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# RedCAP + Unity = Immersive Data Collection. Developing a Stealth Spatial Watershed Map Learning Task in VR

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**Abstract.** This iLEAD paper presents the design of an immersive learning experience integrating REDCap, a secure research data management platform, with Unity, a leading game engine, to create a spatial watershed map task in virtual reality (VR). The project introduces an innovative "stealth" data collection methodology, seamlessly embedding assessment tools and measures into the VR environment without disrupting user engagement. Players interact with a GIS-based watershed map as part of a narrative-driven experience, while contributing to data collection. Key design elements include dynamic visual feedback, and user-centered map interaction mechanics, such as selectable landmarks with drop-down lists. By aligning immersive storytelling with rigorous data collection, the design enables authentic and real-time assessment of spatial knowledge acquisition. Initial testing highlights usability for first-time VR users across diverse age groups, showcasing the potential for designing immersive, data-rich educational tools that blend research with compelling virtual experiences.

**Keywords:** Stealth Data Collection, REDCap, Immersive Research Experiences.

## 1 Introduction

In immersive learning, bridging data collection with interactive experiences presents an exciting opportunity to enhance educational research and practice. This paper introduces a novel approach that combines REDCap, a secure web-based platform for research studies [1], with Unity, a leading game engine, to create an immersive embedded task that collects data seamlessly within a virtual reality (VR) environment. By leveraging a spatial watershed map task set in VR, we explore the potential of "stealth" data collection (i.e.,where user interactions naturally yield research insights without disrupting the learning flow). This integration supports immersive data collection that is both user-centered and rigorous, advancing methodologies in spatial environmental science education with applications to other content disciplines. Our work suggests a way to use VR both as a learning as well as data-gathering tool, expanding the possibilities for real-time and authentic assessment in virtual environments.

## 2 REDCap

REDCap (Research Electronic Data Capture) is a secure, web-based platform and set of electronic data capture tools, developed by Vanderbilt University and hosted at our institution, which support the collection and management of research data, particularly in academic and healthcare settings. REDCap is designed to facilitate secure and efficient real-time data collection/entry for research studies through customizable online surveys and databases. It supports various data types, including text, numbers, dates, and dropdowns, as well as the option to create validation rules to minimize errors. Since it has native integration with third-party software (e.g., Unity), REDCap supports data management in formats including CSV, Excel, SPSS, SAS, Stata, and R for further analysis. Its version control and tracking features also allow researchers to monitor changes, maintaining the integrity and reliability of collected data over time. REDCap's intuitive interface supports various research designs (e.g., online, offline, cross-sectional, longitudinal) and enables reliable offline data collection at VR outreach events with limited internet connectivity.

### 2.1 REDCap's API: The Key to Immersive Data Collection

The REDCap API (Application Programming Interface) is a feature that facilitates automated data exchange between REDCap and external applications, such as Unity, which is commonly used in immersive learning environments. Through the API, Unity can send and retrieve data from REDCap in real time, enabling interactive and dynamic data collection during immersive gameplay. To establish this connection, an API key (i.e., a unique sequence of 32 random numbers and letters that identifies a specific REDCap project) allows authorized applications to access and exchange data with REDCap securely. This functionality supports seamless data retrieval, submission, and integration, allowing researchers to avoid redundant data entry. The API also allows for standardized data collection when a study codebook is predefined in REDCap, which minimizes the need for post-processing data (e.g., reverse-coding). Therefore, this integration REDCap + API + Unity streamlines data management, making it easier for researchers to analyze results efficiently while maintaining data integrity across platforms.

## 3 Stealth Data Collection

Integrating various types of data collection within digital learning environments has become a more common game design technique, as it enables researchers to gather real-time data on learners' progress, behavioral patterns, and even survey responses without intentionally disrupting the immersive experience of gameplay. With headset VR (hVR) experiences, participants often complete external digital surveys (i.e., outside of the VR experience) or paper-based instruments right after they have been highly engaged by playing with a VR device to avoid getting fatigued due to extensive time wearing a VR headset. This is especially important when conducting studies with high percentage of first-time VR headset users, especially with older-aged participants. To address these challenges, we began embedding data collection tools within the storyline of immersive learning experiences. Therefore, we refer to this technique as "stealth" data collection, since it was inspired by the work on stealth assessments in video games and learning [2].

