BLIND STUDENTS STUDY COGNITION VIA SOUND USING AUDIO BATTLESHIP

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ABSTRACT

Recent research suggests that sound may be utilized to help blind youngsters improve their cognitive abilities. The concept, development, and usability testing of Audio BattleShip, a sound-based interactive environment for blind children, are presented in this article. Audio BattleShip is an interactive version of the classic board game Battleship, with distinct interfaces for both sighted and blind players. As a means of navigating and exploring the world, the interface relies on spatialized sound. The program was built on a framework that enables the creation of distributed heterogeneous applications by synchronizing just some common elements, allowing for the rapid creation of interactive applications with a wide range of interfaces. The game can help develop and rehearse abstract memory through spatial reference, spatial abstraction through concrete representations, haptic perception through constructing mental images of the virtual space, and cognitive integration of both spatial and haptic references, according to usability testing of Audio BattleShip for cognitive development in blind children.

KEYWORDS: *Blindness, Blind Study, Children, Cognitive Development, Prototypes*

1. INTRODUCTION

In recent years, a variety of audio-based apps for blind children have been developed. As a proof-of-concept for audio-based interfaces, several applications concentrate on the creation of 3D audio interfaces that map the whole surrounding environment. Only a few research has evaluated the cognitive usefulness of these apps to see how sound affects the development of cognitive abilities in blind individuals. No prior research has focused on utilizing spatialized 3D sound to help blind learners build abstract memory, haptic perception, and the integration of spatial and haptic references**[1].** We also have no prior work that involves both blind and sighted individuals in interactive and collaborative games. The synchronization of various interfaces for each kind of user makes developing interactive systems to incorporate individuals with varied abilities more difficult**[2].** For sighted users, the interfaces usually consist of computer graphical user screens and some audio output. The most popular input devices are the keyboard and mouse.

Blind users' interfaces mostly depend on auditory information for output, as well as keyboards and other haptic devices for input. Because joysticks provide some resistance to mimic the shape of objects, they are sometimes utilized for both input (movement) and output**[3].** The concept, development, and usability testing of Audio Battleship, a sound-based interactive environment for blind children, are presented in this research paper. This system is a sighted-only version of the classic Battleship board game, but it incorporates both graphical and audio-based interfaces for blind users. Audio Battleship is a game that helps blind students improve group interaction, abstract memory, spatial abstraction, and haptic sense**[4].** We also provide a framework for developing distributed applications, with a focus on synchronizing apps with various interfaces.

We used a similar approach for designing and building information-equivalent interfaces for sighted and blind persons as described in for developing interfaces for people with impairments[**5**]. Finally, a comprehensive usability research was conducted to assess the cognitive effect of blind youngsters interacting with Audio Battleship.

We chose to offer several playing modes since the goal of this game is to involve blind individuals in an interactive environment to help them improve cognitive abilities. Blind-to-blind, blind-to-sighted, and blind-to-computer are all options for Audio Battleship. Both players see the identical interfaces in blind-to-blind mode**[6]**. Blind-to-seeing mode gives the blind student a range of tools to help them overcome their limitations as compared to sighted learners who can see snapshots of their activities at any time. Because of computer memory and probability calculations, blind-to-computer mode gives the computer an inherent advantage over the blind learner, although this disadvantage may be mitigated by restricting the algorithm and establishing various degrees of complexity. There are three stages to Audio Battleship**[7].** The player selects the positions of ships from a predetermined list on the battlefield during the ship placement phase. A matrix is a battlefield where ships may be deployed across a column and row by covering various amounts of spaces depending on the ship type. Phase of establishing and joining sessions: After arranging the ships, the player may select between starting a new gaming session, joining a current one, or playing against the computer.

Another person may join a new session if one is established. To join an existing Internet session, the player must know the session's name as well as the host address. Phase of shooting: Both players may alter the matrix with the board's status by taking turns selecting a cell inside the matrix that represents the contender's battlefield and placing a bomb on that location. Whether or not a competitor's ship was struck is determined by the system. A paradigm for creating instructional software with a variety of interfaces for individuals with various impairments. This approach may be described in three steps: (1) create a computational model of the actual world; (2) model the system's input/output requirements including feedback; and (3) create interfaces by 'projecting' the model over a variety of user interaction capabilities. We represented Audio Battleship in this instance by mapping two players, each with a matrix representing the space in which their ships are positioned. The information regarding where the competitor has dropped a bomb will also be recorded in a player's matrix. A token denotes which player is responsible for dropping a bomb on the field of the competitor**[8].**

