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Computer Graphics Design

Memory Box, An Interactive Teaching Application for Young Students with Attention Deficit Hyperactivity Disorder

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Abstract

This thesis presents an outline and fundamental design for the development of an interactive teaching application for young students with Attention Deficit Hyperactivity Disorder or (ADHD). The project proposes a visual teaching aid used by sixth to ninth grade middle school students with Attention Deficit Hyperactivity Disorders. The author argues that the combination of various modern instructional methods, focusing on user experience and interactivity, can improve the learning experience for students with ADHD. He also argues that students can achieve higher marks and improve their overall educational experiences by adding visual and interactive elements to the written educational material. The major areas of research include: user experience, innovations in interactive technologies, and assistive teaching, with a goal of improving the way students learn by using present technologies. The information gathered from various resources on the topic will also be used to outline and structure the final product. In addition, the final product will include a written outline of the interactive teaching application and a physical functional interface. In conclusion to the research, the author further states a need for the proposed visual, interactive teaching application in traditional classrooms.

Key Words: Attention Deficit Hyperactivity Disorder, literacy, disability, assistive technology, interaction, user experience, usability, virtual experience, special education, teaching, child development.

Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurological syndrome which is thought to be genetically transmitted by the parents. According to the "Diagnostics and Statistical Manual of Medical Disorders" ADHD is believed to affect 3%-7% of school age children in the United States. The book describes two types of the disorder Attention Deficit Hyperactivity Disorder, a prominently inattentive type, and Attention Deficit Hyperactivity Disorder, a more hyperactive and impulsive type. A third type is a combination of the two . The inattentive type is characterized by forgetfullness and disorganization, where the hyperactive, impulsive type has more over-active and impassive behaviors. My program focuses on the inattentive type of the disorder. ADHD is usually discovered during childhood or adolescence. The described symptoms usually affect the child's social skill, academic performance, and disturbs his daily activities. The first documented circumstance of the syndrome was in 1902 by the British pediatrician George Still, who described a situation where children had difficulty concentrating and became impulsive and hyperactive.

Today, an increasing social awareness of the syndrome makes it more acceptable for a child to be diagnosed ADHD and may account for an increase in the number of children who are diagnosed as having the syndrome. This increase has also triggered a debate in today's media as to whether or not the generalized symptoms of ADHD can be attributed to common childhood behavior or an actual disorder. Adding to this hot issue is the subject of medicinal treatment and using neurostimulants, such as Ritalin.

Neurostimulant drugs, which are meant to treat ADHD, are considered by the Drug Enforcement Agency to be Schedule II drugs, defined as prescribed medication with high potential for abuse. A small number of parents consider the side effects to be highly invasive, therefore behavioral therapy can be see as an alternative or supplementary method to medicinal therapy. Behavioral therapy works by training the teacher and parent to facilitate improvement in the child's behavior, and as a result change his attitude towards learning.

The book, "All About A.D.H.D: Understanding Attention Deficet Disorder," by Mark Selikowtz recommends that since the majority of difficulty for students emerges in the classroom, support for these students needs to precipitate from the teacher. Selikowtz suggests that learnings activities should provide the student with a new learning experience, and work should be carried out both in the classroom and at home. Because students with ADHD have poor learning skills, other methods of conveying information should be explored. Between the three most common learning styles: auditory, visual, and kinetic, I chose to focus on the visual learning style as the method of helping students with ADHD. My research has shown that many students with ADHD might be visual learners rather than auditory learners.

This thesis explores a new way of supporting behavioral therapy. It proposes an application that will act as a tool for the teacher in the classroom and facilitates children with ADHD. The application will also act as a tool which the student can take home and help sustain the learning structure he practiced with his teacher. Most importantly I wanted to create a tool as an alternative to traditional auditory teaching techniques currently used in the classroom. Although the application can be used to benefit both types of ADHD, I developed the application for the inattentive type in particular.

Research

Introduction

Vision is our most basic connection to the outside world, because of this it's easy to understand why we might take it for granted. A greater mistake is to assume that vision occurs exclusively in the eyes. More sophisticated than a camera lens, the eyes assess an image by way of light beams, information which is redirected to the brain where the majority of the process begins. My introduction to the subject of vision and visual intelligence began with the book "Vision and Art: the Biology of Seeing," by Margaret Livingstone and Harry N. Abrams, a book I read even before I chose to pursue this theme in my thesis.
The book explores what we currently know concerning the functions and physical aspects of seeing. The primary function of the eyes is the visual collection of colors, light, and movement. The book was an interesting start to understanding why we see things the way we do, but it is not necessarily information that relates to my thesis subject. Subsequently, I came to two conclusions, First, the eye does not function as camera where images are processed and sent to the brain. Second, despite the physical images we see, our view of the world is relative; not by choice, but according to function of our brain. Essentially, our brains create what we see. Rudolf Arnheim's book,"Visual Thinking," was my fist step researching the mind's process of visual perception. Arnheim, a ground-breaking writer, expanded the field of visual cognition. Visual cognition had traditionally been defined by psychologists as the processing, storing, and receiving of information.Arnheim broadened the term to include perception.

