

TELLING THE STORY OF PLACES: EXPERIENTIAL LEARNING THROUGH THE DESIGN AND DEVELOPMENT OF IMMERSIVE VIRTUAL LANDSCAPES

Susan J. Bergeron¹ and L. Jesse Rouse²

COASTAL CAROLINA UNIVERSITY¹ AND UNIVERSITY OF NORTH CAROLINA AT PEMBROKE²

Abstract

The notion of a unique spatial narrative, a story of an individual experience in a virtual landscape, can be a powerful tool in bringing informatics to education. Learning by experience is an innate part of our world, and we can leverage those life skills to actively involve students by not only providing them with an immersive virtual environment that can be explored, but also by actively involving students in the process of designing and developing the virtual landscape and its content. By participating directly in the process of creating the elements that will tell the story of a place, students learn about that place as they actively participate in building the virtual landscape and its story.

Introduction

In recent years, there has been growing interest in developing active, experiential learning frameworks for students across a wide range of disciplines. At the same time, rapidly-evolving digital technologies are changing the way we live, and finding opportunities for students to gain experience with these digital tools and methods can be challenging. Virtual world projects can provide unique undergraduate research opportunities by involving students in the design and development of the virtual landscape platform and its components. The development of an immersive, interactive virtual landscape that can foster a sense of presence requires a truly interdisciplinary approach, combining knowledge from geography, computer science, history, graphic design, and other disciplines to create a compelling simulation. Working in such an interdisciplinary environment gives students the opportunity to learn collaborative methods and gain an appreciation for being part of an interdisciplinary team learning experience.

In this article, we will explore how custom immersive virtual landscape simulations can be utilized as a platform for experiential learning, by actively involving students in an iterative design and implementation process where they work alongside faculty and other experts to develop immersive and interactive virtual landscape platforms. Students can contribute not only to the construction of elements of the virtual landscape itself, such as modeling natural and cultural features, but also take an active role in collecting and curating the information that will be presented to users as they explore the virtual environment.

Designing and Building Virtual Landscapes

In recent years, a number of developments within the fields of Geographic Information Science (GIScience), computer science, and entertainment technology have provided a more intuitive way to explore the qualitative aspects of places and landscapes through an experiential approach via the development of immersive and interactive virtual landscape simulations (Bergeron 2011; Harris et al. 2011; Champion 2010). Such tools can provide a compelling active experience for students as they learn to navigate through virtual places just as they would in the real world, gathering information through movement and interaction and constructing an individual 'mental map' of that exploration. For educators, these platforms are an opportunity to leverage the experiential qualities of immersive virtual environments to present concepts and information in an intuitive and dynamic way (de Freitas 2006).

The increasing availability of relatively inexpensive advanced graphics technologies within the last decade are now moving us far beyond static two-dimensional representations of the world and providing the tools to not only generate nearly photorealistic three-dimensional virtual landscapes, but also

incorporate realistic light and textures, dynamic physical systems, and audio (Bergeron 2011; Harris et al. 2011; Lin and Batty 2011). Creating a sense of immersion through the generation of such life-like virtual landscape features, combined with camera perspectives and navigation that mimic human perceptions of movement through space are key elements in generating a sense of presence that allows users to feel as if they are experiencing the exploration of a real landscape (deFreitas 2006; Murray 1997).

To design and develop a working prototype of an immersive virtual landscape platform, staff and students in the Laboratory for Geographic Information Science and the Department of Geology and Geography at West Virginia University participated in a multi-year project, *Virtual Morgantown* (Figure 1), that focused on the construction of a virtual landscape based on the early 20th century historic landscape of Morgantown, WV (Bergeron 2011). The main goal of this project was to leverage advanced geographic information systems (GIS) and geovisualization technologies to develop an immersive virtual historical landscape as a demonstration of the capabilities of such a platform for studies of place (Harris et al. 2011). While much of the technical development of the platform itself was completed by advanced graduate students and faculty, upper level undergraduate students in GIS and Urban Geography courses were given the opportunity to participate in the construction of 2D and 3D datasets that comprised the cultural elements of the historical urban landscape, such as structures and vegetation.



