ChronoLeap: The Great World's Fair Adventure

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Abstract. *ChronoLeap: The Great World's Fair Adventure* utilizes the educational potential of immersive 3D virtual venues for children and early adolescents between 9 and 13. Virtual reality environments transport the mind beyond the 2D bounds of text or photographs; they engage the imagination and can be a powerful tool for conveying educational content [1]. *ChronoLeap* leverages these innate qualities and weaves together the individual threads of single disciplines into a multi-disciplinary tapestry of web-based exploration through the 1964/65 New York World's Fair. Through their myriad of pavilions and exhibits, World Fairs offer links to science, technology, engineering, mathematics, art and humanities topics. *ChronoLeap* provides an immersive 3D environment with highly accurate and detailed models, and merges it with games and themes designed to provide users an educational STEAM environment. The project is a collaborative effort between the University of Central Florida, Queens Museum of Art and New York Hall of Science.

Keywords: STEAM, STEM, Immersive Education, virtual environments, virtual heritage, interdisciplinary, 1964/65 New York World's Fair.

1 Introduction

The roots of the 1964/65 New York World's Fair (NYWF) are entwined with those of a Fair held a generation earlier. The 1939/40 NYWF rose from the "Valley of the Ashes" depicted in F. Scott Fitzgerald's The Great Gatsby to transform over 1200 acres of blight to that of public parkland [2]. Visitors to the 1939/1940 Fair found an ideal future world carefully crafted to provide escape from the economic depression and global unrest that dominated the 1930s. When New York welcomed the world back to Flushing Meadows in 1964/65, Fairgoers experienced more than a celebration of post World War II American prosperity and Space-Age wonder as the Fair also reflected the changing domestic social landscape and Cold War fears.

World's Fairs are a centralized celebration of discovery. The 1964/65 New York World's Fair was the last 'great' Fairs held in the United States with over 51 million

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attendees. For the price of a $2.00 admissions ticket, a Fairgoer could discover art from around the world, glimpse into the nation's history, view advances in science and technology and peer into the future, all in one compact locale. Many of the technologies we enjoy today, or the foundations that made them possible, were showcased at the 1964/65 NYWF. The 21" color televisions on display beckoned viewers to make the costly transition to a new color set. At numerous pavilions, presentations explained why the computer was a technology to embrace not fear. General Electric's Carousel of Progress allowed everyone to journey through a 100-year evolution of home technology. The Bell System provided visitors a close-up look at the Telstar satellite and a glimpse into the communications revolution.

The 1964/65 New York World's Fair environment that *ChronoLeap* builds upon is unique in that it was an actual place with strong science content that possessed a futuristic world appearance. Our user testing has found that this visionary world has strong appeal with the youth of today. Evaluation of the NYWF environment of users from 9 to 12 revealed the content "resonated with their past experiences and/or current interests" and was capable of sustaining continued interest within that demographic [3]. *ChronoLeap* examines the foundations of the technologically driven world we currently occupy and forges links that promote intellectual curiosity and engaged exploration.

Fig. 1. New York State Pavilion and avatar

2 Relevance to STEAM Learning

The virtual world of *ChronoLeap: The Great World's Fair Adventure* provides a true interdisciplinary learning environment, within which users can not only explore a multitude of STEM topics, but can also come to understand the impact arts and humanities had on this showcase of scientific and technological innovation. *ChronoLeap* provides a rare opportunity for users to break out of the siloed view of education. The environment demonstrates how the humanities influence STEM discoveries, how STEM discoveries have inspired critical events in the humanities and incorporates the artistic aspects of technology and engineering innovations pertaining to the 1960s and their evolution to today.

As there was following the Soviet Union's launch of Sputnik in 1957, there is again considerable concern within the education community of the state of science,

technology, engineering and mathematics education. Recently there has been an effort to educate the public on the value of art and now the letter A has been added to STEM to make STEAM [4]. This stresses the value of creative/artistic skills in maintaining the competitiveness of our youth. However, the value of the humanities in this new wave of educational thought is being underplayed. The humanities provides not only a review of what has been, but an understanding of the evolution of STEM, the forces that led to where we are and the skills to understand how STEM topics can influence where we are going as a society.

