while also being successful. They will be interested in providing the child with fun learning experiences, which also entertain them.

Another adult audience will be pre-school and kindergarten teachers. These adults will look for learning experiences that will prepare children for the first grade. They will expect appropriate developmental skills to be included in the

games. They will want experiences which the child can figure out and do by themselves with minimal adult supervision. They will want a product that is reliable and accurate. In addition, the learning games should be able to be shared by more than one child and should help develop social and communication skills.

Another adult audience may be caregivers, such as babysitters, who are responsible for the care of a child 3-5 years old. This group will look for entertaining devices, approved by parents, that the children will want to use. They will want a website the child will spend more than a few minutes at and one that requires minimal adult support.

Primary Target Audience

The children audience will be 3 to 5 year olds. They may be in a pre-school, home or kindergarten environment. At this age they are learning to recognize numbers, and sequence them. These children will need access to a computer. They will be expected to have basic mouse skills, but minimal reading skills. Children might use the software first under adult supervision, but after that they will be guided by sound, visual changes, motion and game-playing tasks. Children this age are generally curious, willing to be adventurous, and have a relatively short attention span. Children will expect the games to be entertaining and to provide a variety of experiences or activities. They will need an adult if

they get stuck. This project is not targeted towards handicapped or special needs children.

Primary Persona

George is 5 years old. He is a bright, child and a quick learner. George's family is big; his mom, dad, one older brother, a baby sister and two grandparents as well. They are an active family and spend time together both playing and learning.

George is very active and likes the rough and tumble games and playing with his friends. He watches TV and likes cartoons. He likes the shoot-'em-up westerns and anything with lots of action. He loves loud noises, yelling and fast moving games. He loves computer games and playing with his older brother Frank who shows him how to use the mouse and keyboard. He is coordinated and can control the mouse well. He likes puzzles and solving mysteries. He likes being surprised and loves to laugh.

George might spend time on the computer just after dinner and before bedtime playing games. While he prefers the loud shoot-'em-up games, he does not mind the learning games if they challenge him, move quickly and have good noises in them. He might also play such games at a friend's house or in pre-school.

Winning is the most fun. Beating the game or not dying is the best. It's also good to beat someone else's score.

To appeal to George, Enchanted Math in the Garden will require him to physically move objects around the screen. Incorrect solutions will cause funny "wrong" sounds to occur, while correct solutions will cause funny "correct" sounds to occur. Correct solutions will cause surprise animations and sounds as well. George will be challenged with levels of difficulty. George will be attracted to the wizards, gnomes, trolls and dragons used in the games.

Secondary Persona

Cheryl is 3 years old. She is bright and interested in the world around her. She lives at home with her mom and one older sister. Her mom works full-time so she is involved in both pre-school and after school programs.

She likes playing with her friends, but not too roughly. She likes playing with dolls and watching cartoons and having her mother read to her. She is curious and adventurous about trying out new things. She likes to learn, but is not quick to ask questions. She is not terribly interested in math, but does not dislike it either. She has played on a computer at school and thinks it is OK. She has played computer games and likes I Spy the best where you have to find all the hidden things. She likes to impress her older sister when she can and even

sometimes show off for her. She likes puzzles and loves being surprised. She draws well already and likes to use bright colors in her coloring books.

To appeal to Cheryl, Enchanted Math in the Garden will incorporate games which require Cheryl to find hidden creatures for the correct solutions. She will be challenged with several puzzle-solving type games and will find surprise sounds and animations throughout. Cheryl will be attracted to the brightly colored screens and the wizards, fairies and elves used in the games.

Production Plan

This will be an interactive, web-based project. Children at this age may not be able to read, so all directions need to be spoken and as self-explanatory as possible. Rollovers will speak where appropriate. Music will be used to add repetition and gain attention. The images will be colorful and full of motion to attract attention. There will be multiple levels of difficulty.

Flash will be the development tool. Screens will be designed using the MSU 4-H Children's Garden's theme garden - the Enchanted Garden - as the metaphor. Navigation will need to be obvious and easy-to-use. Learning experiences and games will include:

- number recognition
- number exploration to learn the numbers, their written and verbal names, and graphic depictions
- number explorations depicting the correct sequence of numbers 1-10
- matching games to practice matching the number with the word, the sound and the graphic depictions,
- sequencing games to practice counting and placing numbers in the correct order

The project is broken up into four sections: 1) the introductory screen, 2) the main screen, 3) one tutorial for each number, and 4) ten games.