Research

Visual thinking

Arnheim believed in the importance of visual intelligence, or the process of breaking information into pieces and reconstructing a perspective in the brain. He defined and described methods of brain function by arguing that what we see is not necessarily a visual equivalent of the physical world, but the brain's representation of visual input from the eyes

(Arnheim, 14). Arnheim wrote, "This image turns out not to be the physical equivalent of what perception contributes to cognition. The mental image of the outside world is known to differ importantly from retinal projection. Therefore, it seems natural enough to attribute these differences to manipulations taking place after the sense of vision has done its work". Similar to the writing of the Gestalt movement, Arnheim understood that seeing is a process of deconstructing and reconstructing information, a process by which an image might reach the brain in recognizable parts. In accordance to their similarity and relative position to one another, these parts make a recognizable pattern. They begin with shapes, then objects, and finally result in an understandable, whole image. This image becomes our perception of the world, allowing us to form concepts and a network of related information; basically "our thoughts influence what we see and vice-versa" (Arnheim, 15). Arnheim also believed that the perception of shape differs between people, stating "there is considerable evidence to indicate that graspability of shapes and colors varies, depending on the species, the cultural the group the amount of training of the observer. What is rational for one group will be irrational for another" (Arnheim, 31).

Differences in perception and recognition of information might also account for some symptoms of several learning disabilities. I remembered Arnheim's writing and had the previously stated theories in mind when I chose my thesis topic. I also hypothesized that a student's problem with Attention Deficit Hyperactivity Disorder (ADHD) may be due to a disparity with his or her visual intelligence. If a student has difficulty in processing visual information designed for the 'average' student, perhaps a different or personalized visual design would provoke greater comprehension. With this problem in mind, I sought to help students with ADHD, specifically those who have trouble with traditional learning instruments, such as text books. My solution was to create a computer-based application by applying skills gained through the Rochester Institute of Technology's Computer Graphics Design Masters of fine arts program. The application acts as a visual representation of a text book and will cater to the needs of a student with ADHD. Further research was necessary to initiate the development of such an application.

Research

Dipping in theories of visual perception

Arnheim's writing inspired part of my work, so I began researching the function of the visual part of the mind. Many theories attempt to explain the process of visual perception, from the early Gestalt movement of the 1800's to present day computational theories. Because I believe the theories of the Gestalt Movement are the key to visual theories, I choose to focus on them first.

As previously mentioned, the earliest unified attempt to understand the process of visual perception began with the Gestalt Movement. Rather than devoting too much time to surveying the ground-breaking theories of this movement, I focused on current publications that examined the principles of Gestalt's theories. It's important to note that members of the Gestalt Movement valued principles such as grouping, similarity and simplicity, and psychological principles of perception used by designers and artists today. Gestalt theorists were also the first to question why we see objects in such a way when an infinite number of other choices are available.

I began this part of my research with the book, "Theories of Visual Perception," by Ian E. Gordon. The book researches the history of visual perception and examines various theories moving from Gestalt theories to modern day research. As the mechanics of visual perception were uncovered, it became clear that the mind has a predetermined internal order for both organizing and masking certain visual data in order to retain information in accordance to its importance. For example, the case of figure-ground relationship reveals the ability to see and isolate human forms from abstract silhouettes. "So powerful is the tendency to organize vision into figure and ground that we take it very much for granted... the magnitude of that figure-ground achievement becomes apparent to those attempting to make machines that can perceive. How could a computer be programmed to ignore everything but people in a complex scene?" (Gordon, 16).

Another term, functionalism, relates to the work of Egon Bruswik, a source in Gordon's book. He acknowledged that we perceive objects and our environment through visual cues. All objects in our environment convey cues which act as triggers. influencing our recognition of them. Since objects are complex, they may convey more than a single cue. Functionalism sought to explain how the mind quickly interprets and perceives the environment using multiple cues. More importantly in situations with multiple cues available, we have a natural ability to distinguish between those cues that are valuable or invaluable. Bruswik describes this phenomenon as a product of evolution, necessary for human survival.

Perception might also be influenced by knowledge. Richard L. Gregory, a professor at the University of Bristol in England, is another source in Gordon's book. He describes the process of human perception as "signals received by sensory receptors [that] trigger neural events. Appropriate knowledge interacts with these inputs to create psychological data" (Gordon, 128). What Gregory describes is a process where we create an image of the world using collected information and what we already know. Psycholigists use this data to make predictions of the world around us. In relation to this theory, an experimental psychologist, J.J. Gibson argues that visual sensors provide us with incomplete images, but we are able to

complete these images using individual perception. Our perception must consist of some type of modular procedure that allows us to complete these images. Gibson also suggests that to understand the mechanical nature of a organism's perception, there must be an examination of the organism's development and the environment in which its visual instruments developed.

We don't usually perceive still images; we move our heads and our eyes to examine our environment. This constant movement then allows us to gather more cues from other objects and allows us to see relationships among other objects. Through movement we become more aware of an object and its properties. Movement also reveals change and by using elements in the environment as a point of reference, such as the horizon line, comparing our object to the change reveals more information about our surroundings.

Similar to Gibson's description, a three-dimensional object can act as such a reference point, allowing the student to view changes in visual information and relate the pieces of information together. I also wanted to make use of visual cues to strengthen the users' connections to subject matter by incorporating a function that would subtract or add to an object's detail or visual cues based on the user's own preferences. In this way, Gibson's theories are relevant to the design of my application. To accurately convey the information to the students in an appropriate visual manner I included visual cues to the position and relevance of the topic. This is why I chose a three-dimensional object for my project.

Considering the evidence I have presented thus far, my application will be most effective built on a strong visual foundation. Therefore, my first priority was to reconstruct information in a visual manner while maintaining the same content as a text book. Because the application is representative of text book information, and due to time and work limitations, I decided to shorten the content to a single chapter.

