Sol y Agua Project: Promoting Information Science in Middle School Classrooms for a Socially and Environmentally Responsible World

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Abstract

The Sol y Agua project augments the learning environment of middle school students with the creation of a computer game based on regional issues explored through information overload, virtual simulations, and real world data [1]. The game has a theme of water sustainability and stewardship with an emphasis on information analysis, negotiation, and decision-making. The game immerses students in themes concerning biodiversity, sustainability, and the human impact on the environment. The activities challenge students to make informed decisions regarding water sources, maintenance, environmental factors, and sustainability, among others. The students learn the impact of humans on the environment through data analysis and run experiments in a virtual laboratory with real data. Data visualization allows students to interpret data in new, fun, and meaningful ways. The game has an emphasis in promoting minorities in the Southwest United States towards pursuing careers in Science, Technology, Engineering, and Mathematics (STEM), where they are largely underrepresented. The game activities have been developed using the Texas Essentials of Knowledge and Skills (TEKS) Standards [2].

Approach

Initial prototype development included the following:

- Perform feasibility study on culturally immersive and educational games
- Conduct interviews with subject experts and collect views and feedback [3]
- Collect regional data to include water volume, sources and quality
- Design game using software engineering principles
- Begin storyboarding, character development, and activity design
- Develop prototype game using Unity game engine
- Incorporate data visualization in the form of Data Driven Documentation (D3)
- Collaborate with educators to determine approach and content of activities
- Conduct usability testing of interface and make changes accordingly

Initial Game Prototype

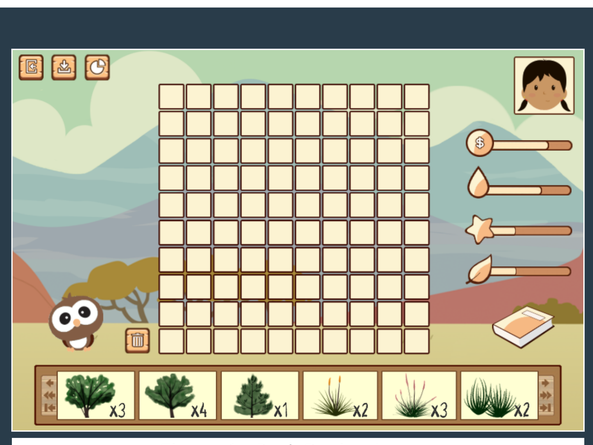

Figure 1: Park Design Layout

Decision Making—Students are challenged to integrate knowledge to choose most efficient landscape items for a park design.

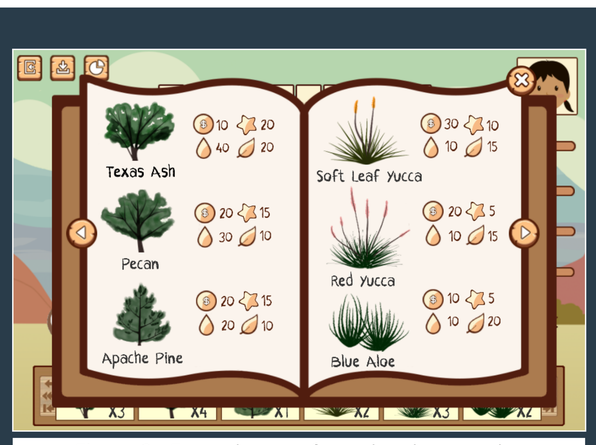

Figure 2: Example page from the plant catalog

Mathematics—Students must use math skills to optimize resource usage when choosing among different plant types.

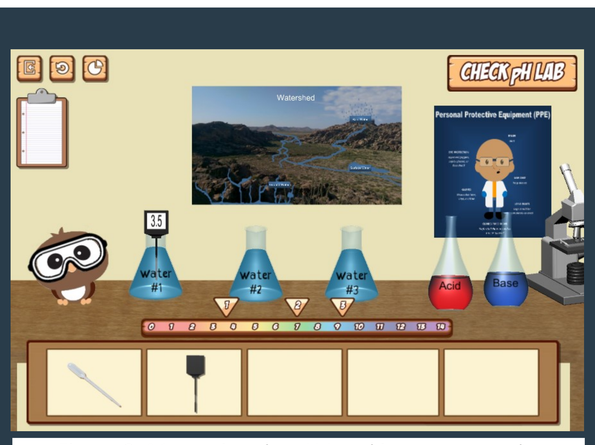

Figure 3: Measuring the pH Level in water samples

Research—Students will learn how to apply the scientific method in the virtual lab which simulates scientific experiments.

Figure 4: Analysis and recording of pH levels

Data Gathering—Students will gather, retrieve, analyze, and record water sample data through virtual lab experiments.

Figure 5: Tree shade visualization

Data Visualization—Students will be able to use various types of data visualization to help with information overload.

Figure 6: Plant attributes and necessities analysis

Data Analysis—Students will be able to generate conclusions and gather relevant data by using data analysis.

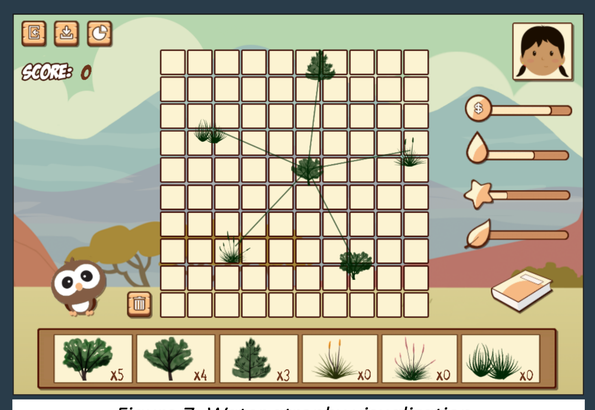

Figure 7: Water atrophy visualization

Data Interaction—Students will interact with real-time data to make informed decisions.