## 4 The Spatial Watershed Map Task

A spatial map identification task is a cognitive task where participants are required to learn, recall, or identify specific locations on a map. It is used in educational research to study spatial memory, attention, and learning processes related to spatial information [3]. Such tasks focus on survey knowledge by providing users with a bird's-eye perspective of an environment that is obtained through visual representations, such as maps [4]. In these tasks, participants are exposed to a map from an overhead perspective for a set period and later asked to identify or recall specific locations or features on it. In a spatial map identification task, participants are typically given time to explore locations or routes on a map. Later, they are asked to identify or place landmarks on a blank or partially filled map. Sometimes, the task may involve selecting correct locations from multiple options.

These survey knowledge tasks can assess learner understandings of layout, relationships, and distances between different locations in a geographic space, because participants are required to comprehend the overall structure of the map, understand spatial relationships, and place locations in the correct context. Spatial map identification tasks have been used in virtual environments for locating landmarks and transferring information on a map [5, 6]. Richardson [5] found that learning in a virtual environment is a highly predictive of learning about a real environment and performance increases when aligned with the map orientation in the experience.

## 5 Background: The Immersive Experience

As part of our VR research design with Watershed Explorers: Industrial History [7], we were interested if the hVR experience would promote enhanced survey knowledge of the Lehigh River watershed. In the prologue, players are tasked with kayaking down the Lehigh River and will explore seven locations with a goal to select one location to promote tourism at that location. As part of the learning experience, players are exposed to a GIS-developed watershed map media at multiple times during the experience.

First, a watershed map image displays the itinerary enhanced by GIS features (see Fig. 1). Still during the tutorial, players watch a two-minute video about the Lehigh River watershed. The video features a GIS map, audio narration, and closed captions to provide a guided overview.

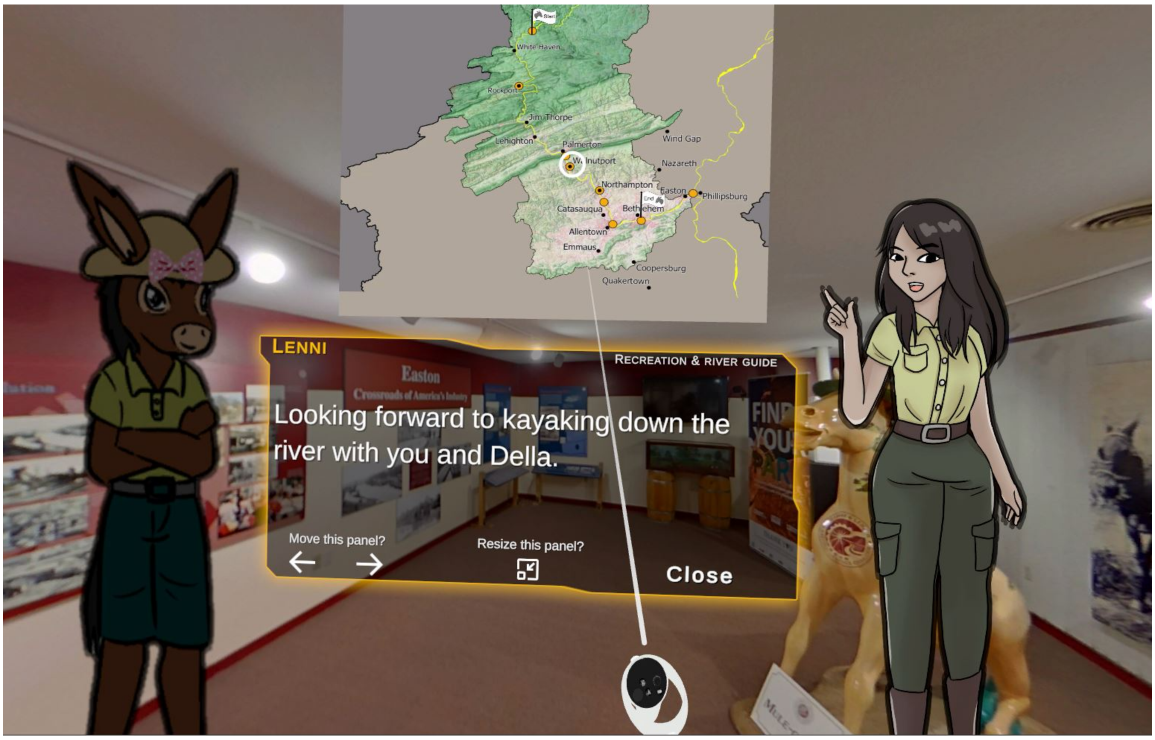


**Fig. 1.** Two white flags mark the itinerary of the kayak expedition in the watershed map. The GIS features include a land use layer, the watershed boundary, main rivers in yellow, place names of cities and towns along the river, and an orange circle for each exploration site of the trip.