The process of delivering information should be different when compared to traditional methods. In a text book, information is delivered in a linear manner. The reader must read the information line by line and the content is restricted to the subject title. In contrast, my application gives the learner control of his learning method. In this case the learning process will not be linear but multi-dimensional, where many pieces of information are connected through their relationships to an image representing the main topic. This will enable the user to navigate freely through the information.

I chose to use a three-dimensional object as a visual representation of the main topic because a multi-dimensional object represents many pieces of information while also acting as reference point that connects topics together. A three-dimensional object provides the user

with many visual cues, allowing the viewer to see how parts function and how they work in relation to each other. Movement, as it relates to change, will provide the user with more information rather than a still, two-dimensional object like images found in text books.

Research

Visual intelligence

We create what we see, meaning that we create everything we see and feel around us (Hoffman, 6). This idea by David D. Hoffman forms the basis for his book, "Visual Intelligence: How We create What We See". This concept led me to the next stage of my research, visual intelligence. Since I chose to focus on the psychological aspect of perception and how we process visual information, I began learning about visual language. In this instance, visual information refers to the visual indicators our mind processes and turns into a three-dimensional environment, complete with relatable objects or concepts. The term 'visual intelligence' refers to our built-in knowledge of how to interpret shapes, depth, colors, movement, edges, angles and other elements. Visual intelligence is the product of millions of years of human evolution; without it, our perception of the world would be limited, or at least very different.

Many years of collective research by psychologists and neuroscientists brought researchers to the conclusion that the human brain follows a set of rules concerning the interpretation of shapes and other visual impressions. Rules can cause us to "interpret gradual changes of hue, saturation, and brightness in an image as changes in illumination" (Hoffman, 115), or perform more complex processes like "the salience of a cusp boundary increases with increasing sharpness of the angle at the cusp" (Hoffman, 99). These are examples of rules that enable us to see the world in a similar manner and by which almost all normally developed humans adhere. Most of us are able to distinguish objects from the environment, see if an object has depth, and if it is in motion or remaining still. I anticipated that studying these rules could lead to a better understanding of the complexity of human perception. For instance, science shows how children often respond positively to bright colors, uncomplicated forms, less texture, and flat colors. I chose to target a young audience and focus on the rules that apply to that specific audience. My design will follow these guidelines by implementing bright colors over neutral backgrounds and rounded edge shapes that can be more easily isolated from their environment.

Research

Learning and development

From this knowledge of visual perception the question is raised as to how greatly visual intelligence varies between each individual. For instance some research has shown that children with ADHD are more likely to be right brain, visual learners, where as visual stimuli such as that found in video games hold their attention. My research based on the book "Driven To Distraction : Recognizing and Coping with Attention Deficit Disorder from Childhood Through Adulthood" by Edward M. Hallowell and John J. Ratey. states that in such situations where visual stimulus is applied to engage the student's attention the student will be able to learn and retain information, otherwise if the information is dull he might be mentally incapable of maintaining his focus. "Because children with ADD notice and usually attend to novel stimuli a key to educating these kids is to 'dress up' educational lessons and tools with color, animation, and diversity, while limiting all extraneous stimuli in the frontal areas, ADD very well could be described as a problem with inhibitory capacity"(Hallowell, 281).

Following my decision to construct a visual teaching application for students with learning disabilities, I decided to learn more about a child's development and learning process. I enrolled in a class called "Childhood & Adolescence", instructed by professor Robert Bowen. I also involved the help of Nancy Caruso, an emotional disabilities specialist, and at the time a teacher at the Cesar Chavez Public Charter School in Washington, DC. By taking this course i hope to obtain greater insight on how my target audience thinks; instead, I learned a great deal about the importance of proividing these young students with support and a proper education that fits their needs. Students in different developmental stages of their lives require different methods of education. This may include support in terms of a comfortable working environment, letting a student exert some control over his or her working environment, or even allowing the student to acknowledge and work around his or her limitations. The instructions from this course drove me to choose middle school children as my target audience since they have well-developed memory spans and are begining to refine their cognitive skills. At this age children also begin to make better use of mnemonic stratagies to improve memory.

These strategies include rehearsal, or "repeating information over and over"(Gabue B. DeHart, 395), "organization; arranging information to be recalled into meaningful categories"(Gabue B. DeHart, 395), and "elaboration; creating a meaningful connection between items to be remembered either verbally or visually" (Gabue B. DeHart, 395). Ultimately, the goal of studying and memorizing is to retain the information in the long term memory, which has large storing capabilities. For students with ADHD the problem occurs transferring the information from short term memory, where information can only

be stored for short periods of time, to long term memory. Memory skills are always used when attempting this transfer; therefore, a student has a better chance of memorizing the information if it is readily available to him or her for rehearsal. Also, the information is cast into categories, which have a meaningful and memorable connection between them. I attempted to design my application with these concepts in mind. The information must be easily available to the user so he does not need to search for it. A connection between the subject on the screen to the main topic should always be viable, along with a link to additional information.

