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A GARDEN SYMPHONY: THE CREATION OF A MULTIMEDIA MUSICAL COMPOSITION TOOL FOR CHILDREN

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A GARDEN SYMPHONY: THE CREATION OF A MULTIMEDIA MUSICAL COMPOSITION TOOL FOR CHILDREN

By

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ABSTRACT

A GARDEN SYMPHONY: THE CREATION OF A MULTIMEDIA MUSICAL COMPOSITION TOOL FOR CHILDREN

By

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Designing computer interfaces for children can sometimes require a very different method of design and production than designing an interface for adults. Collecting and considering feedback from children during the design process can significantly affect a program's success. The purpose of this study is to provide children with an environment in which they are invited to think creatively about musical composition, in ways that they probably have not before. This purpose was achieved by creating a CD-ROM based multimedia application, targeted at children ages 6 to10, entitled A Garden Symphony. Design goals and ultimate choices were determined and met based on data collected from existing research on interface design, music in multimedia and the theory of multiple intelligences. Data was also collected from observations of user interactions with the garden application during two separate phases of pretesting, preliminary testing of a prototype and final testing of a full version of the application. The results of this study show that user testing during the early and final phases of production does provide useful information on the function and design of a program and its potential success at affecting the audience. Thorough user research and testing helped to insure that children were inspired to creative activity and thought while using this program and that they did conceptualize musical composition in ways that they had not before.

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> In various forms and degrees, children possess the capacity to become more musical than they may currently demonstrate. Children quite naturally listen, sing, dance, play, and express themselves musically, with little or no previous training. When learning experiences are tailored to develop their musical abilities, then the complete musicians inside them begin to emerge. (Campbell and Scott-Kassner, 7)

Some believe that all children are musical and all are capable of being musicians of one sort or another, that everyone has musical potential (Campbell and Scott-Kassner, 6). Adults who know the joys of musical composition can certainly not deny others their musical potential and certainly do have an obligation to help others recognize that potential. In addition to nurturing the musicians in all children, experiencing and learning music could help children to be intellectually well-rounded individuals, as suggested by Patricia S. Campbell and Carol Scott-Kassner in their book, Music in Childhood. Campbell and Scott-Kassner write, "Children are stimulated intellectually, physically, and even spiritually in their recognition of music for its own sake as well as its integration with their knowledge of the humanities, the sciences, and the social studies" (5). So, a garden, in which children can compose and experience music as well as learn about the garden, is likely to play a small but important part in the potential impact that music can have on children's lives.

An Invitation to Creative Thought

The general purpose of this thesis project is:

> To provide children with an environment in which they are invited to think creatively about musical composition, in ways that they probably have not before.

Once children are inspired to think about something in a way that they have not before, a whole world of possibilities can open up to them. Perhaps they had thought of music or even taken music lessons in the past. However, when they see concepts of musical composition demonstrated in a totally unexpected environment, they may see other dimensions of musical composition and more of the possibilities it offers them. It can potentially plant a seed of interest and inspire them to pursue greater knowledge and experience in this area.

Some of the specific goals I hope to achieve in the production of this program are:

- To provide an entertaining experience
- To encourage children to make many songs
- To familiarize children with the variations in pieces of music and how they fit together to create a harmonic environment
- To encourage creative activity with music
- To provide subtle information on the life cycles of gardens

Imagine a Garden – Design Concept

A Garden Symphony is intended to be a multimedia application including animation, sound, interactivity and avenues for creativity. This project will target children ages 6-10. Its potential use is by music teachers who wish to stimulate their students' thinking of musical composition, by home schooled students or just for entertainment purposes at home or school. A Garden Symphony will be different from other musical composition or garden exploration software for children or even a trip to a live garden. It will provide a

new perspective of a garden - a perspective through space and time. Movement and expressions of change through the seasons combine with a playful perspective of a garden told primarily in music. The interface will be a garden scene that changes visibly and audibly as the seasons change, all controlled by the child. The changes which may naturally occur over time, should unfold immediately before children's eyes, suggesting information about the life cycles of a garden that could never be revealed on one or two, or even a number of visits to an actual garden. All objects in the garden will respond to rollovers and mouse clicks with animation and sound. Each detailed animation will demonstrate a movement that each garden object might make, either in space or in time. Each sound will consist of one measure of music, providing an interpretation of what that garden object might sound like as music. For instance, what does a bunny rabbit sound like when she hops, and what does a tulip sound like when it blooms? The pieces of music in the garden will attempt to characterize the type and behavior of the plants or animals they represent. Smaller plants will have higher pitched sounds, and animals moving rapidly will have faster sounds. From one season to the next, the melodies for each plant will be produced using the same digital instrument. So, a kazoo, for example, will perform all of the music for the bee, but the melody played when the bee is selected will be different in each season. Children will be able to experiment with all of the different melodies, combining them in different ways, exploring the multitudes of sounds and emotions that are created as music is composed.

Upon entering the program, children will be able to select a season and the garden appropriate for that season will appear on screen. What suits a garden scene to a

particular season will be the type of plants growing there, the animals living there, and the weather conditions. Once in the garden, children will be able to interact with any of the items in the garden, including flowers, trees, bushes, other plants, or animals. A rollover of an item will result in a short animation. A click will trigger a sound and a more detailed animation.

A musical score will be present at the bottom of the screen at all times. Users will be able to add up to four items from the garden to each measure of the score by dragging and dropping each item on the score. They will also have the option of removing any item they put on the score or clearing the score all together. At any point, children will be able to play back the music they have composed in the score. After they have composed a piece for every season, they can combine those pieces and perform the entire Symphony. So, the result of their interactivity with the garden will be the creation of a totally original symphony.

A secondary goal of the garden symphony concept is to familiarize children with concepts of garden life cycles. However, the primary purpose behind the concept is to encourage children's interest in music, because music can play many roles in the lives of children and have a potentially significant impact on their growth both intellectually and socially.

Chapter 2: Planning the Garden

Literature Review

Four areas of research in particular were investigated for this study and provide a basis for the design goals detailed in this chapter. These research areas include general interface design concepts, interface design specifically for children, the theory of multiple intelligences and the use of music to enhance a multimediated experience. Critical concepts learned in this investigation of existing literature have been categorized under ten separate design goals. How these particular design goals will be met in the design and production phases of A Garden Symphony will be covered in Chapter 3 under Conforming to Design Goals.

Goal 1: Define the User and Uses

One of the most important conditions to determine at the beginning of the design process is who the audience is - what age, gender, education and level of experience with computers (Kristof and Satran, 15). Children, in particular, can have very different needs or methods of interacting with a program from one age to the next (Druin, *The Design of* 6-7). Before we can design for children, we must first define this audience. As Kim Wimpsett wrote, "It's clear that web builders need to concentrate on specific age ranges, rather than a generic kids rating" (2). Of course, this idea can apply to any type of multimedia design. Her reasoning is that from one age to the next, children change and mature very rapidly, so it is necessary to target a narrower age range, to ensure that tastes and behaviors have at least some similarity.

Once you have defined your user, you will need to define the conditions of use of your design. This includes defining the:

> Usage - will the product be: used at home? used at work? viewed and controlled by a single person? projected in front of a group?
>
> Environment - will it be: noisy? quiet? too bright or dark?
>
> Equipment - what can you assume about: the kinds of computers, equipment users have? the performance user's computers can deliver? (Kristof and Satran, 15)

With these conditions defined, it stands to reason that you can better outline the process of design. Outlining the phases of design is critical to your success. Regarding this, Ray Kristof and Amy Satran note, "When you venture into new territory, it's impossible to set out fully prepared. But if you haven't figured out how much time and money it will take to get where you want to go, you may run out of both before you get there" (24).

Goal 2: Let the Content Be Your Guide

"A good interface needs to grow logically out of the material and its presentation" (Stansberry, 47). In other words, look to the content for the design, and determine what type of design would best communicate the content.

Navigation design is an area where letting the content guide the design can be very useful. One way Domenic Stansberry says designers often devise a program's navigation is "[. . .] they first examine the material itself, the task at hand, and the program's intended use; then they search for natural fissures, the junctures at which the material seems to divide itself naturally" (Stansberry, 43). From this type of preparation, a menu structure or navigational environment can evolve.

Goal 3: Integrate Information

Using a design that integrates a variety of information can increase a program's usefulness significantly. Integration is defined for this study in two ways. It is the presentation of a mixture of concepts in one session, such as a game that presents concepts of math, nature and music at the same time. Integration can also be defined as the presentation of one category of information using another category to deliver it, such as teaching the alphabet by singing the alphabet song. Some teachers insist that educational integration is a must and that new technology can help with this integration. "I see the Internet and all technology being a real powerful tool for integrating the various areas of the curriculum. Integration is now necessary," said one teacher interviewed for this study. Not only does integration consolidate the large amounts of information being taught, it can help to enhance students' knowledge gain by presenting the information from a different perspective, one possibly more accessible to them. One theory used to support this method of instruction is the theory of multiple intelligences. "The theory of multiple intelligences was developed in 1983 by Dr. Howard Gardner, professor of education at Harvard University. It suggests that the traditional notion of intelligence, based on I.Q. testing, is far too limited. Instead, Dr. Gardner proposes eight different intelligences to account for a broader range of human potential in children and adults" (Armstrong, 1). The eight different intelligences according to Gardener are: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical ("music smart"), interpersonal, intrapersonal, and naturalist ("nature smart"). "Dr. Gardner says that our schools and culture focus most of their attention on linguistic and logical-mathematical intelligence"

(Armstrong, 1). Children who are most gifted in other areas such as music and nature, therefore, suffer in this type of classroom.