Figure 1. Detail of Virtual Morgantown

More importantly, student participants were actively involved in researching and selecting the embedded media that presented geographic, historical, and cultural information to guide users as they explored and learned more about the historical geography of Morgantown. By participating directly in the process of creating the spatial narrative elements to tell the story of a place, students were able to learn about that place as they actively participated in building the virtual world and its story, and saw how 3D visualization and other digital technologies can make such immersive landscapes possible. Because the goals of this research project were to demonstrate the implementation of immersive technologies through a working prototype, user testing was not a focus of the project evaluation. However, qualitative feedback from a number of student participants, both in geography and computer science, have indicated that they

had learned about aspects of local history and its relationship to broader historical trends that they would not have covered in a traditional course curriculum.

Building on this previous work at a large research institution, the authors have focused on further exploring undergraduate student participation in interdisciplinary research and have worked to scale new experiential learning projects to a scope appropriate for regional teaching-intensive undergraduate institutions. In a recent course on Geospatial Technologies at the University of North Carolina at Pembroke (UNCP), a small regional university, a group of students reconstructed the structures on campus (Figure 2) using the free architectural modeling software SketchUp (Trimble 2013), which produces models that can be viewed and shared via Google Earth and exported for use in custom 3D virtual landscapes. In honor of the university's 125th anniversary, the students created four representations of the campus for the original school building, which did not sit on the modern campus, and views of the campus in the 1950s, 1980s, and the modern buildings. The historic representations required significant research, including interviews with campus representatives and faculty, with one of the key resources being the yearbooks for the years represented. While the course topic was focused on geospatial technologies, the students were from diverse majors and disciplines. Each student utilized their previous major coursework and experience to create their portion of the content for the representation (Vargas and Stanley 2012).

Students in an introductory level Digital Earth course at Coastal Carolina University (CCU), a mid-sized regional university focused on undergraduate teaching, participated in a collaborative project to design and model the historic downtown area of Conway, SC. Working with faculty, undergraduate students selected the structures to model, researched the history of their chosen structures and lots, and generated textured 3D models of those structures in SketchUp. The completed models were first uploaded to Google Earth to view the downtown scene (Figure 3), and combined with multimedia prepared by the students to tell a spatial story of downtown Conway, SC.