3 Experiences

The world of *ChronoLeap* is explored through a series of "Time Bubbles." Each bubble is a self-contained level that focuses on a specific STEM theme, linked together through STEM artifacts found within a virtual representation of our partner, the Queens Museum of Art. As the user embarks on a time bubble journey, they find themselves in a world where exploration, inquiry, and interaction are fostered through a variety of mechanisms – a virtual data pad, STEM stops, games and content connections that link seemingly disparate experiences by a thread of shared knowledge. The storyline of restoring a time paradox drives the user to complete each level and continue to move from bubble to bubble. Within each bubble the user finds secondary quests or games that enhance their understanding of how technology influences society and its evolution. The completion of a time bubble permits the user to return to the Queens Museum of Art and embark on a new mission. As with commercial video game titles, the user can unlock playful elements within the virtual world. *ChronoLeap* also serves as a central location to embark on in-depth interactive experiences that help bring understanding and relevance to the advances in technology and humanities/art content that were showcased at the NYWF.

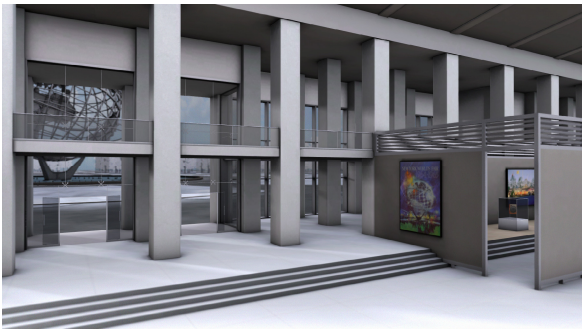

Fig. 2. Interior Virtual Queens Museum of Art

Within *ChronoLeap,* the collaboration between various disciplines such as music, cultural heritage, science and technology permits users to address the content holistically. Thereby, users can make rich connections, investigate the complexity of history, understand the artistic achievements of humanity, and apply these learned

base skills to different STEAM learning experiences. These experiences are found within the larger World's Fair environment as a series of independent in-depth games. Hosted on the project's website, our independent games have a direct connection to a pavilion and address specific STEAM topics. Each game can be downloaded and several played online allowing for individual users to explore content areas that align with their own interests – enriching and supplementing lessons learned in the Fair while also providing a unique opportunity to discover new ideas.

3.1 Pythagoras' Music Challenge

At the Greece Pavilion *Pythagoras' Music Challenge* is a full interactive 3D game that blends art and mathematics. The experience provides the user with an understanding of the mathematical basis for musical intervals – the main component of Western scales and chords – while also allowing for free-play and original composition. Embedded within the visual design are the physics principles behind sound waves wherein each note emits a particle effect representative of its relative frequency. The 12 notes of a C Major scale are represented by bells laid out before the user. "Hitting" a bell generates a note corresponding to the letter displayed on the bell.

Fig. 3. Pythagoras' Music Challenge

3.2 Sea Hunt

Accessed from the Travel and Transportation Pavilion, *Sea Hunt* is a 3D, first-person "eater" from the view point of an anglerfish on a deep sea mount in the "midnight zone" (3000 – 13,000 feet below sea level). This game teaches users about deep sea ecology, the predator/prey relationships of that ecosystem, bioluminescence, hydrothermal vent ecology, and the historical and engineering accomplishments of the Bathyscaphe Trieste (a submersible that reached the bottom of the Mariana Trench in 1960 – a feat that has only recently been matched). In this experience, the player swims around in the dark waters encountering bioluminescent creatures, some of which they can eat, while others, such as the colossal squid and larger toothfish, will attack and eat them. The user encounters giant tube worms, sea cucumbers, jellyfish, copepods, lantern fish, Beroe forskalii, arrow worms, and other creatures of the deep. The game is completed after the player has encountered all of the various creatures, eaten enough to keep its health up, and avoided being eaten.

Fig. 4. Sea Hunt Title Card

3.3 Spain Pavilion

Exhibiting works of art from El Greco, Goya, Dali, Picasso, the Spain Pavilion was often referred to as the "Jewel of the Fair." The exhibits within its walls provided a glimpse into Spain's heritage and its influence on the New World. It explored how the processes of cultural change, through communication, assimilation, acculturation, and transculturation, generated rich cultural systems. In Spain's case, the exemplar is cultural evolution through folklore music heritage, and more specifically, through its internationally known folk expression, Flamenco.