"The good news is that the theory of multiple intelligences has grabbed the attention of many educators around the country, and hundreds of schools are currently using its philosophy to redesign the way it educates children" (Armstrong, 1). Teachers in this study express that they have so much information to teach that it cannot be done without some help from technology and creatively integrated lessons. By integrating information from different areas of the curriculum in a variety of ways, teachers have the potential to reach more students with more of the information. Students that were once overlooked in a linguistically and logically focused lesson can now benefit from these uniquely structured lessons that appeal to other areas of intelligence.

As children experience some of the most developmentally active years of their lives, they should be allowed and encouraged to discover their greatest potential. Exposing children to various disciplines and encouraging them with lessons that emphasize all of the different intelligences, helps to ensure that each child will achieve a broader range of potential than they might have ever thought possible.

Goal 4: Consider the User

During design preparation, considering the user is one of the first steps. "We continue to demonstrate to ourselves - through both our successes and our failures - that the first and

most important question to ask is, *what does the user want to do*?" (Laurel, xiii). After considering this, we will have a better concept of how to design something that they will want to use.

"The program exists for the user, not for the sake of the design" (Laurel, 48). This is a fact that is easy to forget as a designer who is faced with technological limitations and timeline demands. Compromises must always be made, but if the user experience and needs are compromised, even if the timeline is met, it will not make a difference since the program will lack the interface to attract and keep users. In addition, an over zealous design with all possible bells and whistles and the coolest animation and sound effects can lose some of the users to confusion in all the noise.

Considering what children want when designing an interface for them is crucial because they can be the most attentive but also the most easily distracted audience a designer can have. Allison Druin devised some guidelines to follow when designing an interface for child users. The following are just a sampling:

- Design activities to be inherently interesting and challenging so children will want to do them for their own sake.
- Present instructions in an age appropriate format
- Design instructions to be easy to comprehend and remember
- On screen character interventions should be supportive rather than distracting
- Allow children to control access to instructional information
- Design icons to be visually meaningful to children

- Use rollover audio, animation, and highlighting to indicate where to find functionality (*The Design of* 17)

Druin also feels that it is important for children to be involved in the design process. Druin writes, "As the development of new technologies for children becomes more common place in industry and university research labs, children's input into the design and development process is critical" (*The Design of* 52). In describing the development techniques of what she considered some of the better children's multimedia design companies, Druin wrote, "Not only do these companies ask for children's input, but they listen as well. Many animations or activities have been created or altered thanks to the suggestions of children" (Druin and Solomon, *Designing Multimedia* 89). Other researchers agree with Druin, at least to the extent that children should definitely be a crucial part of development as testers of the prototype, if not earlier in the design process. As Wimpsett wrote, "The sooner you get feedback from real kids, the faster you'll be able to build a site [program] that kids will really like" (5).

Goal 5: Give the User Control

"A good interface is one in which the user feels as though he is in control of the system [. . .] the system tends to respond quickly enough so that the user does not get bored with these operations, begins to forget and makes errors" (Bernold, 23). Of course, this latter point is probably even more important for child users, as they can get frustrated quickly with slow or dysfunctional interfaces. If you give the user control of the program, they can explore the information that is most useful to them and are therefore likely to interact

with the program longer than if they were required to sit through a long, tedious monologue of information that they are not interested in.

Another important point to mention specifically regarding children's interactions with multimedia is their desire to repeat actions that they enjoy. Jakob Nielsen described in his observations of children using a program called *Peter Pan*, that children 3 to 8 years old often want to repeat actions over and over again. So providing them with a navigational interface that allows them this level of interactivity and control is a good idea (Nielsen, *Multimedia and Hypertext* 249). Druin and Solomon also wrote, "What I found most interesting, is that children love to select the same hot spots over and over again [. . .] It seems children love familiarity [. . .] However, they do not like it when adults ask them to repeat the same task over and over; but if *they* are at the controls, children love the experience" (*Designing Multimedia* 72-73). Not all children will explore an interface this way though, so it is important to provide a flexible interface that allows for all sorts of interactions. "The product needs to accommodate children who click madly around a screen as well as those who sit back and wait to be told what to do" (Druin, *The Design of* 6).

Goal 6: Make it Usable

One of the most important elements of a design can be its usability, which is dependent, among other things, on the navigation design and use of metaphors. According to Jakob Nielsen, "Usability is traditionally associated with five usability attributes: [. . .] 1) Easy to learn [. . .] 2) Efficient to use [. . .] 3) Easy to remember [. . .] 4) Few errors [. . .] 5)

Pleasant to use [. . .]" (*Multimedia and Hypertext* 279). Any of these attributes can apply to navigation design and use of metaphors, and if they fall short in any of these categories, that creates one more hurdle for the user to overcome when attempting to use the program.

"A good navigation design will: minimize travel [. . .] minimize depth [. . .] minimize redundancy" (Kristof and Satran, 42). So, the navigation should provide few steps between pieces, few levels of information through which a user must delve to find what they really need and no redundant methods for doing the same tasks or going to the same location from the same screen.

Goal 7: Use Meaningful Metaphors

Directly linked with the usability of an interface is the appropriate and meaningful use of metaphors. "When the human mind regards something for the first time, the impulse is to put that new thing in an old category - to find ways in which it resembles something else with which the mind is already familiar. One of the primary ways the mind makes such comparisons is through the use of metaphors" (Stansberry, 34). Using metaphors to communicate an idea and organize information is a common practice in multimedia design. "Perhaps the most common types of metaphors encountered in interactive media are spatial metaphors: those having to do with the arrangement of objects in a physical space" (Stansberry, 35). While using metaphors in this way can increase the usability of the program, as with any elements of a multimedia interface, if it is poorly designed, it will inhibit the usability. "To the extent that an interface metaphor provides users with

realistic expectations about what will happen, it enhances the utility of the system. To the extent it leads users astray, or simply leads them nowhere, it fails" (Laurel, 73).

"Navigational dimensions and metaphors can help users better understand the structure of the information space and their own movements" (Nielsen, *Multimedia and Hypertext* 272). So, when designed properly, with basic concepts of usability in place, navigation and metaphors can ensure a successful user interaction.

Goal 8: Include Interactivity

Another key element in the design of a good interface, especially important to consider when designing for children, is interactivity. "Kids like to leave their mark on things – anyone who's seen scratchings in wet cement or been forced by errant crayon marks to repaint their home knows that" (Wimpsett, 3). Giving children a place to leave their mark, or the ability to interact with an environment and significantly change or impact it will encourage continued interaction with the program.

"But interactivity doesn't have to be complicated. Kids enjoy a cool mouseover more than a lot of text to read" (Wimpsett, 3). This is important to remember. If we bore our users with a lot of text on screen and patronize them with simplistic animation, they will not find the program engaging. Additionally, an important point to remember about interactivity is that the program must be unburdened by it, or it will be so slow that children will wonder if it is interactive at all and lose patience. Interactivity at the appropriate level provides an engaging experience for the user. Balancing the amount of

user control and program control is the trick. "We must find that balance between immersing users in a point of view or narrative and enabling users to shape their own unique experiences" (Druin and Solomon, *Designing Multimedia* 69).

Goal 9: Do Use Characters, But Don't Patronize

Another technique often used in children's multimedia is the use of a character to guide them or join them on their exploration of the program. "[. . .] the use of characters can creatively stimulate kid's minds" (Wimpsett, 6). Perhaps children can identify with the character and imagine themselves actually doing what they see the character doing, in response to their mouse actions. There are many other reasons the use of characters could be beneficial. "Web builders can use cartoons or even real-life characters to aid in teaching, navigation, or excitement [. . .] In fact, characters are practically mandatory for younger kids, and the right personality can usually keep the older ones interested, as well" (Wimpsett, 6).

When designing characters, animation, interactivity, or other features of an interface, you must take care not to patronize your child users. They can sniff out fakery and lameness miles away. "Avoid anything that smacks of being phony, simple, condescending, or boring" (Wimpsett, 7). There are precautions designers can take to avoid this. "User testing and checking out other kids' stuff can help you figure out the correct reading and humor level for your site [program]" (Wimpsett, 11).