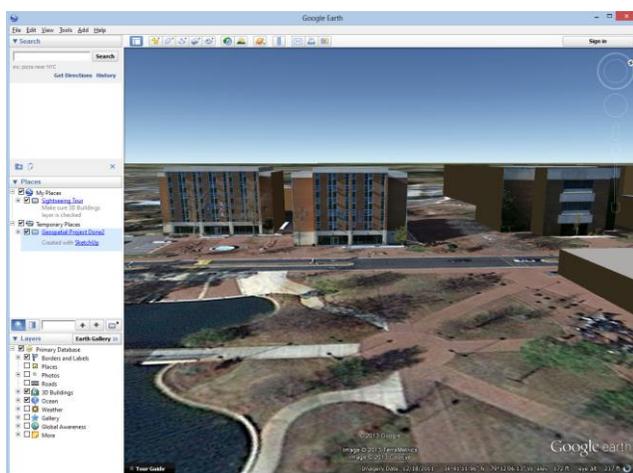


Figure 2. Detail of UNCP 3D Virtual Campus

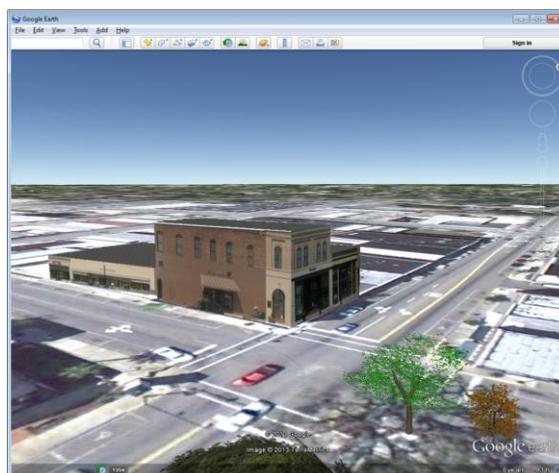


Figure 3. Detail of 3D Building Model for Virtual Conway, SC Reconstruction

Immersive virtual landscape platforms are designed around an individual experience as a user navigates a graphical representation of a place, interacts with features within the landscape, and builds a personal narrative of that journey (Harris et al. 2011; Gould and White 1992). As users explore the virtual landscape they can concentrate on way-finding through the landscape or interacting with features that are of interest to them. While one user might focus on the visual elements and aesthetics of physical landscape in which the cultural representations are situated, another user may seek out interaction with cultural elements within the virtual environment. As part of this spatialization of place, we do many things such as view and navigate our surroundings, interact with objects and people, and even construct individual spatial narratives of our experiences (Staley 2007; Thompson 2003). Those experiences are an

important part of our understanding of the places we inhabit, and the mechanisms that we have all learned to help navigate the world around us can become powerful, active learning tools.

The notion of a unique spatial narrative, a story of an individual experience in a virtual landscape, can be a powerful tool in bringing virtual landscapes and immersive technologies to education. A sandbox, or free movement, approach to virtual worlds allows end-users to explore and have their own experience within the landscape. However, without points of interest or activity in the virtual landscape there is nothing to catch the user's attention or provide context for the content they are viewing. By creating a series of audio, visual, or action queues in the world it is possible to create a narrative with the space of the virtual landscape that fosters a user's sense of 'being there,' often referred to as 'presence.' (Beck et al. 2011) Extending the virtual landscape platform to incorporate these multimedia and interactive elements requires extensive research and design to capture the unique elements of place, and involving students in this process helps them gain experience in evaluating source material and synthesizing information for presentation within the virtual landscape. By guiding individual experience within the immersive virtual landscape through such embedded media and interactive elements, educators can then leverage the mechanism of a spatial narrative to convey concepts and information about the place that is the subject of the virtual platform. For example, visual or audio cues can guide users to explore the virtual landscape in a prescribed sequence, giving the designer some control over the user's exploration of the environment and shaping their experience to include specific elements (Galyean 1995).

Building on the authors' previous experience working with undergraduates in collaborative research, an ongoing project at Coastal Carolina University is more fully exploring the role of new ways of presenting information within an immersive virtual environment. Building on their interests in design and information visualization, two senior undergraduates at CCU worked with faculty on an interdisciplinary research project to explore the use of new natural user interfaces, such as Microsoft's Kinect sensor, as tools in exploring virtual landscapes with reconstructions of historic structures, and embedded scholarship and media about those features. Their *Project David* (Garofalo 2013; Rudolph 2013) built on the ongoing *Ashes2Art* initiative at CCU focused on digitally reconstructing buildings and monuments at the ancient Greek site of Delphi (Flaten 2009), and sought to develop a gesture and voice-based interface that will allow multiple users to explore the ancient Delphi 3D reconstructions in an immersive virtual landscape.

