Losing the Lake:
Development and Deployment of an Educational Game

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Abstract

When asked what the top three issues of the Las Vegas region were, the reply was "water, water, water!" This was the result of a survey done a few years ago of Las Vegas Valley TV anchors. The reason for this response is that sustainability of the urban environments requires sufficient water resources as does population growth. With the advent of global climate change, this resource is in danger. Water flow and mountainous ice packs are impacted by this change in climate there by impacting the amount of water the the region. This is compounded over time as the population increases and the water supply decreases. Even as the flow of water to the Las Vegas Valley is decreasing, many people in the area do not fully appreciate the severity of this crisis. This knowledge is at many times not brought to fruition as many people do not even understand some possible ways to contribute to water conservation. With the idea of educating young Nevadans, future initiatives can be put into practice to further alleviate a dire situation. Research has shown that imagery is important for a students' attention and enables changes in their thought process. With this approach, the goal of this project is to create an engaging environment to help awareness for the young and old alike.

Keywords: Water Conservation, Lake Mead, Web-based Application

1 Introduction

1.1 NSF EPSCoR

In 2007 the Nevada System of Higher Education applied for (and was awarded) an NSF EP-SCoR research infrastructure improvement grant (RII). This 5 year proposal was entitled Nevada Infrastructure for Climate Change Science, Ed-ucation, and Outreach and was funded by NSF for $15,000,000 from 2008–2013. The basic goals of this proposal are discussed quite well in the Projects Summary which says Nevada seeks to create a statewide interdisciplinary program that stimulates transformative research, education, and outreach on effects of regional climate change on ecosystem resources and supports use of this knowledge by policy makers. There are six components to this grant: climate modeling; ecological change; water; policy, decision-making, and outreach; cyberinfrastructure; and education.

In order to integrate the program components, this proposal had structured into it seed grants for interdisciplinary and inter-institutional science teams across the components. These teams were formed in year 2 of the grant and are nearing completion. There were many science team proposals submitted and several were awarded. One of those receiving funding was the project Losing the Lake. This proposal was headed by Michael Nussbaum and included faculty and students from the University of Nevada, Las Vegas and the University of Nevada, Reno.

The rest of this paper is structured as follows: in Section 1.2 we have an overview of the Losing the Lake science team proposal. This is followed by development of the first version of the educational software in Section 2. Section 3 presents version 2, which was a major overhaul and redesign from version 1. This is followed with a discussion of the climate models used which are covered in Section 4. Finally the paper finishes with deployment covered in Section 5 and Conclusions and Future Work in Section 6.

1.2 Seed Grant Proposal

The continual decrease in Lake Mead's water level and the issue of water sustainability in Nevada prompted the action for the seed grant "Los-

ing the Lake: Promoting Sustainability Awareness through Educational Computer-Simulations of Lake Mead Water Levels and Water Supply to the Las Vegas Valley" project, which was aimed at drawing the attention of younger students to water conservation. Since the younger and upcoming generation of Nevada students will be the generation to implement future change, professors from the University of Nevada, Reno and University of Nevada, Las Vegas wanted to target the students and find an effective way to educate them on the subject. The issue of water conservation is not stressed enough in comparison to other important issues and therefore needed to be conveyed in an engaging way that would cause the Nevada students to gain interest. The tactic behind the project was to use concrete imagery, such as the decreasing water supply of Lake Mead, and computer simulations in the form of a game in order to help students understand the issue of the dwindling water supply, and how to personally contribute to conservation efforts and solutions in the future.

The goal of the proposal/project was to effectively engage the younger audiences through simulation and models, using the idea of a game in an educational setting. The models would pertain to the severity of Global Climate Change, Lake Mead, and effective approaches to water conservation. The game was to be internet based, in order to allow students in formal and informal learning environments to have access to it, as well as featured at the Las Vegas Springs Preserve. For implementation at the preserve, a new display for playing the game was to be developed. The game needed to be filled with visually pleasing and advanced graphics in order to keep the audience interested, alongside explanations pertaining to the various causes of drought, climate change, and scientific models.