Goal 10: Use Music as a Communication Tool

As mentioned earlier, the theory of multiple intelligences supports the idea of integrating information in education. Music has been used as a tool for educational integration for some time and has been considered a critical part of a well-rounded education. "Music is much more than an addendum in the lives of children: It is part and parcel of their development as individuals and as members of social groups of family, neighbors, and friends"(Campbell and Scott-Kassner, 4).

While music has for some time played an important part in child development, technology has grown to be just as prominent in children's lives. "Learning geography, history, or science while catching computer cartoon thieves is becoming as common as climbing a tree. *Pointing and clicking* at *hot spots* or *buttons* on a computer screen are becoming as common as turning pages in a book" (Druin and Solomon, *Designing Multimedia* 64). Music is still considered critical to child development and technology is now a critical tool used to introduce children to a variety of concepts. Integrating the two, therefore, suggests a greater potential impact on a child's education and development.

For a while, researchers have been studying the effects of music on development, learning and the psychology of children as well as adults. The results of these studies may vary, but one thing we do know is that sound or music in a multimediated environment does have an impact on the experience of the user. "Some designers believe that sound accounts for more than half of the experience of using an interactive product" (Kristof and Satran, 112). The application of sounds can help to communicate important

information about the content. "[. . .] by adding sound to the interface the bandwidth of communication can be significantly increased" (Laurel, 322).

Others have suggested that music can help to enhance a user's awareness of the world around them. "Ideally, children have opportunities to select sound effects and music, again enhancing their understanding of the world through 'hands on' experiences" (Haugland and Wright, 51). This music or sound can represent objects and aspects of their personality, quality or movement. "Equally important for helping children discover about the world are realistic corresponding sound effects or music. The sounds are representative of the people, animals and/or objects on the screen" (Haugland and Wright, 51). When designed properly, the music communicates critical information about these objects.

Expert Interviews

The intent of the expert interviews with the teachers was to determine several important facts about their usage of multimedia technology in their lessons. Any preferences or patterns of usage that they demonstrate can then be referenced in the production phase of A Garden Symphony. Six experts were chosen to participate in these one-on-one interviews. They were known by the researcher and also referred to the researcher by other educators and associates. In some cases, they were the teachers of children also participating in the study. Interviews were informal and taken in person and recorded on audio tape solely for note-taking purposes, which was explained to the expert in the

description and statement of verbal consent. Also, for experts that could not meet in person, they were asked to view the program and complete a questionnaire consisting of the same questions asked in the in-person interviews.

Demographic information about each expert is summarized in Table 2.1 below.

Table 2.1. *Demographic information on teacher experts.*

Teacher Demographics

Number of Teachers Per:		
Specializaton	Media Specialist	1
	Classroom/General Studies	3
	Language	1
	Reading	1
Age Group	5 to 8	1
	6 to 10	2
	7 and 9	1
	7 to 10	1
	9 to 10	1
Region	Southern U.S.	3
	Midwest U.S.	3

As indicated by this demographic information, all teachers teach students in the targeted 6 to 10 year-old age range. They also instruct in a wide variety of curricular areas. Interviews with these teachers resulted in some useful information regarding their usage of technology in the classroom, their observations of their students' usage of the software, and other information. The teachers' responses to interview questions are tabulated in Table 2.2 below.

Table 2.2. *The six teachers' responses to interview questions.*

Expert Interview Results

# of Teachers Who:	1 2 3 4 5 6
Use multimedia in class	
Use both web & cds	
Use atleast 2-3 times/wk.	
Use as lesson supplement	
Use for research by kids	
Believe media contributes to kids' education	
Think highly interactive interface is good	
Believe web is more useful	
Use music to teach other ideas	
Use non-traditional teaching methods to get attention	
Use physical activity to engage the students	

The results of the expert interviews support a number of the design goals already discussed in this chapter. First, a majority of general studies teachers are using technology to either integrate information or supplement the information in their lessons. Therefore, it would be beneficial to provide them with a program that already integrates information or that can serve as a tool to integrate many topics in their lessons. This will enable teachers to take advantage of the benefits of a program that integrates a variety of topic areas, Goal 3: Integrate Information. Second, teachers find that interactivity is important to children's software. Interactivity not only entertains children, it can provide them with key indicators of how to use the program and keep them engaged, Goal 8: Include Interactivity. Third, all teachers interviewed do believe in using music in their lessons to

help communicate other concepts. The fact that the experts interviewed for this study do commonly use music in their lessons adds merit to the idea that music can contribute to the education and development of children. It also suggests that music can play a key role in multimedia applications designed for children, Goal 10: Use Music as a Communication Tool.

Review of Previous Productions

- *Michigan 4-H Children's Garden*, produced by the Communication Technology Lab at Michigan State University, 1999. This CD-ROM based application consists of two main sections. The first is the Virtual Tour of MSU's Children's Garden located on the internet and linked through the CD-ROM. The second section, which this review shall focus on, is the Plant Problems Exploration. The purpose of this section is for the users to select one of three different plants that have problems. The program's narrator, Dr. Norm, then walks them through analyzing the plant problem and determining a good solution for all of the elements that may be affected in the garden: the plant itself, the butterflies, the people, the dragonflies and the frogs. The program is very colorful with a friendly and supportive cartoon-like main character. There is very little text on screen, so users are not required to do a lot of reading and can get sufficient instruction from the audio. If the user makes a mistake, the audio gently corrects them and allows them to choose again, while also providing responses to the choices they've made, such as saying "frog" when the user clicks on the frog. Additionally, users are in control of the interface. This is a nice feature because it

allows the users to interrupt an animation or change their minds at any point in the exercise. They are not required to complete the entire lesson. One feature that I would like to see enhanced is the rollover recognition. While there are visual responses to clicking actions and instructions that highlight a button as that button is being explained, it may be nice to also have a cursor rollover state in which the cursor changes to indicate that the user is over a "hot" object. However, overall, this program was easy to learn and to follow, with simple navigation, sufficient instructions, a wonderfully colorful interface and cute animation.

- *Lamb Chop Loves Music*, produced by Media Station, Inc., 1995. This is a CD-ROM application narrated by Shari Lewis and Lamb Chop. The program opens with a video of the two talking, which can be interrupted by the user, as can most any part of the program. It proceeds to the main menu of the program, a bedroom scene in which different items, the toy chest, the poster, the book, all lead the user to different sections of the program. The focus of the program is the story being told by Shari and Lamb Chop. The user can select to listen to the story only, or to listen to an interactive story that pauses after each passage of the story and allows the user an opportunity to explore the interface. Exploring each scene by rolling the mouse around the screen reveals a number of "hot" spots, indicated with a "thumbs-up" cursor. Upon clicking on a hidden hot spot, a clever animation plays, usually with some sort of background music to suit the mood of the animation - a lamb tiptoes through accompanied by sneaky, tiptoe-type music. Some "hot" spots play one or two different animations for each time you visit. This is a nice feature for kids who especially like to repeat

enjoyable tasks. Responding with a new animation each time can provide even more enjoyment and encourage exploration. The animations are fun and definitely one of the most engaging features of this program. The story almost becomes secondary to exploring the scene for new and cool animation. However engaging the animations are, they cannot be interrupted, and some of them are long. Also disappointing was the decreasing number of "hot" spots and animations as the story progressed. The first scene is very dynamic and animation filled, but the progression up to the last scene leaves the user wanting more. Additionally, the navigational devices are simplistic, a left arrow, a right arrow, a question mark and a lamb's head. Simple navigation is fine for a kid user, the left and right arrows are fairly obvious, but the question mark and lamb's head icons are more ambiguous. The question mark does provide help, as would be expected, but does not give any indicators as to what kind of help it will give, which is actually just an audio instructing the user on what to do in that particular section. The lamb's head doesn't really say "home", but that's where it takes the user, back to the main menu. Perhaps an image of the room or something that suggests a return to the main menu would be less ambiguous. Overall, this program is filled with color, clever animation, friendly cartoon-like characters, fun and suggestive music and sound effects, helpful instructions and easy indicators of what to do when. This is a program that both children and adults would find easy to use and simply engaging.

- *5 A Day Adventures*, produced by IDD, Inc. for Dole Food Company, 1996. This program was designed to provide a fun nutrition education for children. The main

interface is a place called Banana Boulevard where users are introduced to one of the main characters, Bobby Banana. Bobby Banana is the kid-like character, "skater dude", that walks the user through the program. When he is not there, some other character provides instruction and narration. All graphics are in a two-dimensional, cartoon style, as well as being very colorful. Throughout the program are scattered a number of simple animations. The program begins by offering users "Travel Tips", an instructional session on how to use the interface and what each of the different icons represent. Very little text is used for instructions. Most instructions are presented in audio, and each section offers a help button that repeats the instructions in case the user missed them the first time around. A cursor that changes to a hand over hot spots is also a useful tool, explained to the user in the "Travel Tips" section. When the cursor changes, often, the object it is over also highlights. The music is one of the strongest features of this program. In the jukebox section and also scattered throughout the rest of the program in bits and pieces are seven or eight different songs about the vitamins and other nutrients provided in fruits and vegetables and the beneficial effects they can have on people's health. The music is used to reinforce the concepts presented in the program. In the jukebox section, music videos are presented with titles so a user of reading age can easily learn the words and sing along. As the songs are repeatedly presented to the users throughout other sections of the program, the idea is that familiarity with the songs will grow reinforcing in their minds the concepts of the goodness of fruits and vegetables.