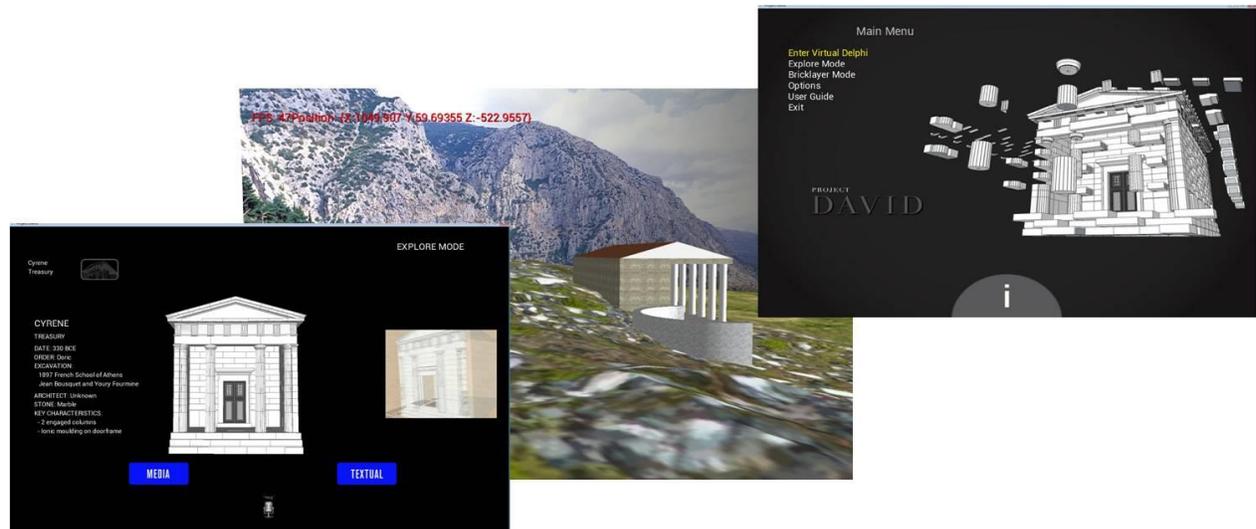


Figure 4. Screen Captures of Project David Prototype

One of the students' main goals in developing their *Project David* prototype was to leverage new user interface technologies to create a more dynamic platform for presenting information about the ancient monuments of Delphi that could also foster collaborative discussions and active participation by students and instructors. The prototype developed for *Project David* accomplished these goals by combining an immersive virtual landscape reconstruction of ancient Delphi with informational screens and multimedia

to delve further into the archaeological and scholarly evidence used to develop each reconstruction. These screens were accessed via voice and gesture commands that allowed the user to access information without exiting the virtual environment (Figure 4). This interdisciplinary project has allowed the students to work closely with faculty mentors in a number of fields, and the results of their research, including a technical prototype, were presented at a leading international conference on computing technology in archaeology (Garofalo 2013; Rudolph 2013) as well as at the Spring 2013 Posters on the Hill event, hosted by the Council on Undergraduate Research (Garofalo and Rudolph 2013).

Challenges and Opportunities

The pilot projects discussed above were designed as exploratory studies, to demonstrate the applicability of immersive virtual landscape environments as platforms for experiential learning through student participation in the design and development process. Each of the projects resulted in a working prototype that was informally tested by student and faculty users, with the focus on initial performance testing of the software. The experiential nature of the development and use of immersive and interactive virtual landscapes in undergraduate teaching and research can make quantitative assessments of their effectiveness somewhat difficult to capture. Subjective feedback from students about their experiences working through the design and development process and with the design prototypes was positive, however, and many students expressed interest in continuing their participation in future phases.

Preliminary work is already underway to implement formal testing of the applicability and effectiveness of the pilot projects outlined above. Currently, more robust evaluation methodologies for the design process and completed immersive virtual platforms are in development, with a focus on two areas: technical performance of the software itself and effectiveness for experiential student learning of domain knowledge. Standard technical performance measures for the software applications have the clearest set of quantitative measures associated with it. Performance thresholds for load times, frame rate, objects per scene, and other metrics assess how well the immersive virtual landscape applications function and provide the performance levels necessary to simulate real-world elements (Fullerton 2008).

The evaluation of the domain knowledge gained by students while collecting and creating the content represented in these applications is generally qualitative, requiring a measurement of students' content knowledge before and after their involvement with the project development. This combination of technical capabilities and domain knowledge provides an evaluation of the abilities gained by those students involved in the development. Surveys for both faculty and students involved with the projects will revolve around the learning experience both in terms of its content and the impact of being involved in undergraduate research.