The introductory screen ties the product to the 4-H Children's Garden Enchanted Garden theme garden. It provides access to credits and cues the viewer that the fairy will be the direction giver. Clicking on the fairy will take you to the main screen.

The main screen provides three functions: 1) access to the ten games, 2) an opportunity for the child to roll over a number and hear it say its number, and 3) access to the fairy who will count 1-10 in sequence for the child. When the fairy counts, she counts to a musical theme created by Mike Lownds, a twelve year old in seventh grade. This counting theme is repeated throughout the games. Children will hear the numbers count using the same melody over and over and

begin to sing along. The melody is intended to stick in their heads and be repeated after the game playing is over.

Once a child clicks on a flower in the main screen, they are taken to that number's tutorial. The tutorial displays the number (and sings it), the word for the number (and sings it), objects for that number (and sings it) and then the number once again (and sings it). When the objects are displayed, they are added in one at a time and the counting theme is repeated. The child is then taken to the game.

The games all use characters such as fairies, wizards, dragons, and gnomes to match the enchanted theme. The characters are all copyright free clip art, but they are placed in photo-realistic backgrounds. Photographs were taken of the Enchanted Garden for this use.

Each game has a home button which allows the child to return to the main screen and select another game to play. Each game has a fairy which is the direction giver. When clicked on, the fairy will give verbal directions to the child about how the game is played. In all games, when a number is clickable, it sings its name from the counting song.

Each game has three levels of difficulty and buttons which allow the child to move between levels. Levels of difficulty are intended to challenge the child. The

first level typically deals with the numbers 1-5. Level two typically deals with numbers 5-10 which are a bit more difficult. Level three begins to mix numbers and words or numbers and objects making this the most difficult level.

Sounds are used to indicate correct or incorrect choices. The sounds are funny and child-like and intended to be enjoyable.

Each game contains an animation or surprise of some sort. Each game also contains a small bug which may be found by the child. When clicked, it makes a funny noise and may be dragged and released anywhere on the screen.

CHAPTER 3
RESEARCH METHODS

Methods include observing and interviewing children aged 3-5 using a prototype of Enchanted Math in the Garden.

Upon completion of the design and development of an Enchanted Math in the Garden prototype, three Lansing area Head Start Program children, aged 3-5, were asked to participate in the research. Parental consent was obtained in advance, working with the teacher and 4-H Children's Garden curator Norm Lownds. The children were asked to sit at a computer one at a time and play with the prototype. The children were read a short introduction and given the opportunity to assent or decline to participate. Upon assent, they played the games and were asked seven questions (*listed below*). The researcher answered questions if the child was lost or stuck in the software. The researcher observed the child playing Enchanted Math in the Garden, took notes about apparent likes and dislikes and watched for apparent usability problems. After the child was done playing with the software, the researcher asked a small number of informal questions about the experience, taking notes on the answers. Anonymity is impossible since the researcher directly observed the children. However, all interview and observation notes will remain confidential. Names were not recorded or associated in any way with the data or observation notes. No video or audio was used. While the interview process involved face-to-face contact, subject's names were not associated with their comments in any way. Notes will be stored in a password-protected computer. Only the Principal investigator and

Secondary Investigator will have access to the data. The data will only be used to aid the Principal Investigator in the design process and assess the value of the tools developed.

This research was used to help identify any problems with design and will be used to refine the software to best meet the needs of children in this age group.

Interview Introduction

I am going to show you some computer games to help children your age learn math skills, like counting 1-10. I would like you to play the games and let me watch and take notes about what you think is fun, what is not fun, or what does not work well. What you say will help make the games even better.

When you are done playing, I would like to ask you some questions. Your answers will help me make sure the games work well and are fun to play. If, at any time, you don't want to talk to me or have me ask you any more questions, just tell me to go away and I will.

Does this sound OK? Would you like to try the games and answer some questions?

Interview Questions

Were these games fun to play?

Which game did you like best? Why?

Which game did you like least? Why?

Was it easy to figure out what to do to play?

What did you learn playing these games?

Would you like to play them again?

Would you like to show these games to a friend?