A large effort was placed in creating the game so that it was appropriate for the array of students using it for educational purposes. Considerations for this included not only attracting the attention of the user, but making sure that the user remained engaged. This was to be handled with advanced computer visualization and graphics, and implementing them in a way that allowed the user to have control over the simulated environment. The project also included the idea of the game design being adapted into a second version, which was effective at creating interest in high school and college undergraduate classrooms. This second version would therefore include higher-level discussion boards, or an open Wiki site, for the topic to keep these older students engaged in with the water conservation issue.

Another major goal of the project was to draw from, and build upon, the NSF EPSCoR climate change infrastructure. For instance, the game would utilize Global Climate Change (GCC) water models. To build upon the infrastructure, the game was to be incorporated into the central climate change data portal for Nevada. This portal would become the repository of the data received from sensor networks throughout Nevada, as well as a means to provide access to the educational game and other software tools. A web-page complete with the Losing the Lake game and its instructions was to be established so that the public would be able to freely have access to play and download the game. The game was also to be further enhanced for the DRIVE6 (DRI's 6-sided Immersive Virtual Environment) and Las Vegas Visualization Theater, where the graphics and simulation would be able to be displayed on a larger scale.

Overall, the proposal aimed to use educational environments to launch the game, with the goal of drawing the students' attention to water conservation using interactive screens, models, graphics, and simulations. With the implementation of the game, there will be ground to build upon for a larger NSF grant that would allow expansion for the project to involve more high schools and high school teachers.

2 Development: Version 1

The initial design was to have a downloadable application that would run on any Windows system and a virtual reality portion that would allow the user to fly over Lake Mead and interact with it in various manners. This was met with many difficulties that ended up causing a complete change to the application.

In order to make the application work across multiple platforms (Windows, Mac, Linux) we chose to develop the first version in QT. This initial approach was designed using the environment of QT [7] using OpenGL for graphics. This is a developement environment that is used to make applications with buttons, dials, tabbed browsing and much much more. The major functions QT handeled in this project were interactive buttons and a tabbed layout to seperate the multiple activities. The buttons were used to select answers to questions and to move between activities.

The graphics were implemented using OpenGL [4]. This is a powerful library that allows for animations, interactive 3D environments and any other graphical need. OpenGL requires the use of a current graphics card for many of its

functions. Since this project was to be distributed to many different computers, guaranteeing that QT and OpenGL were properly installed with a current graphics card became impossible. As the project grew and changed we realized that this application would not be functional to a majority of systems due to hardware requirements needed for some of the graphical portions of the program. The idea of a downloadable program became less attractive as the size increased and became burdinsome to the user to download then run program and that is if the users system meet the requirements. With these revelations, the development team decided that the use of QT and OpenGL had to be abondoned in favor of a development environemnt that would allow an end product that is readily available to as many users as possible.

A crowning jewel of the initial design was a virtual flythrough over Lake Mead with an accuratly detailed terrain. The user had the ability to change the height field scale of the mountains as well as the water level of Lake Mead. Without the use of OpenGL, this portion had to be removed from the final version of the software to be distributed. As an homage, screen shots of this flythrough are used in the "Lake Heed" portion of the final version of this game.

The DRIVE6 at the Desert Research Institute - Center for Advanced Visualization, Computation and Modeling would have been an ideal site to explore this flythrough in their 6-sided CAVE [2]. Here the user could flythrough the Lake Mead region and have a 360º view of the terrain. Since the flythrough portion of the game has been developed, it would still be possible to enjoy this senerio in the future.

Now that we had reached a point that we could no longer continue in this direction, a new plan had to be made and we needed a development environment that could handle the requirements and be done in a suitable amount of time. This when we looked into using Adobe Flash [1], which allows for web-based as well as stand-alone applications. This software allowed for animations, user interaction, seperation of activities and many other features that made the move a welcome one. The one downside is that the development of the flythrough would not be easily ported to this new environment without using time that we did not have.