Mechanisms for evaluating user experience are also an important component of virtual world development and implementation. To date, such feedback for the projects discussed in this article has been largely qualitative, via informal feedback from community participants and users. For example, the *Virtual Morgantown* platform has been deployed at a local history museum, where a comment sheet was included for visitors to provide information or remarks (Bergeron 2011). The response has been almost uniformly positive, but it does not provide a clear quantitative measure of the utility or usability of the project.

However, there are more robust approaches to assessing usability in immersive virtual environments, including quantitative measures of user task performance and user assessment of the immersive experience (Bouda 2012; Crisp 2012; Isbister and Schaffer 2008). As the projects discussed above move from pilot learning experiences centered on virtual world creation to projects that are intended to be used within formal educational settings to navigate and interact within domain specific content, the usability metrics are shifting from informal or expert driven feedback to a user centered approach. Currently, the authors are developing custom evaluation surveys as part of the next phase of implementation that will capture both quantitative assessment of the usability and effectiveness as well as qualitative survey questions that explore the students' engagement with the content presented in the virtual landscape platform.

The collaborative experiential learning projects outlined above are intended to provide students with a hands-on experience that combines existing knowledge with a new domain area. Computer Science students gained experience working with geographic information, Geography students worked with developing computer code or learning design principles. Additionally, these projects provide ownership of a portion of the project, often increasing the students' interest not only in the content, but in the research experience itself. The experiential learning potential of these projects or any undergraduate research initiative is perhaps best discussed in terms of how connected students become with the research project and how that connection fosters engagement with the material and the collaborative process.

Active and experiential learning projects involving digital technology can face significant hurdles at smaller regional undergraduate institutions. Classrooms may be older, and not equipped to provide instructors and students with access to digital tools, such as relevant software, internet connections, or audio and visual equipment. In addition, faculty members who are interested in exploring experiential learning through digital technologies such as immersive virtual landscapes may feel that they lack the necessary technical support. In designing a project around informatics, a number of questions must be addressed early in the planning phases. What technical resources are available to instructors and students? What is the minimum level of technical expertise required of the instructor and the students themselves? Is the scope of the experiential learning project appropriate for the level of instructor expertise and the time frame available? While the case studies discussed above did require a strong instructor background in the software tools utilized in designing the virtual landscape elements, there are a number of resources available to help educators interested in utilizing immersive virtual landscapes within their courses gain those skills.

Conclusion and Future Directions

With a significant focus on teaching loads at many undergraduate institutions dedicated to General Education courses, especially for new faculty, there is an understandable disconnect or retrenchment against the very technology and methodologies that have for years captured the attention and imagination of both faculty and students. The difficulty in scheduling lab access, lack of student computer savvy, and need to cover standardized content in General Education courses often pushes digital methods and technologies into upper level topical courses where only those “in the know” (minors, majors, or students from cognate disciplines) are likely to take classes and gain experience and interest in informatics scholarship.

While it is often those upper-level students who gain an interest and develop skill sets in digital methods who help to build and support virtual landscape projects, the projects themselves can then be used as experiential learning platforms in introductory classes. As students in those courses explore the completed virtual landscapes, their interest may in turn be piqued by the experience and push them to take courses that further delve into those topic areas. Or, they might be inspired by the technical complexity of the immersive virtual platform itself, and may seek out additional courses that can provide them with the skill sets to participate in the creation of such digital projects themselves. In departments that are social science and humanities focused, this could provide students with valuable interdisciplinary coursework and experience in STEM fields that open up a broader range of options in career paths.

Even with potential challenges, the use of immersive virtual landscapes with embedded multimedia narrative and interactive elements to explore topics within a particular course curriculum can provide a powerful mechanism for conveying concepts in a dynamic experiential setting. Students can utilize way-finding and navigation skills to explore and interact within virtual landscapes, experiencing those landscape elements and the information they convey, and creating an individual spatial narrative of that experience. Involving students in the design and development process creates a dynamic relationship between the students and the content they will explore and create in the virtual landscape. Finally, the development of immersive virtual landscape projects is an interdisciplinary process, and participation in such a project can give students valuable experience working as part of a collaborative team.

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