Chapter 3: Planting the Seeds

Conforming to Design Goals

Even before the preliminary testing was conducted, critical design goals had to be considered during the conception and early production of the program. As mentioned earlier, these design goals should be met as this program is being developed, to ensure its success. These goals were first considered during the production of the program's prototype. Then, as full production proceeded following preliminary tests of the prototype, special consideration continued to be taken to meet these particular design goals. Following are the ten design goals and brief descriptions of how they were met in the production phases of this program.

Goal 1: Define the User and Uses

Before any design could be conceived or any production started, it was critical to determine who would be using A Garden Symphony and how. As mentioned previously, defining the user is also referred to as defining the target audience. Targeting a child audience by a particular age range is preferred over targeting them by type. As indicated in the Design Concept in Chapter 1, the age range chosen for A Garden Symphony was 6 to 10 years old. Users will be both boys and girls. They will require very little experience with computers, just enough to know how to work the click and drag function of a mouse.

The potential uses of the program are as part of a classroom lesson or in a home setting for educational or entertainment purposes. Children not of a reading age would possibly

have adults with them to answer any questions about the program's functionality. The program would be played in an environment where music would not be disruptive, or at a computer that includes headphones. Users would be required to run the program on a computer with higher than 300MHz processing speed, either Macintosh or Windows. This minimum requirement should allow the program to run smoothly. This processing speed will be necessary to handle the amount of computations carried out by the program as the music and animations play.

Other software designed for children in this 6 to 10 age range was consulted for examples of how to design for this audience. While there are considerable developmental differences among children within this age group, teachers agreed that students at both ends of the age spectrum could use this type of software. The program may appeal to all children in this age group for many of the same reasons, but they will potentially use it in many different ways. For example, the younger users do not have the capacity to read text that the older users do. Considering both the younger and older users, a compromise was met by including very little text in the program. It was only included where audio would not work or as a supplement to audio that says the same thing.

Goal 2: Let the Content be Your Guide

The design of A Garden Symphony was conceived of following careful analysis of the content. For example, while the general purpose of A Garden Symphony is to explore the relationship among different pieces of music, a secondary goal is to introduce users to information on seasonal changes in a garden. Therefore, the content for A Garden

Symphony is facts about music and about seasonal change in a garden. A garden was chosen as the interface to help children explore musical composition in a way they can understand, and help them relate the information to concepts or objects they are already familiar with. The garden environment presents the material in a fun and friendly way. See figure 3.1 below.

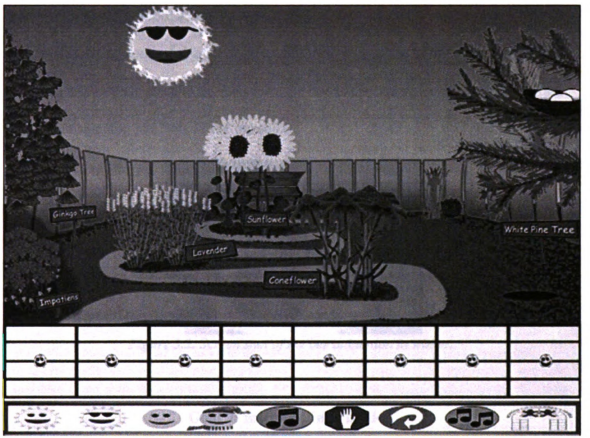


Figure 3.1. *Screen shot of the garden in summer.*

The navigation bar in the garden was directly inspired by the content. Four of the main buttons represent the four main sections in the program. These main sections represent the four stages of seasonal change that a garden experiences throughout a year – spring, summer, fall and winter. Additionally, the remaining buttons on the bar correspond with the musical content. The buttons use icons and names that mirror terms and ideas used in

musical composition as well as other commonly used symbols, such as a stop button shaped like a stop sign, and play and play all buttons showing musical notes.

The content also influenced the animation design in the program. Content was gathered on the life cycles and behaviors of plants and animals commonly found in a garden. Based on this information, animations were created for each plant and animal in the garden, simulating some real-life behavior. For example, queen bumble bees are typically known to hibernate in the winter, therefore, the bee in the winter section of the program was shown sleeping in a hole in the ground.

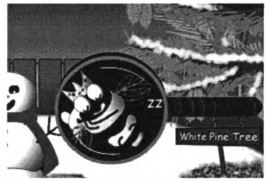


Figure 3.2. *Screen shot of the bee animation in winter.*

Goal 3: Integrate Information

As mentioned previously, the theory of multiple intelligences supports the idea of integrating information in a lesson. A Garden Symphony was designed to appeal to at least two of the intelligences mentioned in this theory, musical and naturalist. Using music, the garden symphony program intends to communicate information about nature, specifically life in a garden. It also uses the garden metaphor and concepts of change in the garden to communicate information about musical composition. Therefore, A Garden

Symphony offers two alternative avenues for learning to children who may have had difficulty learning music and science in a logically and mathematically oriented classroom.

While the purpose of this project is not necessarily to educate children, one goal is to appeal to something within them that will then spark or encourage an interest in musical composition and garden life cycles. By presenting information on these disciplines in such a uniquely integrated and non-traditional form, A Garden Symphony encourages creative thought on musical composition in all children, but especially appeals to those whose strengths are in the musical and naturalist intelligences.

Goal 4: Consider the User

Child users were considered in the production of this program in several ways. To determine what child users enjoy doing, extensive investigation was conducted on existing child user studies. In-person observations of children using other computer programs and interacting with each other revealed some interesting information on what children enjoy. Some of the observations most relevant to this study are listed below:

- Features that solicited some of the largest responses were characters with funny voices, animations and characters behaving in unexpected or silly ways.
- Children do listen to and often follow characters' instructions for physical movement.
- If not too shy, children will sing along with simple songs.
- Children also enjoy hearing contemporary styles of music in computer programs.
- Children want control, to be able to stop their interactions with the program at any time.

- Primarily older children want to be able to move rapidly through the program.
- Children enjoy experimental activities.
- Children will tolerate a certain amount of inconvenience if they enjoy what they are doing, or find another way around the inconvenience.
- Almost every child does the same activity slightly differently. Some are more systematic while others tend to make choices more randomly.

Children were also asked for their opinion on how to design the program. Early in the production phase, they played with a prototype of the garden program and were asked for suggestions on how the design might be improved. See Table 5.2 in the Results section of this document for details on their suggestions.

Goal 5: Give the User Control

As mentioned earlier, all children will probably use the program in slightly different ways. Some will need more guidance than others. Some will want more control than others. A Garden Symphony was designed to accommodate all types of users, giving complete navigational control to those who want it. At any point in the program, they can go to a different section of the program within one or two clicks. For example, the tutorial is currently a fairly lengthy monologue, however, users can leave the tutorial at any time to begin the game or just exit the program.

As a result of user pretesting, the program was redesigned later in the production phase to accommodate some children's need for repetitive action. As mentioned previously, most children enjoy the ability to repeat their favorite actions in a program. This was evidenced

in the pretesting of A Garden Symphony as several older children attempted to immediately repeat the action of adding plants to the musical score but were prevented by the program design. The problem was resolved with a redesign of this mechanism. For more details on this redesign, see the Particular Difficulties section of this document under Results.

Goal 6: Make it Usable

The area where usability was most critically addressed in A Garden Symphony is the navigation. It was designed to follow Nielsen's usability attributes. The opening tutorial defines how the program works and makes it easy to learn. It is efficient to use because it was designed to require no more than two steps at a time to go anywhere within the program. The navigation bar was designed using simplistic icons representative of fairly common ideas and symbols. This makes its functionality easier to remember.

Figure 3.3. *Screen shot of the navigation bar.*

Audio rollover statements on each button also help the user remember how each button functions. The audio statements were added in response to user pretesting. This change is described in more detail in the Results section of this document. User testing during the production phase has revealed no consistent errors. Any errors as a result of slow performance appear to be corrected when the program is run on a system with a processor speed higher than 300MHz. The combination of colors, sounds and animations make the

program pleasant to use. Preliminary testing showed that the interface was, in fact, pleasing to children and teachers alike who responded well to these features.

Goal 7: Use Meaningful Metaphors

In A Garden Symphony, the spatial metaphor is a garden, composed of objects, plants and animals, that represent pieces of music. The activity users do in the garden is a metaphor for composing music. Using what resembles a musical score at the bottom of the screen and other musical symbols, like notes, users can recognize the activity's relationship to musical composition. While a musical score is present on the screen, it remains visually simplistic to avoid confusing users who may be inexperienced with musical composition. The colorful plants and animals in the garden also present a non-threatening environment. Whether children believe that the plants and animals are metaphors for music or that the plants and animals are actually making the music, it's obvious that they are the source of the music in the program. As users drag plants and animals to the score, they are, in essence, writing notes to the musical score and simulating the act of musical composition.