Risks and Benefits

The risks to the child seem minimal. There is always the possibility that a child may feel uncomfortable with being informally observed or interviewed. The child may feel singled out and therefore embarrassed in front of their peers. The computer monitor may cause eye irritation and the keyboard may cause wrist soreness. The prototype software may frustrate the child or cause them to feel it is their fault if the software fails to perform correctly. There is a possibility that the observation or interview process may disrupt an ongoing event and cause frustration to the children.

The potential benefit of creating a more useful math learning tool is greater than the risks involved. Many children today are being home-schooled or are being taught skills at an earlier age. For those children with computer access, web-

based learning tools, which follow national standards, can be of great benefit in aiding children aged 3-5 learn basic math skills.

Testing this software on adults rather than on children would provide little useful input. Adults know too much math, and they do not perceive the world or play games the same way young children do.

CHAPTER 4
THE PROJECT

The entire project is loosely based on the premise of "See it. Say it. Do it." That is, the task is demonstrated so the child can see what is expected. By verbally repeating the task steps, such as the counting theme, the expectations are reinforced and memory enhanced. Then the child performs the task. Repeating these steps reinforces and enhances the learning process. I intended to take advantage of this age group's tendency to play games over and over. By repeatedly reinforcing the visuals of the number, word, sound and objects, children may retain this information on their way to playing the games. A repetitive counting melody will encourage the child to sing along while learning to count. The games provide the basis for task performance. Three levels of difficulty are provided so that quicker learners can continue to challenge themselves.

I embrace the premise of the Children's Garden to "nurture the wonder in a child's imagination and curiosity and provide a place of enrichment and delight for children of all ages." I hope that I have created games for children that will interest, challenge and entertain them. I wanted to bring some fun into the process and what better helpers than gnomes and fairies to do that!

The Look and Feel

The screens were created using bright colors. Some characters were designed using clip art. All clip art used is copyright free. These were combined over real

photos taken of the Enchanted Garden theme garden in the 4-H Children's Garden. This combination provides a reality-based setting. Should children go to the real garden, they would see a similar setting.

Required Skills

Children will need to be able to use a mouse and have some skill at clicking and dragging objects around on a computer screen.

Navigation

It cannot be assumed that the children will be able to read directions. Thus the fairy became the direction-giver throughout. Clicking on the fairy in any screen will always provide directions on what to do or how to play a game.

Figure 4.1. *The Fairy provides directions*

Intro Screen

The introductory screen provides title and credits for the project. Verbal directions are given for the child to click on the fairy to proceed. Upon clicking, they will be taken to the main screen.

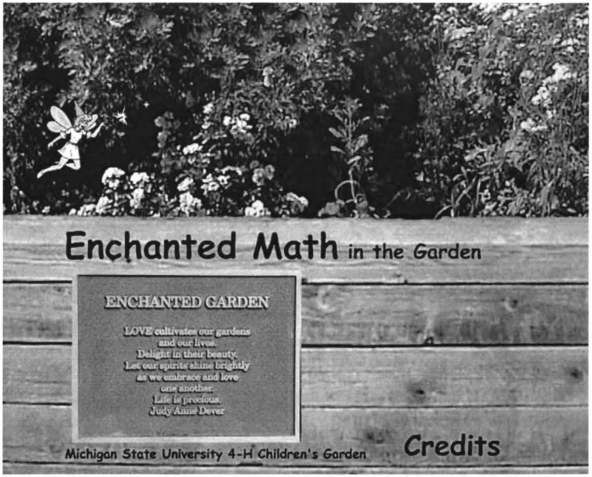

Figure 4.2. *Intro Screen*

Main/Home Screen

Spoken directions from the fairy tell the child "click me to make the flowers count, or click a flower to play a game."

Children who need reinforcement counting from 1-10 can follow along with the fairy as the numbers are sung in the proper sequence. The counting melody used was intended to be memorable so the child might sing the melody while repeating the numbers in sequence. The melody used was child-composed, by Mike Lownds, a seventh grader.

