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Designing for Headset VR from a longer Desktop VR Learning Experience: Watershed Explorers: Industrial History

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Abstract. Watershed Explorers: Industrial History is a headset VR gameful learning experience designed for non-formal education for a wide age range of users. This iLEAD paper describes the design and development choices for the headset VR experience and the trade-offs that were made when converting a longer desktop VR experience into a shorter headset VR learning experience. Results from our usability tests during the design and development phases for the immersive interface, options panel, and the narrative text display are presented.

Keywords: Industrial history, VR headset design, Watershed.

1 Introduction

Watershed Explorers: Industrial History (WE:IH) is a headset VR (hVR) gameful learning experience designed for non-formal education. It is a shorter thematic version of the desktop VR (dVR) experience Watershed Explorers which is a place-based experience to learn about environmental issues and industrial history in the Lehigh River watershed in Pennsylvania, USA [1]. Watershed Explorers was developed using a design partnership model between Lehigh University and four non-formal education centers that included the Delaware & Lehigh National Historical Corridor National Canal Museum (D&L), The Lehigh Gap Nature Center, Jacobsburg Environmental Education Center, and the Nurture Nature Center. In the learning experience, players are hired by the D&L to kayak down the Lehigh River to recommend locations for promoting tourism in the watershed. They are first presented with a two-minute overview video of the Lehigh River watershed and then they explore nine locations along the river with four virtual avatars to learn about the watershed's environmental issues and industrial history by exploring a series of 360º high-resolution photospheres at each location. Each photosphere contains interactable objects that include video clips, historical imagery, information signs, and narrative text about the environmental or historical importance of each visited area. Players must explore each media artifact and answer a question about the location before continuing to the next location. After the last location is visited, the player returns to the D&L museum to recommend three locations to receive enhancements to promote tourism in the area. More detailed descriptions of Watershed Explorers can be found in [1, 2, 3].

Our original dissemination plan was to have an hVR version of Watershed Explorers available in the non-formal centers to be used for public outreach activities and for school groups that visit the centers. The intended audience of the public outreach included a wide age range of users from 10-year-olds through senior citizens. The desktop VR full version of Watershed Explorers typically takes over 50 minutes to complete the experience [2] and this was deemed to be too long of a period for players in hVR, especially if one has never used a VR headset for an immersive experience. Thus, we decided to create two shorter thematic versions of Watershed Explorers which gameplay would each last approximately 20 minutes. It was decided that one of these shorter hVR versions would focus on the industrial history of the watershed to align closely with the mission of the D&L. Many different design decisions had to be made to convert the dVR experience that was developed with Unity into a much shorter

thematic hVR experience. This paper presents some of the main hVR design and development choices for the WE:IH gameful learning experience. The design decisions presented in the next section serve to provide recommendations for developers of fully immersive head mounted display learning experiences for non-formal education who serve a wide age range of users.

2 Designing for Headset VR

The first design challenge was to decide how to move players more quickly through the kayak trip down the river. The original experience had nine distinct locations with many of them containing multiple photospheres with different media elements. These elements included brief videos, historical imagery, and interpretive signage with extra texts and images. To expedite the journey and to keep players moving quickly through the experience, it was decided that there should only be one photosphere at each location with narrative text instead of having multiple photospheres with narration at each location. In addition, we decided to remove all the interpretive signage throughout the headset VR experience. This decision was based on our prior study with the full desktop VR version [3] that found that many adolescent players did not spend time reading the signs and the fact that reading the interpretive signs would keep players in the headsets for a much longer period of time than our goal to limit the hVR experience to 20 minutes. The interpretive signage and additional imagery and videos are included in the full desktop VR version. If an hVR participant would be interested in accessing more information and viewing the additional content, we would be able to refer them to the full *Watershed Explorers* version that will reside on a Web server in the near future.

Most locations in the full *Watershed Explorers* version included important content information about both environmental and watershed-related issues in addition to industrial history content. Much of the industrial history content intersects with the environmental issues in the watershed and we wanted to make sure that those connections were kept in the experience. For example, the Rockport location is a former coal mining community. Coal was the fuel for the industrial factories that made iron, steel, and zinc in other locations in the watershed from the 1800s up until the 1960s. Due to the lack of environmental regulations in the state of Pennsylvania during that period, the former mines in Rockport and similar areas form highly acidic abandoned mine drainage streams in the watershed.

Six of the nine locations in the full *Watershed Explorers* version had a more primary focus on the industrial history within the watershed. These sites included Rockport, the Lehigh Gap, Walnutport, Cementon, Thomas Iron Works, and Bethlehem Steel. In addition, it was decided to keep the first location of the original experience, the Francis E. Walter Dam, since this location is the logical starting point of a kayak trip down the Lehigh River, and is also the game tutorial location where players learn about important interface and gameplay features. The content at each location had to be significantly reduced, prioritizing the media elements within each photosphere that were most important for understanding the industrial history of the watershed. The experience also includes a gallery that includes an archive of historical photos from each location that the player can access at any time. Since the number of photos viewed in each photosphere had to be reduced, it was decided to keep all historical imagery from the dVR version available for the player to access in the gallery of the WE:IH hVR version. In addition, many of the checkpoint questions that were presented to the player after they viewed all media artifacts in each photosphere had to be revised to focus more on the industrial history significance of that particular location.