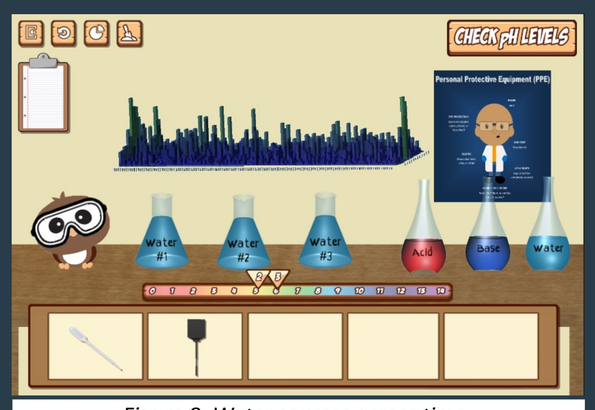

Figure 8: Water sources across time

Information Evolution—Students will be able to discern changes in data across time.

Usability Test Results and Conclusions

User Interface and Visualization Usability Testing was conducted with middle school students. Figures 9 through 12 refer to interface testing. Figures 13 through 16 refer to visualization testing. Testing was conducted using prototype release of game and followed think-aloud methodologies [4]. Testing used a five-point scale: 1 being "Very Low" and 5 being "Very High".

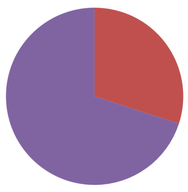

Figure 9: Course Relevant

Figure 10: Affordance

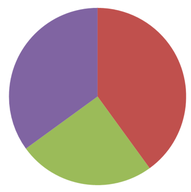

Figure 11: Intuitiveness

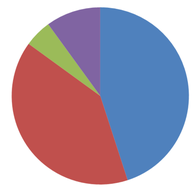

Figure 12: Complication

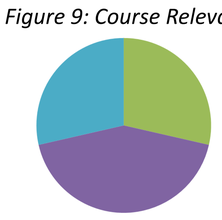

Figure 13: Plant Education

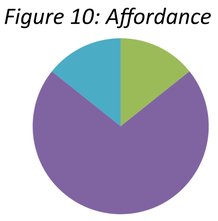

Figure 14: Water Education

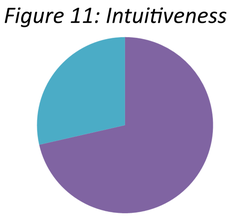

Figure 15: Plant Interest

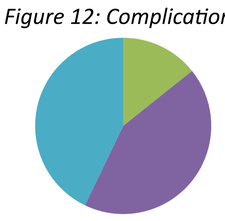

Figure 16: Water Interest

User Interface Test Conclusion (Figures 9—12):

- Group of 20 students with average age 11.8.
- 70% thought the activities were relevant to the lessons in the classroom
- More than 60% liked user interface
- More than 80% thought the game was not hard to play
- 66% knew which items they could interact with

Visualization Test Conclusion (Figures 13—16):

- Group of 7 students with average age 12.1
- 100% thought the visualization taught them about water usage and plants
- 80% showed high interest in learning more about water usage and plants
- 45% expressed very high interest in water usage

Future Work

- Conduct beta testing in classrooms to collect data and feedback from students and educators
- Refine the initial prototype according to data and feedback collected
- Evaluate possible expansion of prototype to other languages and regions
- Incorporate geophysical concepts and modeling to the existing prototype
- Creation of new activities and lesson plans

Acknowledgements and References

The project team would like to thank the Smithsonian Latino Center and the following UTEP contributors:

- Dr. Ann Gates, project supervisor and Director of CYBER-ShARE Center of Excellence,
- Mary K. Roy, Dr. Monika Akbar, and Victor Reyes from the CYBER-ShARE Center,
- Dr. Daniel Tillman and Dr. Song An from the Department of Education,
- Stacey Fox, Smithsonian Latino Center Instructional Designer/Artist.

References:

[1] E. Klopfer, 'Authentic Outcomes', *Augmented Learning*, pp 129-146, 2008.

[2] Texas Education Agency (2015). Texas Essential Knowledge and Skills. Retrieved from: http://tea.texas.gov/index2.aspx?id=6148. Last accessed on May 27, 2016.

[3] C. Santiago (2015). *Constructing negotiated meaning and knowledge for the Sol y Agua Project's role-playing adventure game focused on sustainability problems in the El Paso-Rio Grande Area*. Available from ETD Collection for University of Texas, El Paso. Paper AA110000806. Retrieved from: http://digitalcommons.utep.edu/dissertations/AA110000806. Last accessed on May 27, 2016.

[4] J. Nielsen, 'Usability Testing', *Usability Engineering*, pp 195-199, 1993.

Funded in part by the National Science Foundation Grant No. HRD-1342038, "BPR: Increasing STEM Participation and Success Rates of Latino Youth Using Culturally Relevant Immersive Technologies" and CREST Phase II: CYBER-ShARE, Grant No. HRD – 1242122.
Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation