[Poster] CI-Spy: Using Mobile-AR for Scaffolding Historical Inquiry Learning

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Figure 1: (a) A virtual building with radar, (b) X-ray view of the Long building at CI, (c) Inside view of a virtual room.

ABSTRACT

Learning how to think critically, analyze sources, and develop an evidence-based account is central to learning history. Often, learners struggle to understand inquiry, to apply it in specific scenarios, and to remain engaged while learning it. This paper discusses preliminary design of a mobile AR system that explicitly teaches inquiry strategies for historical sources and engages students to practice in an augmented real-world context while scaffolding their progression. The overarching question guiding our project is how and to what extent AR technologies can be used to support learning of critical inquiry strategies and processes.

Index Terms: H.5.1 [Information Technology and Systems]: Information Interfaces and Representation (HCI)—Artificial, augmented, and virtual realities; K.3.1 [Computing Milieux]: Computers and Education—Computer Uses in Education

1 INTRODUCTION

History is a way of organizing and explaining the past, where the goal is to be able to construct our own version and understanding of past by critically analyzing the available evidence about past events and way of life. A deeper understanding of history requires active engagement during evidence analysis using historical inquiry techniques. Historical inquiry is the process of engaging in purposeful and reflective mental activities that strategically explore multiple perspectives through the reasoned drawing of inferences, the integration and synthesis of information, the evaluation of reliability and perspective, and the generation of possible understandings and interpretations.

Scholars have demonstrated that visiting historic sites and working with archival material can enhance the feeling of connection that visitors have to the past and can elicit emotional reactions in a far different way than rote memorization of historic data does. Visitors to historic locations can experience intense engagement, a loss of the feeling of the passage of time, and a connection with others

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across time and space. This suggests that placing learners within real historic contexts could have important benefits. However, a limiting factor in learning history is that the historical landscapes (unlike geographic landscapes) are physically inaccessible to us; therefore, it is hard for students to make sense of what cannot be observed. In absence of any tangible historical context, students have to rely on traditional props such as audio, video, photographs, and textual sources to mentally visualize historical structures and contextualize the events that took place at that site.

AR technology can facilitate students' abilities to make meaningful connections with situational context and to realize the concepts of time, continuity and change in ways that go beyond textbooks and timelines. AR can support history learning objectives by augmenting a historic site with computer generated imagery reflecting chronological snapshots of the site, thereby providing the experience of visiting the site at different periods of time (see Figure 1(a)). We aim to leverage the affordances of AR technology as scaffolding to teach students to think historically and truly engage in the process of critical inquiry.

Many researchers have used VR and AR scenarios to allow students to practice inquiry. [1, 2, 4]. Dede et al. [1] used design-based research strategies for studying situated learning in a multi-user virtual environment. Dunleavey et al. [2] used AR to contextualize and ground learning in a physical setting, in contrast with conventional classroom instruction which is typically decontextualized and abstract. Schrier [4] explored role of AR games to teach historic inquiry, decision-making, and critical thinking skills. While these applications demonstrate the ability of AR to incorporate a variety of topics into engaging, educational inquiry experiences, our research uses a historical topic as an example scenario to explicitly teach strategic methods of inquiry. Rather than just create inquiry activities, our research works toward guiding students to improve inquiry through scaffolded learning sessions.

2 PROJECT OVERVIEW

In this project, we explore how AR can (1) support students as they develop a deeper understanding of the concept of time, continuity and change for a historic site, and (2) provide an explicit hard scaffold and layered strategy instruction to teach historical inquiry strategies. We propose a mobile AR application that facilitates investigating the benefits of AR's affordances for strategy learning

by incorporating contextualized evidence presentation and in-place evidence analysis using historical inquiry. We propose to use this application to demonstrate how history students as young as fifth graders can learn the process of historical inquiry by analyzing evidence within an augmented real-world setting.

2.1 Case Study: Christiansburg Institute (CI)

We use a case study of a local historic site, the Christiansburg Institute (hence the name CI-Spy), a historic former African-American segregated school that existed until 1966. The legacy and significance of CI in terms of racial segregation make it an ideal case study for teaching local history as a gateway to regional and national history. The application provides access to this site by presenting in-situ virtual representations of buildings and pieces of evidence, explorable by chronological and physical navigation as only two buildings currently exist out of original 13.