Many children with ADHD find it difficult to concentrate in a traditional school environment. These students often daydream or cannot focus during a lecture. Some students have trouble when asked to memorize information from text books or notebooks. These problems may lead to frustration, anger, and loss of confidence in the classroom. A student who is not properly diagnosed and not taught in a way conducive to his or her condition may become hostile and antisocial. Today, awareness of ADHD and other similar conditions has found support in the public and the school systems. Since the appearance of the psychostimulant drug Ritalin, doctors and parents find it easier to treat children using prescription drugs. In many cases the drug is effective, allows the child to concentrate in school, and function as the rest of his or her fellow students. As anticipated, some groups disapprove of treating children with prescription drugs.

Other methods of treatment are available and allow a child with ADHD to effectively follow the same subjects taught to his or her fellow students. In recent years, many more alternative teaching techniques have been developed based on the Learning Styles Model. auditory, kinetic, and visual are the three most common learning styles. Auditory learners remember information they hear from lectures and class discussions. Kinetic learners learn through action, motion, and physical practice. Visual learners learn from images, graphs, illustrations, and other visual presentations. ADHD tends to be more commonly associated with visual learning. It is also a common belief that individuals with ADHD have a tendency to be right brain thinkers. In short, learners with ADHD may react more positively to visual stimuli in the classroom rather than auditory or written information. Although there is no conclusive evidence determining whether or not individuals with ADHD have a higher chance of being visual learners or right brain thinkers, many classroom programs that implement these theories seem to work. Supporting evidence can be gathered from books such as "Right-Brained Children in a Left-Brained World: Unlocking the Potential of Your ADD Child" or "The Edison Trait: Saving the Spirit of Your Nonconforming Child," and from certified alternative teaching instructors who successfully teach students with various learning disabilities through art, role play, and visual presentation.

These theories do not suggest that individuals who are not auditory learners have a mental deficiency, but rather for some reason their mind is more capable when processing information visually. When a student with ADHD receives the opportunity to learn in a style that fits his or her needs, he or she may reveal concealed potential and excel in school. Visual learners think through images; they see information in a visual-spatial manner and then construct images in their minds. In some cases, visual learners may excel in design, engineering, and art. However, it is also important to state that there are many forms of ADHD; each students is still a unique individual, therefore conditions and results may very with each case.

Upon the conclusion of my initial research I approached Nancy Caruso, an emotional disabilities specialist to better understand children with ADHD int the class room. Our conversations helped initiate a series of ideas I would later use in my design. At that time, I began a search for other programs that attempt to teach students with various kinds of learning disabilities. The research I conducted over the internet led me to several companies; of those only a few stood out. One exceptional program, an online application found at ***http://www.Lexialearning.com***, makes use of visuals and text to teach reading to young students with different levels of ability. The program reinforces a word's meaning by using illustrations and teaches correct spelling through visual games. Another company called S.M.A.R.T Brain Games offers 'neurofeedback' technologies that accompany visual interactive software or video games on Xbox and PlayStation game consoles. The neurofeedback technology is made possible through neural sensors attached to special helmet that test the user's concentration and challenges him or her accordingly. Although these educational programs are visually-based and offer interaction similar to my own program, they do not rely on a three-dimensional objects and do not attempt to act as a substitute for an existing educational instrument.

Development process

User interface - introduction

My design is a culmination of two concepts: playfulness and intuitiveness. The application had to be tailored to the needs of its young student audience. To achieve the goal of retaining their focus and participation, the program must be attractive to their senses, therfore I wanted a clean, easy to use interface design.The second concept, intuitiveness, was of equal value, since a key goal of my program was for it to be equal to, or replace, a textbook as an educational tool. My design had to be as simple to use as a textbook and just as intuitive.

The style was inspired by several books I collected, including "**The Elements of User Experience,"** by Jesse James Garrett, which I used as a guide to web interface design. The process Garrett describes can also be used to design computer applications. The book

provides strategies to fulfill the user's needs while minimizing the number of actions in any task. I also employed strategies regarding structure development, user segmentation, usability, and user research in the development stage of the application's design. A second book, "**WebDesign: Flashfolios**" by Julius Wiedemann, was a great source of visual inspiration. The book displays a collection of eye-catching website interfaces. Both web and application designs need to accommodate a large network of information while holding the users visual interest. My intention was to find a design which could offer a youthful look and communicate information in the most elementary way.

Development process

User interface-Outline

The architecture of the program was one of the most critical components of my visual interpretation research. Once the target user group was defined, a system was built to meet its needs, while maintaining a focus on usability. In an effort to make the application more intuitive, the functionality was inspired by elements found in textbooks and websites. A composition was drafted in an attempt to follow three core concepts. First, segmentation was designed similarly to a website, The information is divided into manageable segments that are easily accessible through a menu/content index. Second, I used the design metaphor of a notebook in my interface design. I allowed the user to bookmark content and location, save information, and take his or her own notes. Other customizable functionality, such as the option to change background colors, timer, and sound, may also increase the user's sense of comfort with the application. The third concept, interaction, is designed to keep user interest and make learning more enticing. Interactive functions such as sound, visual effects, and navigational functionality may augment the content.

Segmentation was achieved by dividing the information into segments, assigning each segment a tag or title, and arranging the tags into an easily accessible menu. The menu and tags will provide the user with access to the information panel, which holds the selected subjects content. To strengthen the concept of segmentation, each tag or similar tags were assigned a specific color, which appears in the form of a thin horizontal bar under the subject name.

Customization was enclosed in the form of a series of functional buttons. found in the control panel. These buttons include: zoom in and out for the three-dimensional model, buttons that change background or add tags, and finally a model-style toggle button. The control panel gives the user control and encourages playfulness and experimentation. Another series of buttons permit the user to toggle the sound, stop the timer, and take a break from study.