We developed two apps, one for blind users and the other for sighted ones. Each program includes two user interfaces: one for ship navigation and another for firing. For sighted individuals, the ship placement interface consists of a window with a grid depicting the battlefield. The mouse is used to define a location and a direction up, down, left, right for the ship. The shooting phase interface consists of a window with two matrices, one for the battlefield where the player's own ships are positioned and the other for the competitor's field, which shows the locations where the player has previously drooped bombs as well as the result of the operation**[9].** A text box was included to give information about the game's progress. A tablet is used as an input device in the application for blind users. The tablet can map the whole screen, and various mouse events may be triggered using a pen-based pointing device. Over the tablet, a grid was constructed to mimic the battlefield's matrix, as well as some extra 'help buttons' for initiating activities. The player must point at a certain location on the grid and specify the direction by sliding the pointing stick to a cell up, down, left, or right during the ship's placement phase**[10].**

2. DISCUSSION

During the shooting phase, the player just has to double-click on a grid cell. Sound feedback is given to educate about a particular spatial position on the board and the occurrence of certain events, such as the consequence of dropping a bomb in a competitor's battlefield cell. The assistance buttons aid the player by reminding them of the locations where an enemy's ship has been struck or has not been hit. A developer must choose a method for creating a distributed application while creating collaborative software. In essence, the developer must choose between two paradigms. One option is to go with a framework that has a centralized server capable of servicing many clients. In this instance, the information required by all clients is delivered to the server first, and then disseminated to the clients in some way. In certain situations, such as NetMeeting, it is no longer feasible to work with the clients if the server is unavailable for whatever reason. A replicated architecture is the second paradigm. All of the required data for clients is duplicated in the client apps in this scenario. The benefit of this kind of architecture is that clients may continue to function even if their network connection is lost. The RMI-based Match Maker TNG framework integrates both paradigms for creating collaborative applications. This framework features a centralized server that sends the required data to the clients while also replicating the application's whole internal data structure.

Each application may have a comparative synchronized status as a result of this. The data structure of this server application is organized in a tree termed the ‘synchronization tree.' Clients do not have to listen to the whole tree; instead, they may listen to certain sub-trees. The synchronization tree will most likely mirror the application's internal data structure. Several synchronization frameworks utilize event-based technologies, whereas Match Maker TNG replicates using the Model-View-Controller paradigm by creating a Match Maker TNG model for each item to be duplicated. The object model is included in the Match Maker TNG model, but it may also include information about the view. The potential of interpreting these models differently in various applications is significant when they are used. For example, a model may be completely understood by an application running on a high-performance PC, but when the same model is read by an application running on a PDA, certain bits of information may be overlooked. Another example is Audio Battleship’s usage of the model. It is feasible to include information for individuals with impairments into the model. An application designed for individuals without impairments may overlook this.

The models are distributed to the clients using Java's common event framework. When a new node is created, removed, modified, or activated, the server performs four fundamental actions to notify the clients about changes in the synchronization tree. Each of these four actions requires a unique method to be implemented by every Match Maker TNG client. Because the user interfaces of the two apps are so dissimilar, the best approach to synchronize them is at the data model level. Players' information, game state turns, and the coordinates of a particular location with the associated state are all stored in Audio BattleShip objects ship, water, destroyed ship, shooting to water. These objects are used to build a synchronization tree with nodes that hold information about players and objects that match to the board size. The turn-taking token is at the base of the Match Maker synchronizing tree, according to this. The information about the two players is kept in the root as two child nodes. Each cell that represents a player's battlefield is kept as a child node of the player's node. This provides the benefit of just transmitting the information of one cell to the linked application if the information changes, rather than the whole matrix. Sound-based synchronization problems are compounded by the fact that most computer languages handle sound playback as a distinct thread and Java is not the exception. In many instances, we must ensure that the user has heard all of the auditory information before proceeding with the program execution which may include playing another sound clip.

The Java Media Framework was utilized to synchronize multimedia events in order to achieve this. Audio BattleShip is a sound library that may be easily customized to alter language and sound effects. Blind learners assessed the Audio BattleShip interfaces. The first experience included testing several software modules with four blind students who attend the Santa Lucia School for the Blind in Santiago, Chile on a daily basis. After completing a software module, learners tested it by interacting with it, making comments, and answering questions. Thinking-aloud techniques were also used. All of these methods assisted designers in redesigning the product and bringing it closer to the mental model of blind youngsters. The initial prototypes were put through their paces. The functioning and design of the user interface were examined. The research included four blind students from the same school. During four sessions, they played the game and answered questions. In all sessions, two members of the study team watched them, answered questions, and recorded their remarks and actions. The majority of the issues concerned audio interfaces, as well as the mapping and usage of input devices such as tablets. We evaluated how effectively the conventional board Battleship game's physical matrix was translated into the interactive world. The mapping of the screen matrix by a tablet with a rough grid on it was also tested using a synthetic substance.