To teach students to think historically and truly engage in the process of critical inquiry, the application incorporates an inquiry framework in our application that is based on our prior work on SCIM-C (Summarizing, Contextualizing, Inferring, Monitoring one's own thinking – Corroborating multiple sources of evidence), an explicit scaffold that was designed to help students analyze historical sources as part of engaging in historical inquiry [3]. We suggest that preparing students to engage in the process of inquiry while struggling with evidence can help bridge students into learning about the past and empathizing with the perspectives of earlier times. Moreover, dynamic media visualizations of chronological changes can provide a window into historic reconstruction and a method for inspecting an account.

3 CI-SPY: MOBILE-AR APPLICATION

The system will be used at an actual historic site (CI) by elementary school students; therefore the main requirement is that it should be hand-held and easily portable. It will provide 6DOF tracking to update the AR scene view based on a user's perspective. We selected the iPad as the platform to develop the application, and we are using its built-in GPS, inertial rotation sensors, and camera for tracking. We developed the application on Unity platform and used Metaio for point-cloud and marker-based tracking.

The functional design of the application is guided by two main activities of inquiry based history learning; in-situ evidence gathering, and in-place evidence analysis. These activities are performed in context of the real historical site to answer a guiding question of historical significance .

3.1 Evidence Gathering Activity

Pieces of evidence are collected from both virtual as well as real buildings at the historic site. The system uses GPS tracking to render the virtual buildings at the longitudinal and latitudinal coordinates of the original buildings on CI campus (see Figure 1(a)). Both the real as well as the virtual buildings are tagged with 3D textual annotations to identify the buildings. Various pieces of evidence such as historic videos, audios, textual sources and 3D models of artifacts are placed inside the buildings. The system also has a radar view at the top-right corner of the screen to provide location of the buildings with respect to the user. The blips in the radar view represent various buildings and are rendered in different colors based on if the building is yet-to-be visited, already visited, or next-to-be visited (see Figure 1(a)).

To provide temporal/chronological context, a timeline slider is implemented in the application. By moving this slider, students can see various buildings come in and out from their views of the CI landscape, and by setting the slider to a particular year they can see the buildings that existed during that time period.

For collecting evidence from the virtual buildings, students are teleported inside the virtual buildings (see Figure 1(c)), where var-

ious pieces of evidence are strategically placed according to the historic context of that building (e.g., virtual classroom at CI would have various posters on the walls, a carpentry class would have 3D models of furniture). The students tap on these pieces of evidence and analyze them as explained in the evidence analysis activity in the next section. Once the analysis is done, the piece of evidence is stored in the student's virtual backpack for later access.

The evidence from the real buildings is collected using x-ray vision. The system uses point-cloud tracking and occlusion culling to present pieces of evidence inside the real building. As shown in Figure 1(b), the students look inside the real buildings through virtual windows. They can then select a piece of evidence and analyze it as explained in the next section.
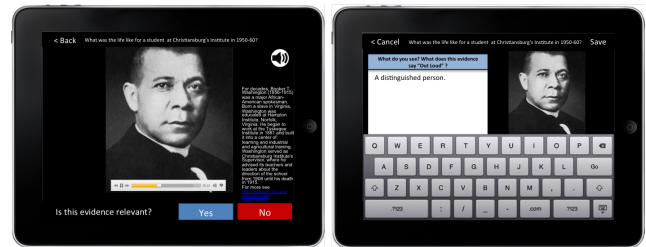

Figure 2: (a) The evidence viewer, (b) The evidence analysis screen

3.2 Evidence Analysis Activity

The goal of this activity is to actively engage students to analyze evidence in the context of the guiding question when they are physically present at the historic site. We hypothesize that physical presence, AR as hard scaffold, and in-situ evidence analysis using SCIM-C activities will deeply engage students in the "doing" of history, facilitating inquiry-based thinking. The evidence is selected from real/virtual building and displayed in the evidence viewer (see Figure 2(a)). Along with the evidence, any additional information such as audio or descriptive text is also displayed. Students study the evidence and then indicate if the evidence is relevant. Then, they are shown an evidence analysis screen to answer more SCIM-C questions (see Figure 2(b))

3.3 Conclusions and Future Work

We present CI-Spy, a mobile AR application to teach inquiry in context of history learning. We plan to further refine and evaluate our system by comparing it against conventional instructions by conducting informal evaluation sessions with fifth-grade students and teachers.

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