2.1 The Head-up Display (HUD) and Options Panel

The HUD (Figure 1) is a main user interface (UI) element that contains several important elements that the player should be able to access at any time during their gameplay. It includes a location panel and an “eye compass” that matches the direction the user is looking at inside the photosphere [3]. Surrounding the compass, there are buttons to access supporting panels, including gameplay progress, narration log, and options. During our design process, we decided that it would be important for players to access these UI elements anytime with the design intent to minimize the player’s cognitive load during game play. The gameplay progress area was designed to let players keep track of their overall progress as they move through the experience. It enables the players to see which locations they have visited and which locations they will visit as they continue with the experience. In this area, they can also access additional historical imagery and a glossary. The narration log enables the player to revisit the narrative text at any location they have previously visited during their experience. The options area permits players to adjust the volume of the experience and to change the language to select a Spanish version of the

experience. Another HUD component is a pulsating (i.e., enlarges and shrinks) question mark icon button that only appears after the player interacts with all photosphere elements. This question button opens an exploration checkpoint question for the player to answer before they leave each location. These checkpoints were validated by our partner content experts to ensure that the learning objectives of each photosphere align to the overall goal to promote industrial history content knowledge in the watershed. Feedback is provided to the players if an incorrect answer is selected, and the player must select the correct answer to continue to the next photosphere. The HUD also includes right and left navigation arrows that permit the player to move the HUD in those directions. To ensure that the player is always able to view the HUD at any time during gameplay, it is consistently placed below the narration panels when an avatar presents information. This ensures that the HUD always stays in the player's field of view and does not get covered by any other UI element during the experience.

2.2 The Narrative Text Display

A major design challenge in our development of this hVR experience with narrative text for non-formal education is to ensure it can be read by a wide age range of people, from adolescents to senior citizens, who attend educational programs at non-formal STEM-related centers. To address this, we provided the player with the ability to control the size and position of the text panel. In our initial prototype testing, we conducted UI tests using a 57-year-old person of the design team who wears reading glasses to determine an optimal initial panel position and text size. We decided that if such a person could read the initial text display on the panel, then most players may not have to change the panel size. In case a player would have difficulty reading the text, we created a button on the bottom center of the panel that could be clicked to enlarge the panel and the text (see Figure 2). During our initial interface testing, we discovered that in some instances, the panel's location within the photosphere was slightly angled toward the player's frontal gaze. A slight shift of the panel's position to the right or left would enable the player to more optimally read the text on the panel. As a result, we added the horizontal navigation arrows to each panel to allow the player to move the panel to the right or left (see Figure 2). As we move forward with our iterative design and development with our initial prototype, we intend to test the readability of the narrative panels with a sample of older adults that will include those who have prescription reading glasses or a vision condition that may cause blurriness or distorted vision.

Fig. 1. The HUD. Note enlarged green question mark is displayed to indicate it should be selected to complete the question checkpoint.

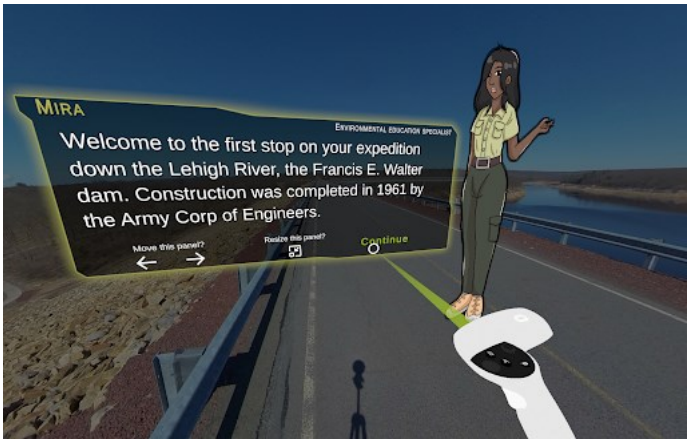

Fig. 2. The narrative text display which contains the moving and resizing panel buttons at the bottom.

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References

1. Bodzin, A., Fu, Q., Araujo-Junior, R., Hammond, T., Anastasio, D., Schwartz, C.: Implementation of a desktop virtual reality field trip in public outreach settings. Multimedia Tools and Applications (in press). https://doi.org/10.1007/s11042-023-17729-0
2. Araujo-Junior, R., and Bodzin, A.: Supporting Watershed Literacy with a Desktop Virtual Reality Exploration Game. In: Proceedings of the 8th International Conference of the Immersive Learning Research Network (iLRN), pp. 1-6. IEEE Xplore, Vienna, Austria (2022). https://doi.org/10.23919/iLRN55037.2022.9815959
3. Araujo-Junior, R. and Bodzin, A.: Effects of a place-based digital gameful learning experience on middle school students' watershed literacy and attitudes about desktop virtual reality gameplay. Interactive Learning Environments (in press), https://doi.org/10.1080/10494820.2022.2118785