Interactivity was primarily applied to the three-dimensional model in the form of motion control and direct selection. The three-dimensional object represents the most important focal feature of the application so it must be easily accessible, simple to explore, and capable of being used as a point of reference. In addition, the model is a visual representation of the information in the tag menu. With the application of interaction, the user will have the ability to access the same subjects as the in the tag menu by clicking parts of the model. For example, if the user clicks the region of the model that represents the left ventricle, the information panel opens and displays the content which relates to that area. This also occurs when the user chooses the left ventricle subject tag from the tag menu. The user also has control over the three-dimensional model through the motion control panel. These controls allow the user to pause and play the model's rotation, or even run the rotation in reverse.
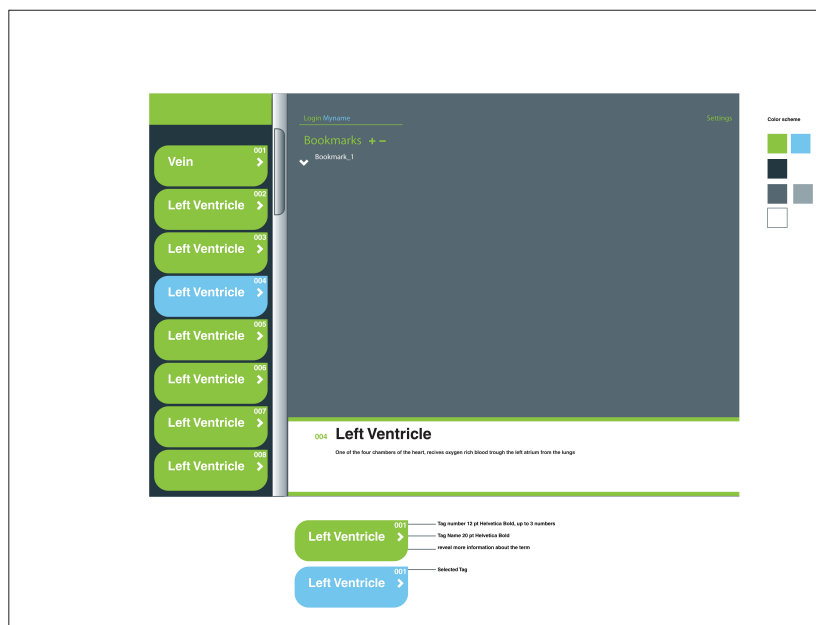
Initial style sheet used to plan the functionality and look of the design.

The visual style was a combination of website-inspired design and the practicality of traditional traditional science textbooks. The goal of the style sheets was to reflect practical information and visual clarity for a sharp, youthful look. With the exception of the three-dimensional object, I restrained from applying visual depth to any elements in the interface. A limited color palette was used in the design. It included a moderate use of bright green and blue fields set apart by neutral gray color variants. The text was set in larger-than-average point size and a simple layout was chosen to increase legibility. The screen size was set to 1200x750 to allow enough room for the three-dimensional model to move in the center of the screen while still maintaining the functionality of the side panels.
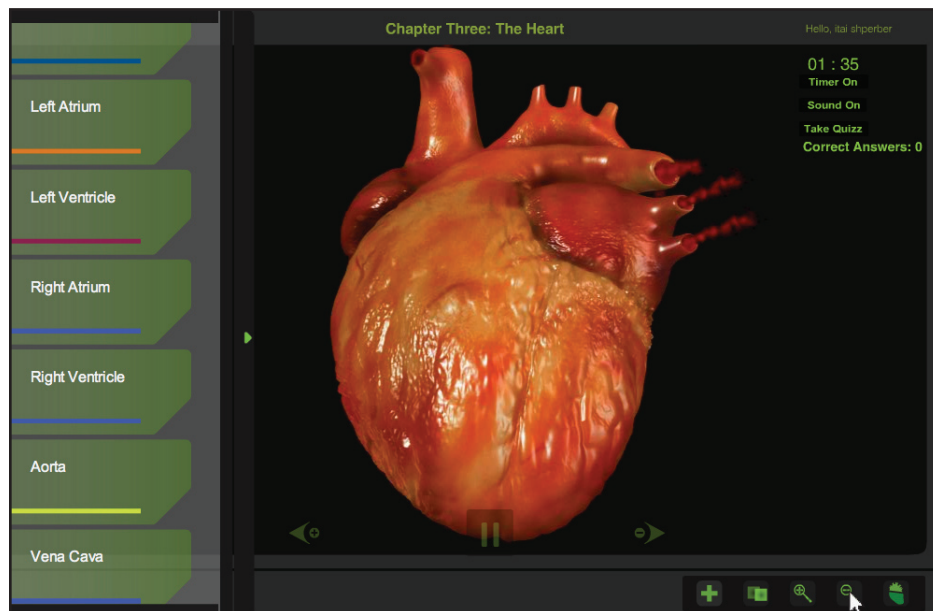
Completed interface design with a rotating view of a human heart model.

Development process

Content

After careful consideration I chose the human heart as the subject of my application. The process of applying the information was organized into three steps. First, the application needed to match or replace the textbook in a middle school classroom. I first looked for an 8th grade Anatomy textbook. After several failed attempts to contact local schools for a list of textbooks, I decided to research them online. My search focused on the average American middle school lesson plan for 8th grade anatomy. I narrowed the results through a web-based popularity rating system. From there I choose the book "Essentials of Human Anatomy & Physiology" by Elaine N. Marieb. I used this textbook to steer my content in the proper educational direction.