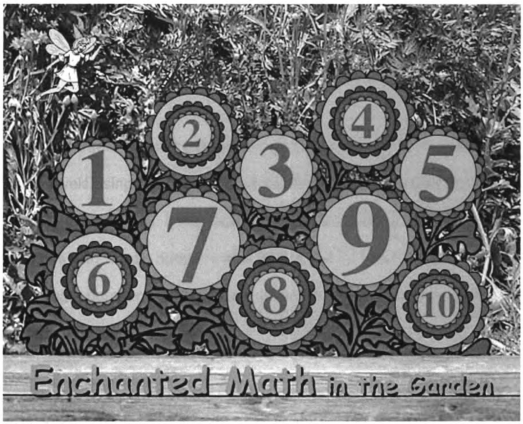

Figure 4.3. *Main/Home Screen*

There are ten flowers, each representing a different game. Clicking a numbered flower takes you to a short tutorial for that number and then on to a game (there

are ten games, each with three levels of difficulty). Levels of difficulty are included so that quick learners can continue to challenge themselves.

When a flower is clicked, a short animation shows the number of that game as a number, is spoken, is shown as a word, is shown as a graphic and then one more time as a number. While the number is being shown as a graphic, the count is incremented and the counting melody is played up to that number. Since this sequence plays each time the child wants to play a game, the learning is reinforced by repetition. The same counting melody used when the fairy counts is used for each of the numbers. Then the child is able to begin playing the game. The child can click the fairy for instructions at any time.

Game Levels

There are three levels of difficulty for each game. Children may navigate between game levels using forward and back arrow buttons. Each level increases the difficulty in some way. It may use the higher numbers 6-10, it may combine numbers with words, numbers with graphics or numbers with sounds rather than matching a number with itself. The hardest level may require matching a word to a graphic or a word to a word.

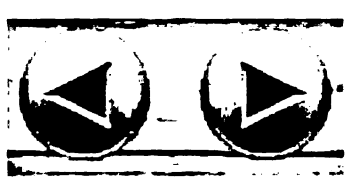

Figure 4.4. *Game Level Buttons*

Home Button

It is important that a child can return to the Home Screen at anytime and begin a new game or make the fairy count the numbers. Clicking on the flowers at the bottom left corner of any screen will return the child to the main/home page.

Figure 4.5. *Home Button*

The Games

Learning experiences and games are designed to include:

- number recognition
- number exploration to learn the numbers, their written and verbal names, and graphic depictions
- number explorations depicting the correct sequence of numbers 1-10
- matching games to practice matching the number with the word, the sound and the graphic depictions,
- sequencing games to practice counting and placing numbers in the correct order

Flower 1:

Game Name: Number Match

Skill: Number recognition, matching number-graphic and number-word

Task: Child drags a number to a specific spot that matches with a picture showing that number of objects.

Other actions: All numbers say their names when clicked on.

Flower 2:

Game Name: Plant Me in Order

Skill: Number recognition, sequencing

Task: Child drags unordered, numbered plants from pots to plant in the ground, sequencing the plants in the correct order.

Other actions: Flowers say their number when clicked on.

Flower 3:

Game Name: Plant the Seed and Watch It Grow

Skill: Number recognition, matching number-graphic

Task: Child picks an image of the number of seeds matching the numeral on the pot and drags it to plant it.

Other actions: All seeds say their number when clicked on. The number on the pot will say its name when clicked on. The flower that grows as a result of selecting the correct match may be clicked on to say its number.

Flower 4:

Game Name: Flower Count

Skill: Number recognition and sequencing, word recognition and sequencing

Task: Child clicks on the numbered flowers in the correct sequence.

Other actions: Numbers must be clicked on in correct sequence. As a correct number is clicked on, it arranges itself along the bottom in the correct order. These numbers may be clicked on to say their names.

Flower 5:

Game Name: Help Plant the Wizard's Garden

Skill: Number recognition, matching number-number, number-word and number-graphic.

Task: A wizard appears with a sign containing a number or object. The child identifies the number or "how many" and clicks on the matching garden hole's number.

Other actions: When the correct number/hole is clicked, that number of flowers grow from the hole.

Flower 6:

Game Name: Find the Creatures

Skill: Number recognition, matching sound-number and sound-word

Task: Child finds hidden creatures and learns their number by rolling over them, then drags them to sit on the mushroom with the matching number.

Other actions: All creatures say their number when rolled over. All numbers say their name when clicked.

Flower7:

Game Name: Spin and Match

Skill: Number recognition, matching number-number and number-word

Task: Child identifies the number of the flower growing in the pot and clicks on the spinning flower that matches.

Other actions: When correct spinning flower is clicked, the matching flower changes color.