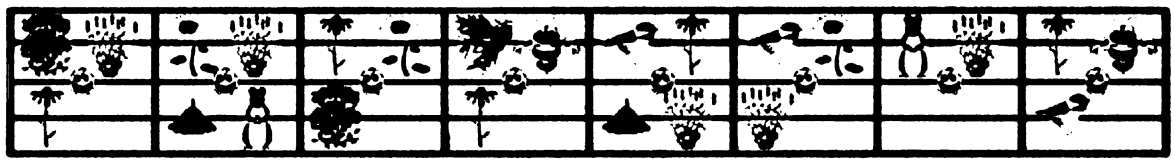


Figure 3.4. *Screen shot of the musical score filled in summer.*

Goal 8: Include Interactivity

As mentioned, kids do like to leave their mark on things. A Garden Symphony exists for children's creations. It is nothing but an animated, sound filled interface without a child using it to compose a song. The garden provides interactivity in the form of rollover

animations, rollover sounds and click responses. Most animations were designed to demonstrate an actual behavior, so they were made as detailed as possible, more detailed than just a simple highlighting of color. However, the greatest interactivity depends on the imaginations of the children using the program. Children leave their mark in the garden by composing an original song. Not only does the song exist thanks to the child's activity, it also visually impacts the state of the garden as it plays. How a song is composed, what plants and animals are chosen, determines what activity goes on in the scene as the song is performed. In simple terms, children can make the garden dance. The original design also intended to provide a mechanism for children to save their compositions. This will be developed in the next version of the program since it can greatly benefit the design and add to the interactivity already in place in the program.

Goal 9: Do Use Characters, But Don't Patronize

The main character used in A Garden Symphony is the chipmunk. He introduces the program and provides instruction on how to play. He is happy and friendly and has a squeaky little voice. Currently, during the tutorial, he stands, talks to the user and then runs off screen. In future versions of the program, he will be designed to run around during the tutorial and show users how to play, as well as popping up randomly in the garden, as they play the game, to provide any needed assistance. Ideally, the chipmunk as well as other characters will play a larger role in the garden in future versions of the program.

Goal 10: Use Music as a Communication Tool

Obviously, music is used as more than just a recognition tool in A Garden Symphony. The music that children hear and compose within A Garden Symphony is representational music. This music serves to communicate information about members of the garden and their movements and behaviors in each of the seasons. This music supports the visual representation of a chipmunk and shows the user what a chipmunk might sound like if it were music. Likewise, for other animals, flowers and trees. For example, the music used to represent a bee going out to look for pollen was composed with an instrument that sounds like a bee's buzz, set to a rhythm and tone reminiscent of a serious mission. Therefore, the visual and audio cues during this animation reinforce each other to communicate information about the bee's primary behavior in the summer.

Technical Issues Addressed in Production

While it was critical to address particular design goals in the production phase, certain technical issues also needed to be addressed. A Garden Symphony is an interactive application that consists of multiple states of activity and numerous variable behaviors. The need to track a number of choices made by users can easily be accommodated in the Macromedia Director™ programming environment using the scripting language, Lingo. Therefore, this was the chosen programming environment for A Garden Symphony. Director™ uses metaphors of film and theatre production, with terms like stage, cast, score, and frames. The stage is a window in which the program is visually arranged. Instances of graphics stored in the cast are placed on the stage. Once on stage, these graphics are referred to as "sprites". A programmer can place as many sprites of the same

cast member as she wishes on stage. The program can also be arranged in the score, which is a large table with columns for each frame of the Director™ movie and rows for each channel. Sprites are placed in the score at the intersection of the frame, indicating at what time the sprite is on stage, and the channel, indicating the depth of the sprite on stage relative to other sprites. Sprites will be referred to again in the Results section of this document.

Each sound in the program is one precompiled measure at 4/4 time (four beats in a measure), or Common Time, created using the midi and wave components of Cakewalk Home Studio9™. All sounds, when combined, synchronize or play harmonically. While these sounds are precompiled, the user still has total creative freedom with which sounds are chosen and how many are chosen (1-4) for each measure. The fact that these sounds are precompiled allows users to create quality, sensible music without needing to know anything about musical composition.

Chapter 4: Evaluating the Growth

About Formative Evaluation

Designing a successful multimedia application requires a lot of preparation, analysis of existing research, testing and testing again. Getting users involved early in the development cycle of the program is most important. Early user involvement can identify issues that could significantly impact the program's usability. "Once children are interacting with the design, errors and observed confusion can directly predict errors children will make when using the future computer product" (Druin, *The Design of* 10). This method, referred to as formative evaluation, considers and even consults the receiver of the message during the design process. "First used by educational researcher Michael Scriven in 1967, then made famous in broadcasting circles by its use in *Sesame Street*, the term *formative evaluation* refers to the systematic collection and analysis of evidence to aid decision making during the planning, design, and production stages of a program, product, or system" (Mody, 62). With this type of evaluation, the original idea of the communication flow as sender-message-receiver has been reconstructed to allow feedback from a sample of the receivers before the message is finalized and sent to the entire audience. This reconstruction of the traditional flow has come about to help ensure that, in simple terms, the message that is sent is the one that is received. The effect that this method has had on the development of multimedia programs is that designers have been able to develop more valuable and useful programs for their intended audience, thanks to direct feedback from members of that audience.

Formative evaluation typically has two major phases: preproduction and production testing, also known as pretesting. "Preproduction formative evaluation may be used as an aid to planning, to help decide what to communicate in a broad general area (e.g., health) through assessments of the information contexts and information needs of users" (Mody, 62). Information provided in Chapter 2 is the sum of preproduction research conducted for this particular study. The literature review, expert interviews, and product reviews have all been conducted to determine what information should be considered in the design and production stages of this study. This thesis document will refer to production testing as pretesting, "[. . .] in which prototype or pilot messages are pretested to obtain audience reactions prior to final production" (Rice, 132). The rest of this chapter will summarize the pretesting procedures used in this study.

Testing the Soil – Preliminary Testing Method

Some designers believe that the earlier you test your design idea on the intended users, the better. This is the idea behind the pretesting phase of formative evaluation. As mentioned previously, pretesting involves presenting the product to a sample of the intended audience for feedback on potential errors or problems. Pretesting was accomplished in two phases for this study, preliminary testing and final testing. Preliminary tests were conducted early in the design phase of A Garden Symphony. The concept and design were tested by five children ages 6 to 10. "Observing even a few children using the product during early product design will catch a substantial number of issues that are difficult to predict ahead of time" (Druin, *The Design of* 15). The prototype

these children tested contained one completed season, spring. Children were selected from a group of children at a local elementary school and children known by associates of the researcher. The parents were presented and asked to sign a permission slip that explains the premise of the study and asks the parents to grant permission for their children to participate. The main goal of this informal preliminary testing was to find out how children react to the interface; if they could use it; what would make it easier to use; what would make it more fun to use; and any suggestions they might make for changes. In a home and computer lab setting, a video camera was set up to capture the children's responses as they used the program. Casual interviews after children used the program provided additional information about their reactions to the design. The goal was to get feedback from children on the design of the program before the program had gone too far into the production phase. In this same phase of testing, children were asked to play with several other edutainment type programs which have a similar appeal to A Garden Symphony. Observation of these interactions provided additional information on children's typical interactions with these types of programs. All information collected during this preliminary testing phase is summarized in the Results section of this thesis document.

Pulling the Weeds – Final Testing Method

Final Testing is a form of pretesting, according to the method of formative evaluation. Final testing for this program was conducted after a majority of the program was completed, and was not intended to be as proactive as the pretests conducted early in the design phase. However, it does serve to identify any potential problems in need of repair

before a final version is released. "Evaluating products with children at the end of the product development cycle provides invaluable information for future directions" (Druin, *The Design of* 15). This round of testing was conducted slightly differently than the preliminary testing. The local elementary school proved to be a useful source for potential users and doing the testing in the school's computer lab provided the researcher with access to more students, in a setting more familiar to the students than the preliminary round of testing. However, the sessions could not be videotaped in the school, so observation, interviewing, note-taking, and analysis and write-up after the fact were the main methods used to conduct and record the sessions. In this phase, children were asked to interact with a complete prototype of A Garden Symphony. After a period of observation, they were asked a few questions regarding their opinion of the program and specific aspects of it. Some of the same children who participated in the preliminary testing of the program also participated in this phase, but most of the other participants were first-time users of the program. Both individual interviews and group interviews were conducted to gather user feedback. The results of this testing were considered in the final revisions phase of this study. See the Results section of this document for further details.

Chapter 5: How Does Your Garden Grow?