In *ChronoLeap's* Spain Pavilion, the planned experience is told through the eyes of Paco, a 12 year old assistant of an adult anthropologist. Initially Paco introduces the breadth of Pavilion activities in the general context of Fair. He then enlists the aid of our player to help him organize various cultural elements found within the Pavilion. The user must help Paco investigate three levels of discovery that ultimately culminate in a game addressing Flamenco. From the perspective of STEAM, the experience demonstrates a novel relationship between the knowledge of arts, humanities and science, and it builds bridges between different forms of access to knowledge. This relationship has been previously studied and defended from several points of view: the development of creativity through arts [5], the benefits of integrating the arts into STEM study [6], the role of music and arts in STEM initiatives [7] and the economic impact of cultural and creative industries.

4 Learning Theories

Studies have addressed the capacity of immersive environments to improve and enhance the education process. Immersive environments can provide multiple perspectives into a particular topic thereby allowing a user to view a real world scenario from a variety of disciplines. This kind of perspective-taking offers unique opportunities that might be difficult, dangerous, or even impossible in everyday life (e.g. learning about deep ocean ecology through the perspective of an angler fish) [8] [9] [10]. Additional studies have repeatedly indicated the relevance in the present context of integrate immersive environments and games in education to improve the motivation and engagement of youths. Successful learning strategies in games are

when the users have an active participation and interact in the experience of learning [11]. Research has demonstrated the ability of educational gaming to improve the engagement of students both in formal and informal learning situations. Some theorist consider educational gaming as a kind of "empirical application of constructivist theory" [12] [13].

Specifically within *ChronoLeap*, educational content is delivered using a wide variety of modalities. We have utilized the expansive topical world of the actual Fair to serve as a mechanism to deliver content-appropriate knowledge associated with with particular pavilion. A "learning by" set of educational metaphors was adopted during the overall experience design: learning by seeing/hearing, doing, playing, creating, and sharing. Each of the various STEAM delivery mechanisms utilizes one or more of these metaphors maintain a wide range of learning strategies and most importantly levy the advantages and disadvantages of any individual approach.

Within the *ChronoLeap* environment, users encounter "STEM Stops" that adopt the learning by seeing/hearing approach. The most traditional of methods within the Fair, STEM Stops provide the user with a high level of content but a low level of interactivity. Text, image, video, and sound clips appear in pop-up windows that are collected as the user explores the various pavilions within the virtual Fair. Each of these STEM Stops can be revisited at any time by the user. This method provides educational information in a passive format that is similar to that found in books or websites.

Learning by doing is experienced by "hands-on" games similar to the Pythagoras Music Challenge game described above. These are intended to provide the 'if this – then that' experience that a student might find in a "lab" class. In these modules there are no right or wrong answers, the focus is on real-time interaction and experimentation. Our user is presented with a simulation based on scientific models and dynamic data sets that can be manipulated with sliders and buttons.

The time travel adventure aspect of *Chronoleap* focuses on freeplay learning. The user undertakes the various themed missions within the time bubble levels collecting items and completing missions. This is designed to be an age appropriate version of popular video games such as *LA Noire*. The emphasis on freeplay allows users to embark on a voyage of discovery and exploration. This method differs from many traditional approaches in education in that the path to knowledge is not predetermined by the designer/instructor but rather the designer/instructor must design the game in such a way that the user feels compelled to explore.

Learning by creating is a method in which the user generates content given the context provided by the simulation. Just as an educator might assign a student to write a short story about a historical event, in this context, the user might be asked to create a digital interpretation of a particular painting, event, or concept. This method of learning empowers the student to give their own impression of an idea or concept. By giving the user the ability to take control of the content, the subject matter can become more personal and meaningful. We have adopted this thought in our Sketch and Tell exerience. Once a user has completed *ChronoLeap* and defeated the time paradox, they are presented with a pure user-generated content experience. Building on the future visions presented at the 1964/65 Fair, in Sketch and Tell we ask the user

to consider their home, automobile or city of the future. They physically draw their item of the future and our software captures the visuals and, most importantly, an audio explanation of these visions. Here we are stimulating their ability to observe, interpret and create – providing a true STEAM experience.

Finally, we examine learning by sharing of selective materials through online forums. This method ultimately becomes the showcase for user-generated content, enabling the users to teach and learn from each other. We view this as a digital version of the traditional show-and-tell.