3 Development: Version 2

3.1 GUI Overview

Overall Layout: The use of graphics through-

out the game is important to the project in many ways. First of all, graphics make the game visually pleasing for the users, which make the users more likely to stay engaged. Graphics are also strong tools in explaining how drastic of a problem the dropping water level is for the Las Vegas Valley. There are not only pictures, but models and animations used for this effect. These graphics are at times interactive. Allowing the user to change the variables with the scroll bars and sliders makes it possible for them to see more clearly the effects of the changes. Making things interactive keeps people engaged, because then the user is not just listening to information, but manipulating the scene themselves. These images are more likely to stick with the users after they play the game and will draw their attention to what has been learned and how to apply it.

Buttons: The layout for the Losing the Lake game includes a main display, as well as a constant bottom panel. On this panel is the "Jump To button. When the user places the cursor over this button, the different sections of the game appear, and can be jumped to at any point in time. To the right in the panel is a set of three circular buttons. The top of these three circles allows the user to turn the sound and narration on or off. Upon starting the game, the default setting is for the sound to be on, which is helpful for younger students to read along with. Next is a help window button that is labeled with '?' and describes how to continue and an explanation of how the score is managed. The last button labeled with '!' is to display a list of contributors to the project. The majority of this panel displays the current score and points possible at that point in the game in order to track progress. The blue bar is the score of the user and the red bar shows the points that could have been awarded.

3.2 Game Sections

Introduction: The game play first begins with a rippling image of Lake Mead and a narrated introduction to the issue of losing the lake, which describes the drop in Lake Meads water level. The opening of the game sets the stage for learning about water conservation, the lake, and climate change.

Multiple Choice: This is quickly followed by the Q&A section as seen in Figure 1. Here, the user is able to select the level of difficulty for the game as either easy, medium, or hard. This allows for optimal game play tailored to an array of students. The questions posed are in order to first engage the user by questioning his or her prior knowledge and further introduces the topics of dis-

cussion. It also provides web links for answers that are answered incorrectly.

Conserving At Home: The next section, "Conserving At Home, deals with the various changes that can be made to conserve water at home. It is posed as a challenge to the user to conserve the most water possible, and has a list of options on the side. The user can either select options from the list, or from the virtual model of the house. When an option is chosen, the corresponding area of the house is lit up and glows. In this way, the game is creating as much interaction as possible. The choices are then described as either good, bad, or great options complete with explanations to inform the user about his decision, and how it impacts the water conservation effort. There is also an animated graphic that shows how much water the changes saved, using water coolers Figure 3. The water cooler on the left reveals how much would normally be left over, while the water cooler on the right holds the water that would be left over after making the changes.

Conserving In The Valley: The scope of the conservation effort is then changed to the entire valley in the Conserving In The Valley section Figure 4. Here, the same concept of making the best choices is applied. These choices range from resort water usage to homes using grey water. On the graphic of the valley, the applicable areas are lit up much like the visual of the house and when an option is chosen, related pictures appear in the Valley. Once again, the choices are graded by level of effectiveness and the change in water conservation made through the decisions is displayed using the water coolers.

Climate change: The section concerning the River Basin shows an animation of the water within the basin and an educational explanation of where it comes from. This section has
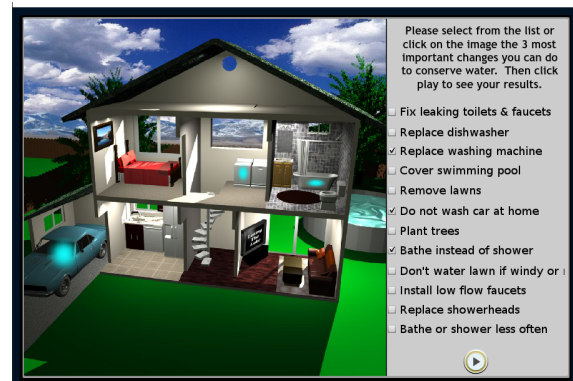