Results

The preliminary testing and final testing phases of this study serve to predict the usefulness and over all success of the program. Testing implicates whether or not intended goals were met and even suggests ways to improve the program for use either now or in the future. This chapter summarizes the most significant findings of the study, specifically those that had the greatest impact on the design of the program.

Particular Difficulties

The first and second rounds of testing, revealed a number of potential usability problems. None of the problems were surprising, but all of the more serious problems indicated a need for change. Those particular problems and the changes made in response to these problems are summarized below. The problems are categorized by their hindrance level -- minor, moderate, or severe. A minor hindrance would be a problem experienced by few users and/or does not detract from the usability of the program. A moderate hindrance would be one experienced by a significant number of users that affects the usability of the program enough to confuse and frustrate the users. A severe hindrance would be one that most users experience and that prevents them from continuing interactions with the program. The percentage of users who experienced the particular problem is also indicated for both the preliminary testing and final testing phases.

Problem: Placing items on the musical score

Hindrance Level: Moderate	**% of Users Experienced – Prelim Test: 100**	**Final Test: 0**

The prototype was designed so that users could click on and drag any of the plants and animals down to the musical score. Once they released the mouse button, an iconic representation of the plant or animal would appear on the score in the particular measure over which they released the mouse button. The way this process was originally designed required the user to drag the icon so that it was completely within the parameters of one measure. This function was programmed using the Lingo keywords, *sprite. . .within.* This told the program that if the icon was within the parameters of any particular measure when the mouse was released, to show the icon on that measure. Anticipating some users having difficulty getting the icon completely within the measure, a smiley face was added to the center of each measure, and users were instructed to drag the mouse over the smiley face to drop the icon on the measure. Preliminary testing revealed that the smiley face instruction was not enough. Users often released the mouse button when the icon was only partially within the parameters of the measure, and, therefore, no icon appeared on the measure. This proved to be very frustrating for most users. The older users adapted rather quickly, more so than younger users. Those who were younger sometimes gave up on a particular plant or animal because, it seemed to them that it did "not want to go" on the measure.

Change: From *within* to *intersect*

This is an issue of control. As mentioned previously, users must feel they are in control of the interface. If not, they may become frustrated and give up, as children did in this

example. The solution to this problem was relatively simple. It involved changing the keyword *within* to *intersect.* As a result of this minor change, users can now drop the icon even when it is intersecting the measure only the slightest bit, and the icon will appear on the measure. This change was especially helpful for the younger users, as was demonstrated in the final round of testing.

Problem: Dragging icons during the animations

Hindrance Level: Moderate % of Users Experienced – Prelim Test: 60 Final Test: 0

The program is designed so that, after users add a plant or animal to the musical score, a detailed animation and piece of music play, demonstrating what that plant or animal might do and sound like as music in that particular season. Originally, the design required users to wait for these detailed animations to complete before they could drag another one of the same plant or animal to another measure on the score. For example, a user could not drag another coneflower down to the score while the coneflower animation was playing. So, this delay prevented users from rapidly adding the same item to multiple measures of the score. Preliminary testing showed that this was not an issue of great concern for the younger users, who tended to move less rapidly throughout the program. However, older users, once they developed a familiarity with the function of the interface, seemed frustrated that their interactions with the program were delayed. As mentioned earlier, Druin points out, "The product needs to accommodate children who click madly around a screen as well as those who sit back and wait to be told what to do" (6).

Change: Interruptible animations

To solve this problem, another script was added to the program for each of the plants and animals. This script was added to the plant and animal sprites during their animation sequences and was virtually identical to the scripts on those sprites while they weren't animating. The minor differences in these scripts prevented an error involving the display of an overstate whenever users clicked and dragged an animating plant or animal. Final testing showed that this change was worthwhile since it allowed users much more flexibility than before.

Problem: Returning to the tutorial

Hindrance Level: Minor % of Users Experienced – Prelim Test: 100 Final Test: 0

The preliminary prototype of the program opened with the tutorial that immediately exited into the spring section of the program. There was no way to review the tutorial without leaving the program and restarting the game. It was always intended for the final design to include a way to review the tutorial, and the results of the preliminary testing reinforced the belief that this would be a beneficial feature. Most children recalled how to play and stop the music, however, very few recalled the instruction to drag the icon over the smiley face to get it to stay on the measure. One boy even had a question regarding the smiley face, but once he restarted the program and was able to view the tutorial again, he found the answer to his question.

Change: Make the tutorial more accessible

As mentioned in the Literature Review, a good interface makes the user feel in control of the program. To allow the user this kind of control over the tutorial information, the program was redesigned, as originally intended, so that the user is first presented with the choices to visit any one of the seasons and begin composing, or take a tour of the garden. Now, if a user is composing in a particular season and wants to review some of the instructions on how to play, they can return to the main entrance and choose to take the garden tour again. If they don't care to see the whole tour, they can interrupt it at any time and return to the game with the song they've composed still intact.

Problem: Confusion about the tree sap

Hindrance Level: Minor % of Users Experienced – Prelim Test: 80 Final Test: 10

Two of the plants in the garden are trees, a ginkgo and a white pine. In the spring, both of these plants have animations that demonstrate sap running through the inside of the tree. This is shown as a cross-section of a tree branch, magnified with a magnifying glass. An animation inside the magnifying glass is a simplistic graphical representation of sap flowing. During preliminary testing, very few users were able to identify this animation as sap flowing.

Change: Add sap signs

The solution to this problem was to add a sign that says "Tree sap," with an arrow pointing to the magnifying glass. This change is useful for older users of reading age, however younger users, may still need some assistance to determine the context of this

animation. Indications for Future Development in Chapter 6 will outline some of the future steps that may be taken to enhance the usability of this program for a wider age range of users.

Problem: Users skipping the tutorial

Hindrance Level: Moderate % of Users Experienced – Prelim Test: NA Final Test: 70

Final testing revealed a problem that was in some ways the result of a change made after the first round of testing. As described before, the first round of testing showed that users needed some way to review the tutorial. The solution for this was to provide the tutorial as an option at the main entry point of the program. It was designed to be an option, not a requirement, so that users who are well acquainted with the program will not be required to view the tutorial every time they load the program. However, during final testing, in spite of the voice-over instructions to "Choose a season you'd like to compose, or take a tour of the garden," most often users did not take the tour first and did not realize that the tour would tell them how to play the game.

Change: Additional audio instructions

To ensure that users would realize the importance of the garden tour, the following audio statement was added to the program following the statement mentioned above. "The garden tour will tell you how to play the game. Take the tour if you haven't already." The garden tour sign also wiggles as the statement is playing. This statement will play each time the user returns to the entry screen until the user has watched the whole tutorial. Another potential fix for this problem would be to automate entry into the tutorial as a

user enters the program, providing them with a "skip tutorial" button if they've already seen it. Currently the tutorial runs in one long sequence. As the need for further tutorial information has grown and will grow as the program is developed further, a new design of this section of the program should be considered. Chapter 6 will outline how this section could be redesigned to benefit the user.

Problem: Forgetting the buttons

Hindrance Level: Moderate % of Users Experienced – Prelim Test: 10 Final Test: 30

Both users who viewed the tutorial and did not view the tutorial occasionally forgot the meaning of the buttons on the navigation bar at the bottom of the screen. The season buttons in the shape of suns seemed to be those most often forgotten in the final round of testing. Most users did not experience any difficulty using the program due to this, however it was deemed a large enough hindrance that steps were taken to simplify the interface.

Change: Add rollover audio

As mentioned in the Literature Review, one of Jakob Nielsen's five usability attributes is that the navigation must be "easy to remember." To help users identify each of the buttons in the navigation bar and risk no chance of them forgetting their meaning, the program was redesigned to play a short piece of audio that identifies the button. For example, if a user rolls the cursor over the button that takes them to spring, they hear the audio statement, "Spring!"

Problem: Interface freezes

Hindrance Level: Severe % of Users Experienced – Prelim Test: 10 Final Test: 20

This could be a potentially serious problem. During production and final testing, a lag in the visible refresh of the program was encountered several times. It typically occurred on Windows computers with a 300MHz or slower processor. After high levels of activity, the visual portion of the program froze. The program appeared to still be running, sounds played and hot spots responded to mouse clicks audibly, but the images were frozen on screen. This problem did not happen for most users and did not happen consistently.

Change: Set higher user requirements or overhaul graphics

Currently, one of the only probable solutions known for this problem is to run the program on a computer with a faster processor speed. Since some of the latest computers are currently processing at 700MHz, this isn't a totally unreasonable solution. However, many children's school computer labs are most likely going to have processors closer to the 300MHz range. Another potential but quite time consuming change to the program itself would be to redo all of the graphics in a low color resolution. Currently, for aesthetic reasons, the graphics have a color bit depth of 32. The bit depth could be significantly reduced, however, this would also significantly reduce the visual quality of the program. A final solution has not yet been determined for this problem.