After players complete each visited location during the exploration stages, they also see the watershed map in a short animation to illustrate their kayak trip progress. During each transition, a kayak with two of the avatar guides travels down the river from one location to the next leaving a thicker and orange-colored path on the map to highlight the spatial route as they move between the two locations (see Fig. 2). Additionally, each location name is always displayed in the immersive interface to let the player know their current location during the experience.


**Fig. 2.** A kayak carrying two avatar guides moves along the river during transitions, leaving an orange path on the map to highlight the route between locations. This sequence is presented within an immersive video interface, enhancing the experience of a realistic environment.

## 6 Immersive and Stealth Data Collection

To assess players' survey knowledge of the watershed, we developed a pre-and post- stealth assessment map identification task. The same GIS map image without the place names was used for this assessment. The assessment image includes a white rotating circle displayed on the map over each location of interest (i.e., the cities and towns marked with a big orange dot). The player is prompted to select each circle and identify each location. When the player points the raycast (i.e., the virtual pointer) on one of the white rotating circles, a drop-down selection list including the name of the nine locations is displayed. Players make their selection by clicking the location's respective name. The selected name is then displayed on the map (see Fig. 3). After all nine selections are made, the player can submit their choices.


**Fig. 3.** Players select locations by clicking their respective names, which are then displayed on the map. Once all nine selections are made, the interface allows the player to submit their choices by changing the non-interactable button "Not yet finished" by a colorful and interactable button displaying "Submit now".

### 6.1 Initial Testing

We first conducted a series of early prototype tests in our lab to ensure the task could be completed and the data would be captured as designed. Next, we tested our initial protype with center directors and education specialists at two different industrial history museums ($n$ = 4). Feedback from these tests resulted in creating a player option for enlarging the map to make the drop-down target easier to select with the raycast.

Next, we prototype tested the pre- and post- map identification task at a summer expo that was held at our institution on August 1st, 2024. Twenty-one participants provided feedback, with the most significant usability issue being a glitch triggered by pressing multiple buttons simultaneously on the headset controller. This input combination disabled the digital pointer, preventing interaction with the immersive interface. As a result, five participants were only able to complete the pre-test assessment map stealth survey. Given that most participants were using a VR headset for the first time and were still familiarizing themselves with the controller layout, it is understandable that accidental multi-button presses may have unintentionally activated the glitch.

### 6.2 Preliminary Findings

Sixteen participants, who reported being male ($n$ = 8) and female ($n$ = 8), with ages ranging from 18-80 years old completed both map identification tasks in the hVR experience. Data was coded in the API as "1 = correct" and "0 = incorrect" for each selected location. Pretest scores had a mean of 2.31 (SD = 2.72) and posttest scores had a mean of 3.63 (SD = 2.19). A paired t-test was conducted and resulted in $t$ = 3.085, $p$ = .004. Thus, a statistically significant difference was found from pretest to posttest with the map identification task, resulting in an increase of the participants' watershed survey knowledge with a small sample size ($n$ = 16). We viewed our prototype as a success, especially given the fact that many users were first time VR headset users including a 79 and an 80-year-old participant.

## 7 Conclusion

The integration of REDCap within Unity to create an immersive, data-driven VR learning experience opens new avenues in educational research and practice. This paper demonstrated how embedding data collection within a spatial watershed map task in VR promotes seamless, "stealth" data collection, minimizing disruptions while maximizing authentic assessments. Using this process, learners' natural interactions within the VR environment yielded meaningful data that informs research on spatial memory, attention, and overall learning efficacy. The concept of embedding stealth assessments within immersive learning narratives underscores the potential for more engaging, rigorous, and meaningful learning assessment interactions. All participant data is securely stored within the REDCap system, accessible only to authorized researchers in accordance with institutional data privacy policies.

Looking ahead, our prototype serves as a foundational mechanism for immersive, data-rich learning experiences that bridge educational research and practice. Continued exploration of "stealth" data collection and integration strategies will broaden the scope of applications across content disciplines. The convergence of immersive learning with embedded data collection technologies holds potential for educators, researchers, and lifelong learners to experience and promote deeper engagement, continuous feedback, and evidence-driven educational innovation. Thus, further enhancing not only how learning is experienced, but also how learners' behaviors and input can be measured in interactive immersive environments.

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