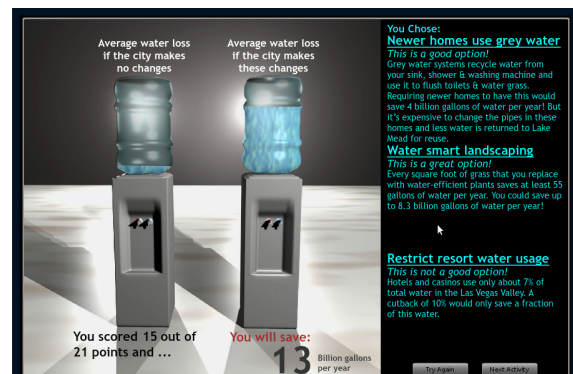Figure 2: Conserving At Home: Cutaway of an average household.

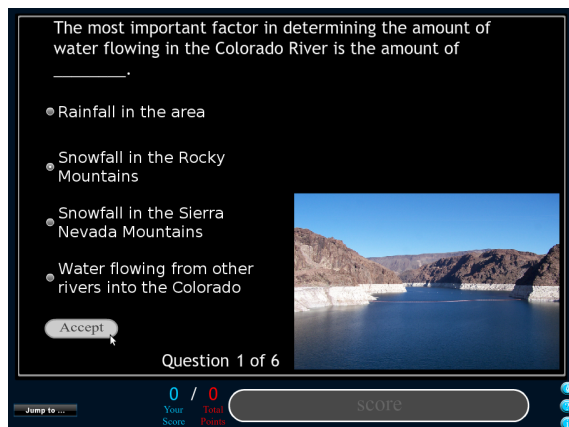Figure 3: Water coolers showing how much water the player can save.

many visuals that indicate how drastically the water levels are changing, using pictures from previous years and comparing the drop in water. It also emphasizes how a glacier is shrinking due to decreased snow by showing an animation, which follows through the pictures and highlights how much the glacier has shrunk. These pictures are important in making the user aware of how important the topics of the game are to Lake Mead.

Next, the game shifts to the section dedicated to "The Greenhouse Effect. Here, the user is introduced to the concern of climate change. An animation aids in explaining how the greenhouse effect works, and its many causes. The user then needs to use his logic once again to estimate the percent of snowfall reduction. A scroll bar is utilized to change the percentage as well as keep the user engaged in the game.

The final educational section, entitled, Future Warming, uses more interactive visuals to emphasize the issues of climate change. First, to show how CO_2 and the temperature are related, this section presents a graph and thermometer (Fig-

Figure 1: Typical layout for Q&A.

ure 5), which are effected by the user adjusting the slider of CO_2 concentration at the bottom of the screen. There is also an interactive piece that illustrates how the projected change in temperature affects snowpack as seen in Figure 6. As before, the piece is made interactive using the temperature scroll bar at the bottom of the screen. The section concludes with more educational information about how science is used in the study of climate change. This shows the user how to get involved in the issue through school.

"Lake Heed" Simulation: Finally, "Lake Heed is introduced as the lake under the responsibility of the user. A final graphic (Figure 7) shows the shrinking lake from above, and using the knowledge gained throughout the game, the user is challenged to make the best decision for conserving the lakes water.

Conclusion: The final score of the user is displayed at the conclusion of the game and the project challenges the user to go and conserve water. This score shows how much the user earned in comparison to the most points possible. This allows users to monitor their progress throughout the game and keeps them striving for a goal. Seeing the difference in their success relative to the best choices motivates the users further learning about the subject.

4 Global Climate Models

The climate data used in this project was compiled and analyzed from the following three modeling groups. The Canadian Centre for Climate Modeling & Analysis, the US Dept. of Commerce Geophysical Fluid Dynamics Laboratory, and the Hadley Centre for Climate Prediction and Research. For each of these modeling groups the following three scenarios where taken into consid-