Flower 8:

Game Name: How Many Are There?

Skill: Number recognition, counting, match count-number and count-word

Task: Child counts the flowers in the pot and clicks on the number that matches their count.

Other actions: Flowers in the pot count when rolled over. Number selections identify themselves as "too high" or "too low" to help the child select the correct number. All numbers say their names when rolled over.

Flower 9:

Game Name: Flower Repair

Skill: Number recognition, sequencing, matching number-number. number-word and word-word.

Task: Child drags numbered petals to match those on the flower to make it whole again.

Other actions: Numbered petals on the left side say their number when clicked on.

Flower 10:

Game Name: Help the Caterpillar Escape

Skill: Number recognition, sequencing

Task: Child drags caterpillar body parts to complete the caterpillar in the correct sequence.

Other actions: The numbers may be dragged in any order. Once all numbers are in order, the caterpillar says "thank you" and crawls away.

For Fun

Each game contains a bug that makes noises when clicked. It may be dragged anywhere the child wishes. This element is not obvious, but provides a surprise reward upon exploration.

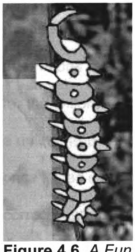

Figure 4.6. *A Fun Bug*

CHAPTER 5
RESEARCH RESULTS

Anticipated Problems

The games all require the child to be able to control a computer mouse, click and drag objects across the computer screen. It is anticipated that the motor coordination of a three year-old child is less well developed than a five year-old child. Children who possess a low degree of motor coordination and mouse skill may find it a prohibiting factor in their ability to play the games.

Observation Results

General

Observation was done at a small table off to one side of the larger classroom. Other activities were going on while the testing was being done. Some of these activities were noisy, such as dancing and laughing. Occasionally the noise was so loud as to prohibit hearing of the verbal directions on the computer.

Mouse skills were better than anticipated. Unfortunately, a two-button mouse was used for the observation and the second button introduced difficulties and frustrations for the child. A single button mouse would have made it a bit easier for the children. All children were able to click and drag objects. One child found a unique approach: standing, the child used one hand to hold the mouse steady once it was in the proper location, and then used their other hand to press the correct button.

All children observed indicated that they had fun playing the games they chose and would show them to a friend.

Design problems were discovered in the introduction page and in the direction-giving process.

Introduction

The introduction page provides three functions. First, it provides access to the ten games. Second, when the child rolls over a flower they hear the name of the number on that flower. Because the flowers are in two rows, the child needed to return to the bottom left to hear the numbers 5-6. They had a hard time getting to the 5 without rolling over the 6-10 flowers, disrupting the sequence. The child could not easily roll over the numbers in a 1-10 sequence. The third function is provided by clicking on the fairy. This begins a short animation with the fairy counting the numbers 1-10. Each child observed continued to roll over the flower numbers causing them to say their numbers while the fairy also counted. It was confusing and should be modified.

Directions

All children indicated that it was hard to figure out what to do in order to play the games. While it was intended that the fairy provide directions, in all observations the child could not hear the directions in the noisy classroom environment. In all cases, the researcher had to help each child figure out how to play the games.

However, once the child knew what was expected, they were able to successfully play the games. The games will need more than verbal directions.

Once a child completed a game, they were not sure what to do next. The researcher prompted them to choose to play it again at a harder level, or to go back to the home page and choose another game.

The Games

When asked what they learned from these games, they were not able to identify any learned skills. However, I observed one child begin a game incorrectly identifying the numbers and end by correctly counting them backwards and forwards. I also heard children sing along with the counting songs which was one of the repetition goals.

Specific Observations (3 children)

Game Number 1: After a short demonstration of how to play the game, one child correctly identified the number to be dragged, successfully found the matching number and successfully dragged the number to the correct location. The child then began counting all the objects for me.

Game Number 2: not played

Game Number 3: not played

Game Number 4: After a short demonstration, one child experimented a bit on level 1. The child liked the "sorry" phrase heard when clicking the wrong item and

began repeating it. The child experimented a bit, not quite sure of the sequence of the numbers 1-5, but finally got the sequence. The child moved to level 2 and did quite well. The child returned to level 1 and figured out they could click on ordered numbers on the wall and make them count. The child proceeded to click on them and to count them out loud both forwards and backwards. While the child began by wrongly identifying several number as "seven", they ended correctly identifying 1-5 forwards and backwards.