Particular Happy Notes

Most teachers said they could or would use the program in their lessons, and they all felt it had great potential for a variety of uses and for additional development. Teachers

expressed very few complaints or concerns. Of those they did express, most were anticipated and already considered for future development. For example, some teachers asked for a way to save the songs, and some asked for the chipmunk audio to be a little clearer, both of which are addressed under Indications for Future Development in Chapter 6.

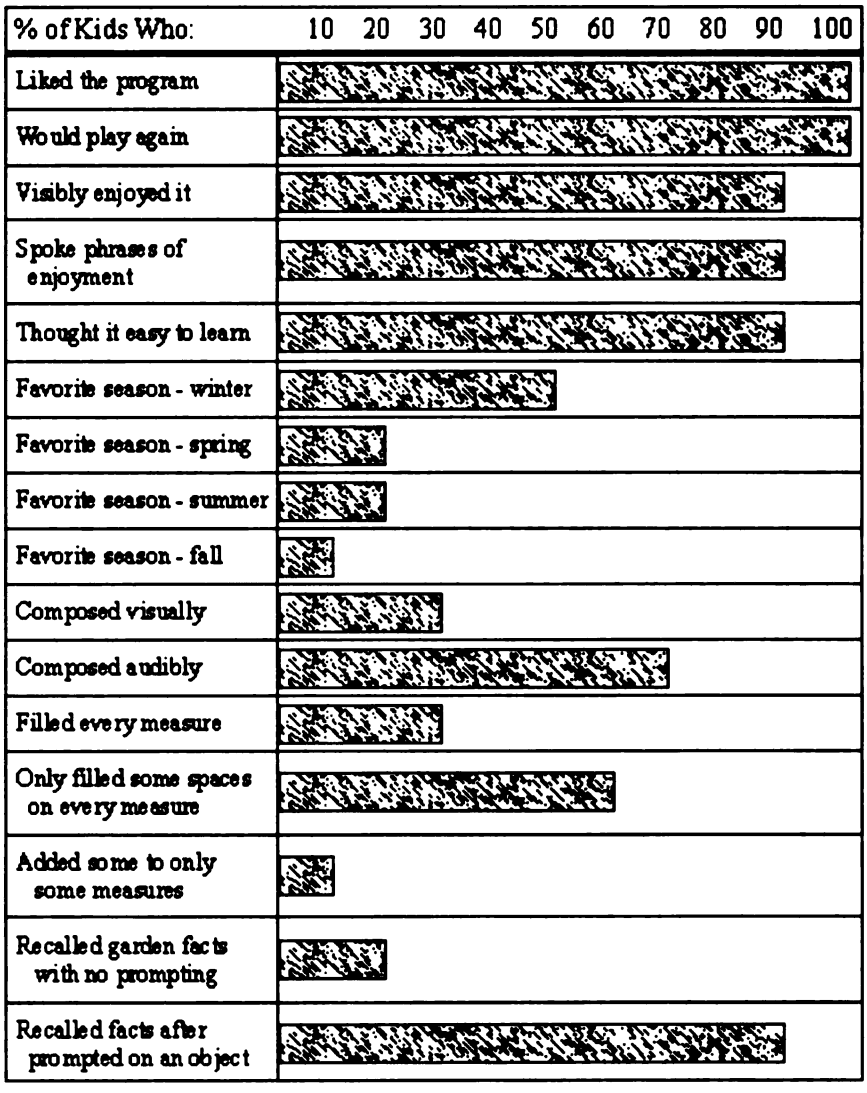
All child testers said they would play again if they had the chance. Some of the unsolicited positive responses included a boy so involved with the program that he conducted in the air as his composition played back to him. There were also bobbing heads, a number of "This is cool!" comments, and too many giggles to count. Most of the children commented that their favorite part of the program was listening to the compositions they made. They indicated that they liked the result of the various pieces playing in unison. This is an especially happy note since one of the main goals of the program is to familiarize children with different pieces of music and how they can fit together harmonically. Some of the greatest fascination with musical composition can come from knowing what is possible, and still knowing the feeling of surprise when what is imagined actually comes to life even better than it was imagined. Providing children with this sense of fascination and surprise was definitely an unstated goal of this program, and while difficult to prove, the results of user testing absolutely indicated a level of fascination and surprise in the voices and faces of these children as they composed their garden symphonies.

Overall Results

Twelve children and 6 teachers participated in the final testing phase. Only two of the children who participated in preliminary testing also participated in final testing. The children were first, second, fourth and fifth grade students. Grades taught by the teachers ranged from kindergarten through fifth grade. Table 5.1 tabulates some of the most significant findings of the final testing phase. It orders children's answers to particular testing questions and observations of their behavior and rates their responses by percentage of the 12 total participants.

Table 5.1. *Overall responses to questions and interaction with the program.*

Overall Results of User Testing with Kids



In addition, both teachers and children provided suggestions on how they thought the program could be improved. It has been demonstrated that including children in the design process can potentially impact a program's success at reaching the target audience. So, getting their design suggestions during the preliminary phase of pretesting, before the program was fully developed, was crucial. The children's suggestions from preliminary testing are listed in Table 5.2 below.

Table 5.2. *Kid suggestions for improvement during preliminary tests.*

Suggestions for Improvement
Kids ● Have random animations during periods of inactivity ● Make the sun do something, like spin around ● Let user drop item anywhere on a measure and have it stay ● Add something to indicate what the tree sap is, like a sign ● Make the sun talk ● Add more plants ● Drag the sun down to the score

Some of these suggestions were considered during the production phase and met before final testing. Some of the most significant suggestions from kids in final testing were redundant with those made in preliminary testing, such as the suggestion for random animations and dragging the sun down to the score. Some of these suggestions will still be considered for future versions of the program. Teachers also provided some useful feedback and suggestions for improvement during the final testing phase. Their suggestions are listed in Table 5.3 below.

Table 5.3. *Teacher suggestions for improvement during final tests.*

Suggestions for Improvement

Teachers

- Redo the chipmunk audio with clearer pronounciation
- Make the chipmunk's instructions slower
- Make the symbols for the seasons (the suns) more creative
- Add more plants
- Reduce the age level or add more challenging garden facts for the older kids

Overall, teachers and students alike were very enthusiastic about the program and often mentioned the uniqueness of the idea. "It's a unique idea. There's nothing in this area, of plants and music," responded one teacher. Most all users found it visually as well as audibly appealing. "It's fun. It's very visually appealing. I liked playing with the music. I thought the whole thing was fun," another teacher said. While the program seemed to have less of an educational impact, the researcher was satisfied that the purpose and overall goals of the program were met, indicated by one boy's comment, "I never really thought of plants making music," followed by his peers in a choir of agreement. That children indicated that they had never thought about music in this context, but now did, directly supports the proposed intentions of this study – *to provide children with an environment in which they are invited to think creatively about musical composition in ways that they probably have not before.*

Implications of Results to Intended Goals

1. *Provide an entertaining experience* – Children testing the program were visibly entertained. They laughed throughout the program, with the most laughter

surrounding the various chipmunk, bee and chickadee animations. As mentioned previously, they made grand conducting gestures as they conducted their orchestra of plants and animals. They giggled with delight after the first and second and so on, performances of the songs they composed. "This is cool!" was heard many times during the testing sessions, and all children agreed that they would play again.

2. *To encourage children to make many songs* -- By design, the program allows children to make a number of variations on their composition and even wipe the score clean and begin again with an entirely new composition. Had it not been for the time constraints of the testing period, most children would have continued playing.
3. *To familiarize children with the variations in pieces of music and how they fit together to create a harmonic environment* -- The garden setting served as a non-threatening and friendly interface for musical composition, which benefits the music novices using the program. Children quickly grasped the concept of composition demonstrated in the program. They expressed a definite enjoyment and preference for the music they made after combining the different pieces of music provided in the program, as mentioned previously. While they enjoyed listening to each individual plant's or animal's sound, they were visibly more pleased and sometimes surprised when they listened to the results of their composition with multiple sounds in the same measure. This usually led to further exploration, combining each of the other pieces of music, until the "perfect" combination was discovered – perfect to each composer's ear.
4. *To encourage creative activity with music* -- As suggested in the previous passage, children were given an environment in which they could combine pieces of music and

experiment with the different combinations of sounds until they created the perfect composition, as they saw it. Some children created their symphonies using the same sounds, their favorite sounds, over and over. Some experimented with a variety of sounds. Some put one sound in each measure, and some filled the score with four in each. Some stayed in one season more than other seasons because, they said, it made their favorite sounds, while other users composed visually. They chose how their composition would sound based on how the musical score looked as they added different plants and animals to it. It is a musical chemistry set of sorts, with which the children mixed and matched combinations of sounds until they came up with the solutions they were looking for, and all without risk of explosion.