Once I chose the reference material, I compiled a list of subjects from the book and summarized the information into three to five lines of content for each subject. I also began researching the heart's function and its relationship between different subjects. Dr. Louis Wasserman M.D, a cardiologist at Onondaga Hill Cardiovascular, provided me with resources such as periodicals, books, and online tutorials. Using these tools, I drew a flowchart of the heart's function and began to create and texturize a three-dimensional model.

Development process

The Model

Creating the heart model was one of the most difficult parts of the project. As I familiarized myself with the complexity of the heart, I realized I needed additional visual references. Once again, Dr. Wasserman provided medical websites featuring images and videos of the heart's internal and external functions. The most valuable source of human heart related imagery was the website 'Atlas of Human Cardiac Anatomy' by Paul A. Laizzo PhD, at *http://www.vhlab.umn.edu/atlas/index.shtml.* I began the project with two-dimensional drawings that depicted three separate views of the human heart. These drawings were scanned and used to create the outer shell of the heart. From there, the modeling was created in a one month period using Autodesk Maya, 3d modeling software. I decided the model's visual style should be a combination of realism and abstraction. The idea was to encourage students to use the program and play with the model, while teaching them to recognize the various parts of the heart. I began with a simple version of the model that matched photos of the heart and then formed the model to exagerate each principal area. Once the outer shell of the model was complete it guided the formation of the internal heart chamber structures. The model's initial texturing was created in Maya using procedural texturing, which produced unsatisfactory results. The texture was austere and lacked the required semi-realistic surface. As a result, the procedural texturing process was abandoned and replaced with image based texturing using the Mud Box application. I found that with the new textures and displacement maps from Mud Box, the model looked far more appealing.
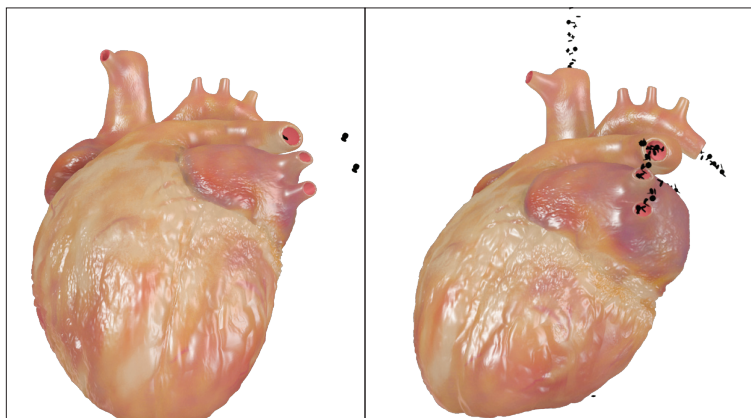
Two frames from a 360 degree render of the human heart model completed using mud box and maya.

Animation was the final step in model completion. Animation techniques such as clusters and lattices created a moving heart with internal functions. A stream of blood coming in and out of the heart was produced using a particle system with the intention of increasing visual interest. The heart was rendered in a 360 degree perspective on 220 frames. Four additional

renderings also capture the internal function of each heart chamber. The rotation sequence was imported into Adobe Flash as an image sequence and composed into a movie clip. Finally, the remaining image sequences were designed to load into the application dynamically, so I used Adobe After Effects to render them as Flash Videos (FLVs).

Development process

Script

My application was created in Flash using Action Script 3.0 and Adobe AIR. The script was created using external classes which communicate with each other and give the application its flexibility. The class deduction flowchart shows the connection between each of the classes and the process of communication between them. The dynamic classes are ranked in such a way so they could individually influence other class functions and make changes to other class variables. The application was created as a dynamic interface with most of its content imported from external sources.

A necessary part of the application's function was to allow the user to add notes in the form of new tags in the tag menu. At the time, the application was created for Flash Player version 9. However, the only possible way to allow a published SWF file to contact and change files on the user's local system was to publish it in the form of an AIR file. By using the Adobe Integrated Runtime environment, I made changes to the xml files and added additional content. Therefore, when the files are reopened, the additional information will show with the standard content. The Adobe AIR environment had additional benefit. For example, Adobe AIR automatically contains the files in a package during publication and creates a certificate; the package contains every necessary file for the project without having to reveal the directory to the user. The certificate also provides the user with the assurance that the program does not contain any harmful files.

Testing/ Study group

The last step for this project was testing the final product. The product was tested in three different stages. First by teacher Nancy Caruso, who worked with me throughout the developmental part of this project. Caruso was asked to use the program and fill out a short questionnaire. Caruso was instructed to circle her response for the following seven questions as accurately as possible in a rating from 1-5, 1 being Highly Disagree to 5 being highly agree. The following questions were asked:

1. How would you compare the Memory Box application as means of conveying information to a text book used in your school?

2. In terms of usability, can the Memory Box application can be compared to a text book.

3. The Memory Box application conveys the information in a concise and clear manner.

4. I find the application to be of height usability rating.

5. The visual style will encourage the students perception in the application.

6. The visual environment is not too complex for the participating students grade level.

7. The available options such as back ground sound and zooming in and out may encourage the student to use the application.

8. Do you have any suggestions to improve the application?

9. Would you allow other applications such as Memory Box to be regularly used in your classroom?

Nancy returned the following answers:

1. (4)

2. (5)

3. (5)

4. (4)

5. (5+)-Though they haven't seen it yet, I bet they will drool.