Game Number 5: After a short demonstration, the child successfully played levels 1 and 2. The child was able to match the number and click on the matching number. The child liked the "success" noise heard when correct.

Game Number 6: During the short animation before the game, the child began signing along with the number count. When seeing the game picture, the child said, "Cool!" A short demonstration was required to show the child what to do; then the child was able to correctly match the spoken numbers with the written numbers and drag the characters into the right location.

Game Number 7: This game did not require a demonstration, but did require verbal coaching. The child then played level 1 successfully.

Game Number 8: Children played all three levels of this game. This game was harder for the children and one said it was their least favorite. It was not obvious what to do. Once coached, the children could count the flowers, find the matching number and click on it. One child loved the buzzer noise when they were wrong. One child found the cricket and enjoyed moving it around and hearing its noises.

Game Number 9: The child who tried this game did not find it the most exciting. After a short demonstration, the child was able to repeat the task, but seemed unexcited by the game. The child did not complete the game and chose to return home to select another game.

Game Number 10: A short demonstration was required to show the child what to do. The child then played level 1 and level 2. While playing level 2, the child seemed to improve and gain confidence and began experimenting a bit with matching shapes to help figure out the number order. The child laughed when the caterpillar crawled off saying "thank you".

CHAPTER 6
CONCLUSIONS

Indications for Future Development

Two areas require further development: 1) the introduction page and 2) the direction-giving process. Two games require minor adjustments and the teacher's manual needs additional directions.

Introduction

On the introduction page, it was not clear to the child to click on the fairy for directions. The flower roll-overs which say the flower's number were quite successful, but when the child chose to have the fairy count the numbers, they continued to play and roll-over the flowers which made it impossible for them to hear the fairy count. This part of the introduction page needs to be re-worked.

The fairy needs to be more obviously identified as the direction/demo-giver. The layout of the numbers needs to be changed to make it easier to roll over them sequentially – such as in a circle, all in one row and smaller, or a sine wave.

When the fairy counts the numbers, the rollover process needs to be disabled so it does not interrupt the counting. During counting, the counted number should stand out more.

Directions

The direction interface needs to be further developed. Getting directions from the fairy, particularly in a noisy environment was not effective. Only verbal directions were not effective for young children. Once children were given a demo on how the games worked, they were successful in duplicating the process. Each game needs to include a short demo that shows the child how to play the game.

Once the child completed a game, they were not certain what to do next. When a game is completed, it would be useful to prompt the child in some way to choose the next level or the home button, or to automatically move them to the next game. Adding verbal instructions to the buttons on roll-over would be one option. Using animation to draw the child's attention to the button might be another.

Games

Other than adding a demonstration module to each, the games do not require major corrections. Game 10 requires a minor fix to enlarge the target size so the number 9 will "stick" more easily. Game 8 could be enhanced by adding a "too low" or "too high" cue to incorrect buttons to help the child narrow in on answer. The flowers to be counted should be clickable and say their number. This would help the child figure out the correct number to click on.

For the Teachers

A teacher's instruction booklet is also necessary. Using a page for each game, it would include a picture of the game along with directions on how to play the game. It would include the skills and tasks for each game and note any unique features of the game. It was suggested that these page be encased in plastic for durability.

General

Work might be done to see if a two-button mouse could be made to generate the same result from either button. This would make it easier for the children who were using a two-button mouse.

Conclusion

Children today are learning more at a younger age. Enchanted Math in the Garden provides a tool for 3-5 year olds to learn basic number skills at home or in pre-school in an enjoyable format. The scope and focus of the project are purposefully limited to allow for an intensely concentrated experience. The games successfully use number recognition, matching and sequencing tasks to aid the child in meeting the designated goals of the project and in developing their number skills. The games use repetition and a variety of stimuli such as animation, sound, color and Enchanted Garden themes to attract and hold a child's attention.

The skills required to count from 1-10 and recognize each number in its various forms are well interwoven into the games in this project. It is this researcher's conclusion that while the introduction and direction-giving facilities need enhancement, the games meet the desired project goals. There are probably a variety of permutations and combinations that could be created to provide further experiences. In addition, higher numbers could be included. While not within the scope of this project, it could create the basis for additions to this project in the future.

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