5. *To provide subtle information on the life cycles of gardens* -- Their recall of specific facts they learned about the garden was minimal. However, when children were specifically asked what a particular plant or animal does in a particular season, and then reviewed the animation, children were almost always able to relate back to the researcher what the plant or animal was doing in the animation. While they couldn't always think of the technical terms, they related, in their own words, a reasonable understanding of the general concepts. Regarding the chipmunks in spring, they said: the chipmunks get married; he likes her; or she chases him. These are all simple ways of describing the behaviors and human-equivalent concepts of chipmunk mating.

Probably the most surprising result of user testing was the way one child in particular chose to use the program. Many other children may also choose to look at the program in this way, but he was unique among the users in these test groups. This seven-year-old was

most enthralled with the sounds that the plants made. He not only listened to and enjoyed each individual piece of music, but he also put great effort into guessing the exact instrument used to make each piece. He literally held his head and stared at the screen until he could guess which instrument made each plant sound. What was even more fascinating was that a majority of the time, he guessed correctly. So involved with this guessing game, he had to be reminded that he could use all of these instruments to build a song. While this was the most unique situation that occurred during testing, one of the most significant was the statement made by the one boy, which was mentioned in the overview of this section. This statement perfectly sums up the results of these tests and speaks directly to the potential impact of the program and the uniqueness of its design -- "I never really thought of plants making music."

Chapter 6: Preparing for Next Season

As with all projects such as this, it is never done. There is always more that can be added, enhanced and developed. The Garden Symphony, with its relatively open-ended design, has many possible directions for growth. The only constraints are those set by nature and the four seasons. The varieties of music and plants that can be added to the program are virtually endless. Of course, one must be wary of fatiguing the users with an overly accessorized interface. Providing users with too many options can result in confusion and frustration. "For empowerment to occur, more powerful functionality must go hand in hand with greater ease of use" (Laurel, xii). More features do not necessarily mean a better interface. So, any decisions to enhance the program must be made only after considering the impact of those enhancements.

Indications for Future Development

In its current state, A Garden Symphony could be released to the general public, but would benefit from some relatively minor, but somewhat time consuming changes to the program. These changes are enhancements or features that the researcher wanted to develop during the production phase of this project. However, these particular changes were saved for later versions due to the time constraints of the project. Their absence does not conflict with the intended goals of this thesis project.

One of the original intended features of the program was one that would allow the user to save the songs they compose. This could be accomplished relatively easily by adding a

save feature to the toolbar at the top of the program window, which is currently unused. Users could essentially save the configuration of the program at a particular point, saving the program information that determines what plants and animals are currently on the score for each season. They would then be able to reopen this file while in the program and see and hear the song they composed earlier. This feature was requested by many of the users and always intended for implementation by the researcher.

Some suggestions were made to add random animations that would appear on the screen whenever there is a lull in on-screen activity. Two animations were designed involving the chipmunk and the chickadee, however these have not yet been incorporated into the program. A variety of random animations could be designed, even some that help the user, providing instruction on what to do next, incase the reason for their inactivity is confusion.

The voice over audio, in particular the chipmunk's audio, should be recorded again in a professional recording studio. All audio was recorded with the same voice, over a simple microphone, with a limited amount of sound effects/editing tools. Ideally, the chipmunk's voice should be spoken by a voiceover professional with experience doing different types of voices. Some teachers noted that the chipmunk's voice was sometimes difficult to understand. This is attributed to the fact that the voice was distorted with sound editing software in an effort to make it sound like a chipmunk's voice might.

The reset button currently removes all plants and animals from the score in a particular season. One click clears the entire score. The disadvantage of the button functioning in this way is that one accidental click can wipe out an entire season of a symphony and result in user frustration. To prevent this frustration, users should be provided a second chance window, meaning that when they click the button, a second window opens and asks if they are sure they want to clear the whole score. If not, they can simply click on the "no" button and return to the composition.

The latest addition to the program is a function that allows users to listen to one measure at a time. They can do so by adding items to a measure and then clicking on the smiley face on that measure. The program highlights the measure and only the music in that one measure plays. Due to time constraints, a description of this feature has not been added to the tutorial. Instructions on how to play one measure at a time should be added to the tutorial before the program is finalized for release.

For future versions of the program, other additions and revisions may need to be considered. When users were asked how they might improve the program, one of the most requested changes to the program was to add "more." They wanted more sounds, more plants and more animals. The current garden is very full. Too many more items might make the scene too cluttered. However, one way to avoid this clutter and still add more items to the garden would be to increase the size of the garden. This could be accomplished by simply adding more sections of the garden. What is currently shown of the garden is really only one section. The garden could have many sections that include

many different plants, animals and sounds. As the garden is expanded, the sections of the garden could even be ordered by plant type with all the plants of a particular type shown in the same section of the garden. This method of organizing the plants would contribute to the scientific information children can learn while composing in the garden. In addition, more scientific facts about the garden can be included throughout the program. These facts can appear as random animations or incorporated with the detailed animations that play for each plant and animal.

More scientific facts will help all users increase their knowledge about the garden while composing music there. However, as indicated by teachers in this study, the older students would benefit most from this increase in information. Around fourth grade, they begin to really focus on this type of information in their school lessons. Younger students study plants and science, but at lower academic level. The scientific content of the current design seems to be appropriate for the younger children, but not challenging enough for the older children in the study. "I do think that it would be most useful probably for the second graders, because they are doing plants. My kids absolutely loved it, but for them it was more fun," one teacher said of her fourth grade students. She also indicated that more "fast facts" about science and the garden would make it more useful for her older students.

Another difference between the younger and older students is their ability to read. The text on screen in the garden is limited, purposefully, so younger users would be able to use the program just as well as older users. Most instructions were provided with audio

and visual demonstrations. However, since this is already a very audio dense program, in some cases, text was necessary to prevent confusion with multiple audio statements playing one after the other. Also, if every item in the garden played a piece of audio as the cursor rolled over it, for example, the number of computations demanded on the program could easily create program errors. This does not mean that the differences between younger and older users should not be considered. They should be considered, but may not necessarily be accommodated in one program. As the amount of scientific information in the program is increased, how that information is presented to children at different developmental stages should be considered carefully, even within the small audience, 6 to10, chosen for this study. One option would be to design future versions of the program that are divided into levels based on the learning levels of children in first grade through fifth grade. While the original intent of this program was not to educate, but simply to encourage creative thought, further study indicated that the program could easily be transformed into a powerful educational tool. With the right information and minor additions to the program, teachers could use A Garden Symphony in many different ways to contribute to their lessons. Providing the teachers with lesson plan documents that refer to A Garden Symphony would also increase its usefulness for teachers.

The list of possibilities goes on and on. A few additional possibilities would be, one, to add an environmental impact feature. Users could change the weather in the garden, or change how animals and people treat the garden, and as these things change, so would the visual appearance and music produced by the garden. Another way to improve the

program would be to break the tutorial into short sections. This will be more important especially as more features are added to the garden and the need for additional instruction on how to use the program grows. The tutorial could have lessons on how to choose a season from the navigation bar, how to play and stop the music, how to clear or reset items on the score, and how to leave the program and save a song. A tutorial with sections, as opposed to a long string of audio, also prevents the user from having to listen to information they already know in order to get to the information they need. Also, requiring the user to visit the tutorial section as they first enter the program will help insure that they start playing with the information necessary to operate the program.

Conclusion

One of the most important lessons one can learn as a multimedia designer is that the projects are almost never finished, and that deadlines are less like finish lines than they are like milestones. Even the most successful programs always have room for improvement. As users and technology continue to change, the goal is often just to try to keep up. A Garden Symphony, as shown in this study, is a fully developed program capable of entertaining children at great lengths and in many ways. However, it also opens the door to a world of possibilities for further development. As one teacher said, "It seems like there is so much you could do with it. The integration is so great because kids are so open to thinking of plants as making a sound. Kids are like that [. . .] it's like a whole possibility of ideas." For that matter, kids are open to so many ideas and places in their imaginations where adults no longer venture. This is one of the joys of designing interfaces for children. It requires an adventure into the creative minds of children that

adults rarely get to take. In a child's mind, possibilities are endless and musical plants are believable, but kids are as smart as they are creative. They cannot be patronized or distracted into thinking that a program is better than it really is. They have a sort of x-ray vision, they can see right through the glitzy and the phony interfaces, whether they know it or not, and tell it like it is. That is why getting children's feedback early in the conception of a program designed for them is so important. These users can provide some of the most uninhibited, brutally honest responses to the design of a program; responses that will also be the most helpful and time saving feedback a designer can get. The point is to design a program that children can use and will enjoy using, and who can provide better testimony to this than the children themselves can provide. Children enjoyed composing in A Garden Symphony, their physical and verbal responses to the program proved this. They thought of music composition in ways that they had not before and testified to that fact. The program invited them to creative thought and activity, and that was demonstrated in the different ways they used the program. A Garden Symphony met the purpose and goals of this study, but it also has a world of potential that should be investigated. So many other goals can be accomplished with further development of this program, even on the smallest scale. If nothing else, others can learn by the examples set forth in this study and take a piece of it with them to the design of their next piece of children's software.

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