5 Discussion of Results

Educational experiences in immersive environments have demonstrated improved learning processes in different aspects: engagement, contextualization of learning, transfer capability and collaborative work [14] [9], and especially in the arts and music [15] [16]. However studies have also established some of its current limitations [17]. In addition, other studies have evaluated the importance of sound and music in an immersive environment to improve communication processes [18] or the development of skills such as memory [19].

The New York World's Fair environment underwent significant evolution from when the project began to its current beta *ChronoLeap* version. Formative testing in the second half of 2011 revealed the desire by users for a more compartmentalized world than the massive sandbox environment initially envisioned. We found that user feedback continually requested a level approach. Users were uncomfortable with freely navigating 660 virtual acres and effectively making the STEM connections across the expansive environment. This also enabled the introduction of a strong story line to assist users, as we found this to be the second inquiry during testing – the all-important "why am I doing this task?"[12]. Subsequent testing has revealed the users enjoyed the time travel story line coupled with the mission based level approach. As each mission focused on an overriding STEM theme it became easier for the user to make the connections between the subjects.

Formative testing conducted on all twelve of the independent games yielded positive results both in terms of general enjoyment and transference of knowledge. Specific to Sea Hunt, the perspective-taking approach to education was employed wherein the player, takes the "point-of-view" of an angler fish. This metaphor provoked a discussion about what it might be like to play the game through the eyes of several of the other creatures and experience the predator/prey relationships through a variety of modalities. Another player commented that he would like to be able to "see himself" (as in a third-person perspective) suggesting that the player had embraced the metaphor of player-as-fish. Furthermore, several participants commented on the "mysteriousness" of the game and felt this quality made the game more exciting – perhaps indicating an increased sense of immersion [20].

The children in this study were unanimous in their belief that the game was compelling and enjoyable. When asked if they believed if the game was a good way to learn about deep ocean ecology, all students answered "yes." Many of the

participants communicated that they were unaware of bioluminescence, tube worms, hydrothermal vents, and most of the creatures in the game. They referenced many of the organisms by name in the post surveys indicating that the students took the time to read the pop-ups and were able to actively discuss the various elements of the ecosystem. The participants also commented that they wished there were more levels and they wanted the game to be longer [20].

In addition to the formative evaluation, both Sea Hunt and Pythagoras' Music Challenge have been played by large groups of middle school students over the course of the last 12 months within the research laboratory. It has been observed, informally, by both faculty and staff that these and our other independent games foster collaboration among groups of school children wherein the students gather around the computer while one person plays the game. The observers often read-aloud the educational pop-ups offering advice and discussing the content together.

6 Interdisciplinary Collaboration

So what happens when you bring together computer scientists, artists, historians, musicians, and variety of science disciplines? The project benefitted from a highly interdisciplinary collaboration between the University of Central Florida, Queens Museum of Art and the New York Hall of Science. Each organization brought a unique perspective as to how the 1964/65 New York World's Fair could be interpreted as a virtual learning environment, thus providing a solid interdisciplinary perspective at the early planning stages. Of equal importance was the real world experience both the Queens Museum of Art and New York Hall of Science possessed with the target age group. The New York World's Fair collector community was also most helpful in providing assistance in securing the historical materials required to create the pavilions within *ChronoLeap*. We highly recommend securing partnerships beyond the confines of the academic community.

7 Conclusion

ChronoLeap: The Great World's Fair Adventure provides engaging exploration and opportunities to learn about foundational themes, events and individuals from the 1960s and their continuing relevance today. Users are transported to the 1964/65 New York World's Fair – an event whose pavilions and exhibits bring together an expansive range of learning points in a single environment. The virtual world that recreates this event is more than a simple architectural recreation of the Fair; it is a destination for examining the historical foundations of the world we all now occupy and forging interdisciplinary links of wonder and exploration for the user.

Educational researchers have frequently cited the potential for virtual environments to promote learning [21] [9]. Virtual environments provide learners with access to artifacts and contexts that are otherwise not available to them in the real world (e.g., expensive or rare technologies, historical settings such at NYWF). Such environments can encourage exploration and discovery that are consistent with constructivist

pedagogies [22] [23]. Virtual environments can also immerse people within new perspectives and new identities that can stimulate learning [24] [25], [9] [26] and lead users to think more like experts [27] Given their strong potential for learning, the virtual environment will continue to develop for education in STEAM and the humanities, including teaching literature [28], art and design education [29], and history education [30].

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