6. (3-4)

7. (5)-The graphics are phenomenal, I even learned something
new.

8. Suggestions for improvement: A tutorial with how to navigate the different
parts and web pages would be beneficial and more user friendly. Also it   may be my
computer, but the program is running really slow.

9. Would I allow other applications to be used: ABSOLUTELY the enrichment
of information this has brought/will bring to our school is unsurpassed. The
graphics motivate kids and make learning fun. It creates a successful learning
situation for student who generally become frustrated with tasks that are too complex
for them to master.

In response to question number eight, I reduced the file size of all loaded FLVs in the program
and cleaned the Flash library of all unnecessary elements. Caruso's review was an important
first step to refining the application and fitting it for use in the classroom.

The second stage of testing included four students from Caruso's class who fit the target
audience. The students were asked to take a short pre-quiz to test their knowledge on
the human heart system. Then they used the Memory Box application for 20 minutes. As
a measure of the students progress following the use of the application, the students were
asked to take a post-quiz, which included the same questions as in the first quiz. The answers
from both quizzes were compared. All four students showed a small improvement in scores
by a range of 1-2 correct answers on the second attempt.

The final stage of testing occurred during the thesis show after the projects presentation. The
application was installed on a single computer station along with review sheets. Members of
the audience were asked to test the application and answer the questions on the sheets. Four
reviews sheets were returned with positive responses.

Conclusion

At the beginning of this thesis my goal was to create an application that would act as a tool for
teachers in the classroom and facilitate children with ADHD. I also wanted to implement an
alternative to traditional auditory teaching techniques currently used in the classroom.

Since I have no experience in the fields of psychology or childhood education, this project
required a substantial amount of research prior to the design and developmental stages. I

needed to answer a number of questions in respect to teaching techniques, visual thinking, and the nature of ADHD. I believe the research and support of professionals such as Nancy Caruso and my advisor, Susan Ackerman, answered these questions.

Though the sample size of the test group was small the response of both students and teachers in the initial research indicated that my project seems to have had a positive impact on the learning environment for ADHD students.The positive responses from both teachers and students indicate that such a tool would be welcomed in the class room and could be used in conjunction with, or as a replacement, to conventional leaning materials.

If I would have to start this thesis over I would have done some parts differently. I devoted a great deal of time to learning and testing new applications which were never used. Much of this time could have been saved with better planing and decision making. There is also much room for improvement, due to time constraints. Only a minimal amount of textbook material was used in the application. Under different circumstances, more chapters could be included and a greater extent of interactive functionality could be applied.

In conclusion, I feel this thesis has meet its goal. It was important for me to illustrate the importance of alternative learning techniques and the application of modern technology to promote these methods. I would like to see these methods implemented in the near future as a working model so students with ADHD have more support in classroom and learning settings.

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APPENDIX A

Interface elements
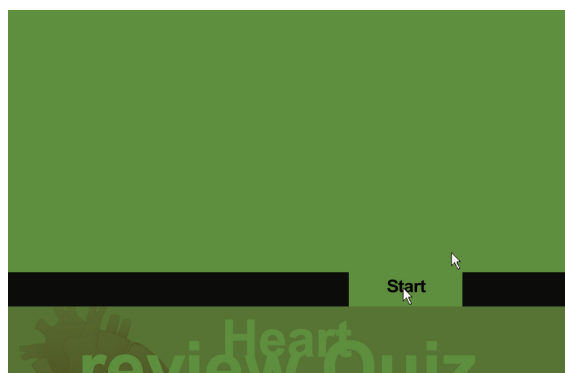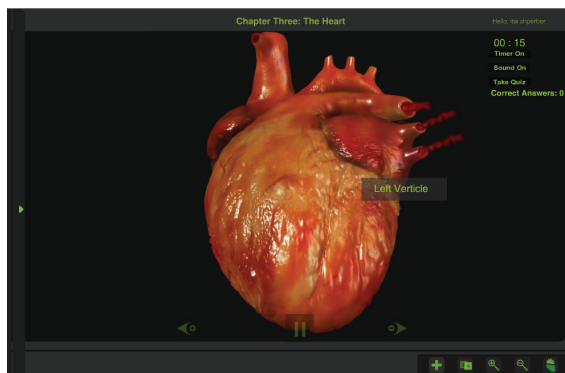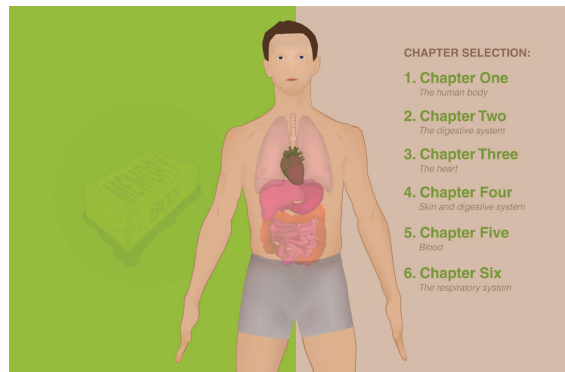
APPENDIX B

testing forms

Project Title: "Memory Box"

Investigator: Itai Shperber

Dear Student,

I am conducting a research study meant to test an application named "Memory Box". "Memory Box" is a computer application that uses 3D models and Interactivity to present the same information you see in your text books. I would like to test if the "Memory Box" application can help student such as yourself in the classroom and learn more about your experience with the application.