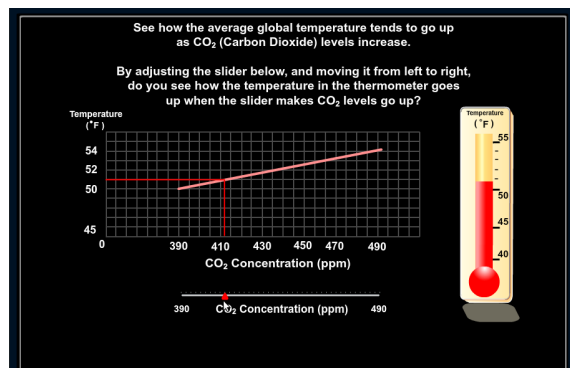Figure 4: Conserving in the valley: Overlooking the Las Vegas Valley.
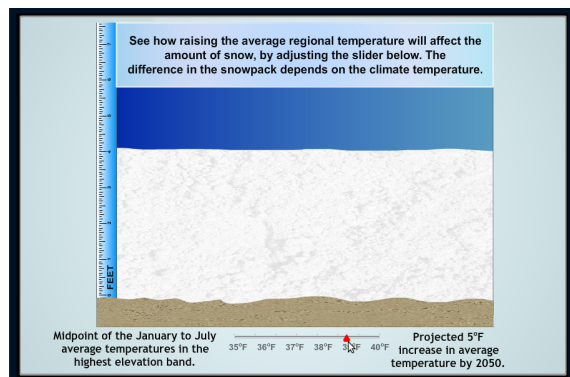

Figure 5: How temperature and CO_2 relate.

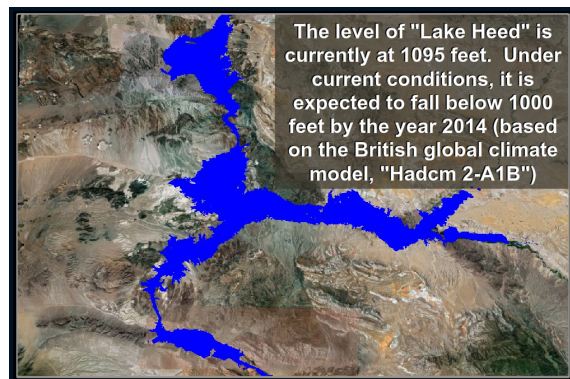Figure 6: How temperature affects snow pack.

Figure 7: Simulation of "Lake Heed".

eration.

SRES A2: This is a "higher" emissions path which has a more fragmented and slower technological change and economic growth with higher population growth[6].

SRES A1B: A "middle" emissions path where technological change does not rely too heavily on one particular energy source in the energy system which includes all fossil and non-fossil energy sources[6].

SRES B1: A "lower" emissions path that has a rapidly changing economic structure toward service and information, with emphasis on clean, sustainable technology with reduced material intensity and improved social equity[6].

5 Deployment

This project would be meaningless if it was not deployed to the public for use to gain knowledge and understanding of this crisis. As stated previously in the goals of this project, there are multiple methods employed to insure a proper distribution to the demographic communities of the Las Vegas Valley.

Springs Preserve: Springs Preserve is home to many attractions not limited to a lush 8 acre garden full of native and non-native plants, 1.8 miles of trails which span through 110 acres of native habitats and archaeological sites and museums with many entertaining and educational exhibits and attractions[8].

Nevada Climate Change Portal: This a conglomeration of project participants of which are actively contributing to the study of climate, hydrological and ecological information in the state of Nevada[3].

HPC-VIS website: As a project by some students from the HPC-VIS lab, this project will also be available through the labs website[5].

6 Conclusions and Future Work

In this paper we have discussed the design and implementation of an educational game called "Losing the Lake". This is a flash based, web deployed game targeted towards educating young Nevadans who will be our future policy and decision makers. We have deployed it in several locations previously described and are monitoring the number of downloads from the websites and use at the Springs Perserve.

For future work we would like to see an HTML5 version created. Adobe has been working on a conversion method to allow applications made in their Flash environment to be exported to HTML5 and a format that is playable on iOS devices. At this time the conversions are not without their flaws (mainly involving sound and action script) so if this project were to be deployed in these formats there would be more work to do. Sadly, the time and money for developing is over so this is not an option at this time. However, in the future, these conversions will be available thereby giving an inexpensive method for further distribution.

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