The usefulness of certain interface components, such as sounds intensity and quality, loudness, and response to user actions, was then evaluated. Both the keyboard and the tablet were used to teach users how to play the game. They thoroughly investigated the advantages and disadvantages of utilizing a tablet, as well as its functionalities and parallels to the Audio BattleShip interface. When engaging with the program, we searched for associations between auditory stimuli and game actions, as well as a comprehension of cause-and-effect action connections. Learners liked engaging with Audio BattleShip as a consequence of this early testing. They contributed to the development of the program by providing valuable input on sound synchronization, sound overlapping, sound aid, color contrast, cursor size, location identification, and tablet mapping. We evaluated the cognitive effect of Audio BattleShip on five learners over the course of six 90-minute sessions. A video digital camera was used to record and register all of the sessions. The remarks and responses to particular questions were also recorded. Two special education instructors watched the blind students using the tablets to complete activities using Audio BattleShip and filled out observation forms developed especially for this purpose.

For each cognitive activity, we created a paper form with multiple questions, a response scale, and open observations. Learners engaged with their companions before representing the adversary's movements on a concrete board. One player explained the coordinates, while the others located and marked the pieces on the board. They also used a previously devised technique to search the adversary's ships. We investigated the effects of utilizing Audio BattleShip on abstract memory through sound spatial references, spatial abstraction via the concrete representation of the virtual world, and haptic perception tactile and kinesthetic via mental representations of the navigated area. To build mental pictures of the navigated virtual world, children also incorporated spatial references via sound and haptic analogies through tactile manipulation. The first task included constructing mental pictures of the navigated virtual world by combining spatial and haptic references through sound and touch manipulation. We also wanted to see whether learners could experience the virtual environment via haptic perception by creating mental representations using Audio Battleship. The majority of students were able to tell the difference between each auditory stimulus. Most people might easily draw a comparison between Audio BattleShip and the classic Battleship game's concrete board.

The same proportion of students could draw a parallel between the Wacon tablet and the adversary's virtual world. Throughout Audio BattleShip, they didn't require a solid board to keep track of their movements and navigation. Some students did very well versus an opponent 40 percent, while others did well. When played against a computer, the same outcome was achieved, indicating that students could devise a method to solve issues and beat the opponent. Spatial abstraction via the concrete depiction of the virtual world and abstract memory through spatial linkages with sound Almost 90% of students were able to fully depict the adversary's movements on a solid board. Throughout Audio BattleShip, none of them needed to utilize a solid board to navigate. The goal of this research was to create and test a sound-based virtual environment for developing and practicing abstract memory through spatial reference, spatial abstraction through concrete representations, haptic perception through mental images of virtual space, and cognitive integration of both spatial and haptic references.

3. CONCLUSION

Our findings show that utilizing Audio BattleShip in conjunction with cognitive activities and physical objects may aid in the development and exercise of mental pictures of space, haptic perception, abstract memory, and spatial abstraction in blind learners. The ways in which blind students interacted were varied. Using interactive sound-based apps like AudioBattleShip may improve certain collaboration skills. We need to know more about the types of collaboration abilities that can be stimulated and how they may be improved via sound engagement. This is particularly essential for blind students, who are used to conducting solitary work with minimal social contact while utilizing digital gadgets. Using digital audio interfaces like the one described here, we want to create new methods and situations for cooperation between blind children and blind and sighted learners. The engagement with AudioBattleShip was a hit with the students. This is due to the fact that the engagement enabled them to compete and assess their skills and talents. This encounter also had an emotional component. They improved their self-esteem and self-worth as a result of competing against and defeating other learners, both with and without eyesight. Learners also expressed a preference for playing with a blind partner rather than against the machine. They said that engaging with computers did not provide the same challenge or feedback as playing with a friend. They were encouraged to play and engage with sighted students because it was a chance for them to demonstrate that if certain circumstances are fulfilled at the start, they can achieve the same level of performance as the sighted. A key strength for AudioBattleShip was the usage of Wacon tablets as interaction devices. These gadgets enabled blind learners to engage with various haptic interface devices and proved to be very suitable for this kind of software.

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