I would like to invite you to participate in the testing of the "Memory Box" application. Your parent knows we are going to ask you to participate in this project. It would take approximately 40 minutes to complete the task. you will be asked to servery the application for 20 minutes and take a short 10 minute quiz. The results of this study and quizz will not harm you effect your grades in any way. If you have any questions or hesitations regarding the study please feel free to ask your parents or the researcher before signing this form.

When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.

participation in the study is voluntary. you do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too.

If you decide you want to be in this study, please sign your name.

I, _____, want to be in this research study.

_____   _____
          (Sign your name here)   (Date)

Project Title: "Memory Box"

Investigator: Itai Shperber

Dear Parent,

I am a graduate student under the direction of Professor Shaun Foster at in the Department of Computer Graphics Design at The Rochester Institute of Technology, I am conducting a research study that is meant to test a visual learning application named "Memory Box". We would like to test the effectiveness of the "Memory Box" application with students such as your son/daughter and learn about the student's experience with the "Memory Box" application. The application seeks to convey the same information you might find in textbooks thorough visual means using user interaction and 3D Models .

I would like to invite your child to participate in the testing of the "Memory Box" application. Which will involve the students use of the application for about 20 minutes and an additional 10 minute quiz. Your child's participation in this study is voluntary. If you choose not to have your child participate or to withdraw your child from the study at any time, there will be no penalty (it will not affect your child's grade, treatment/care, etc).

Although there may be no direct benefit to your child, your child participation may help us improve the functionality of visual learning applications such as the "Memory Box".

When we are finished with this study we will write a report about what was learned. This report will not include your child's name or that you were in the study.

If you decide you want to be in this study, please sign your name.

I, _____, want to be in this research study.

_____   _____
         (Sign your name here)   (Date)

Cardiovascular System Quiz

Student ID _____

1. the heart is divided into four chambers the right and left Atrium and right and left...?

   a. Superior
   b. Centrium
   c. Ventricle
   d. Monterior

2. How many chambers are in the human heart?

   a. 2.
   b. 4.
   c. 5.
   d. 7.

3. Blood exits the left ventricle in which one of the following blood vessels?:

   a. Coronary Artery.
   b. Pulmonary Trunk
   c. The Aorta.
   d. Pulmonary Vein

4. Blood vessels carrying blood away from the heart are called:

   c. Capillaries.
   a. Arteries.
   b. Coronaries.
   d. Veins.

5. Blood flows from the right ventricle into the.

   c. Pulmonary Trunk.
   a. Right Atrium.
   b. Superior Vena Cava.
   d. Pulmonary Veins.

6. Oxygen rich blood from the lungs enters the heart through the _____ and then pumped out the _____ .

   a. right atrium; aorta.
   b. right ventricle; pulmonary arteries.
   c. left atrium; aorta.
   d. left ventricle; pulmonary vains.

7. Blood flows from the vena cava into the _____ .

   a. left atrium.
   b. right atrium.
   c. left ventricle.
   d. pulmonary veins.

8. What "tube like" tissue carries blood back to the heart?

   a. Arteries.
   b. Pipes.
   c. Veins.
   d. Oracles.

APPENDIX C

Review Of Literature

Visual Thinking : A Review Article.
Arnheim, Rudolf.

Visual thinking is a golden standard to the subject of art and psychology or the minds visual process. This book is an essential foundation material for those who research the process of visual language and visual learning.

The Elements of User Experience : User-Centered Design for the Web.
Garrett, Jesse James.

A book detailing the fundamental of creating a Graphical User interface and enhancing User Experience. This book is one of the most definitive guides in the field of GUI design. I will use this information to develop the applications GUI and plan solutions to fit the special needs of my target audience.

Greenhill, Laurence L., and Betty B. Osman. Ritalin : Theory and Practice. 2nd ed. Larchmont, NY: M.A. Liebert Publishers, 2000. Print.

Ritalin : Theory and Practice.
Greenhill, Laurence L., and Betty B. Osman.

''Ritalin: Theory and Practice'' is a reference for parents and health care providers on the subject of Ritalin, Its abuse, side effects and the results of studies. The book is a true guide for the proper use of Ritalin and uncovers some of the misunderstandings of medicinal treatment for children with Attention Deficit disorders.

Visual Intelligence : How We Create What We See.
Hoffman, Donald D.

The author of this book explores the science behind the cognitive part of the human visual system and how we construct what we see. The book contains details on the rules governing the human visual system, namely why we see things in a certain way. Since my target audience, consists of students with students with A.D.H.D who have a tendency to perceive information visually, I can use the information in this book to design a visual environment tailored to these type of students.

A.D.H.D : A Complete and Authoritative Guide.
Reiff, Michael I., Sherill Tippins, and American Academy of Pediatrics.

A.D.H.D: a complete and authoritative guide, is a guide by the American Academy of Pediatrics that intends to correct a number of misconceptions on the issue of A.D.H.D. The book is a step by step guide for parents and teachers, and a useful resource of information on syndrome and its treatment.

All About A.D.D. : Understanding Attention Deficit Disorder.
Melbourne, Selikowitz, Mark.

All about A.D.D : understanding Attention Deficit Hyperactivity Disorder, discusses what is Attention Deficit Hyperactivity Disorder and proper ways of treating the disorder through therapy and alternative education. This is an excellent resources for those who want to learn more about progressive education techniques.