Requirements Document

Version 1

DIGital

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Accepted as baseline requirements for this project

For the client

For the team

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Introduction

The archaeology education curriculum trains aspiring archaeologists through hands-on experiences such as traditional field schools. These programs teach students fundamental research and excavation techniques that are essential for professional work. Approximately 20,000 students attend field schools worldwide each year, and the field contributes an estimated USD 1.28 billion annually to academic and heritage-related sectors [1]. Field schools are vital because most professional archaeology positions require prior field experience, making these programs a critical stepping stone in both career development and the preservation of cultural heritage.

Our sponsor, Dr. Kayleigh Sharp, is an anthropological archaeologist and assistant teaching professor at Northern Arizona University (NAU), specializing in underrepresented archaeological groups in the Lambayeque region of Peru. Her work sits at the intersection of archaeological research and education, aiming to make hands-on archaeological training more accessible to students and enthusiasts. When she is not out in the field, she lectures several classes at NAU, including introductory archaeology classes. Her hope for this project is to provide an inexpensive and accessible way for aspiring archaeologists, and anyone interested, to learn and practice archaeological processes. She has also expressed interest in using the product in her introductory archaeology courses, as well as potentially out in the field in Peru.

Problem Statement

Although field schools are important to an archaeologist's career, there are several issues that prevent newcomers from enrolling. Each year, thousands of aspiring archaeologists are unable to pursue training due to the high cost of traditional field schools. Furthermore, the physically demanding nature of fieldwork often limits participation for individuals with disabilities.

Currently, there are several courses online that could serve as alternatives. However, they primarily aim to inform students about archaeological theory and history. Field methods are presented in a more conceptual manner, offering little to no hands-on experience. Few options implement actual archaeological field methods. Examples include the CHI 2021 Student Game Competition submission RelicVR and our sponsor’s virtual experience of the free slave settlement, Miller Grove. While both give people the ability to practice field methods, neither goes in depth enough to replace nor supplement traditional field schools.

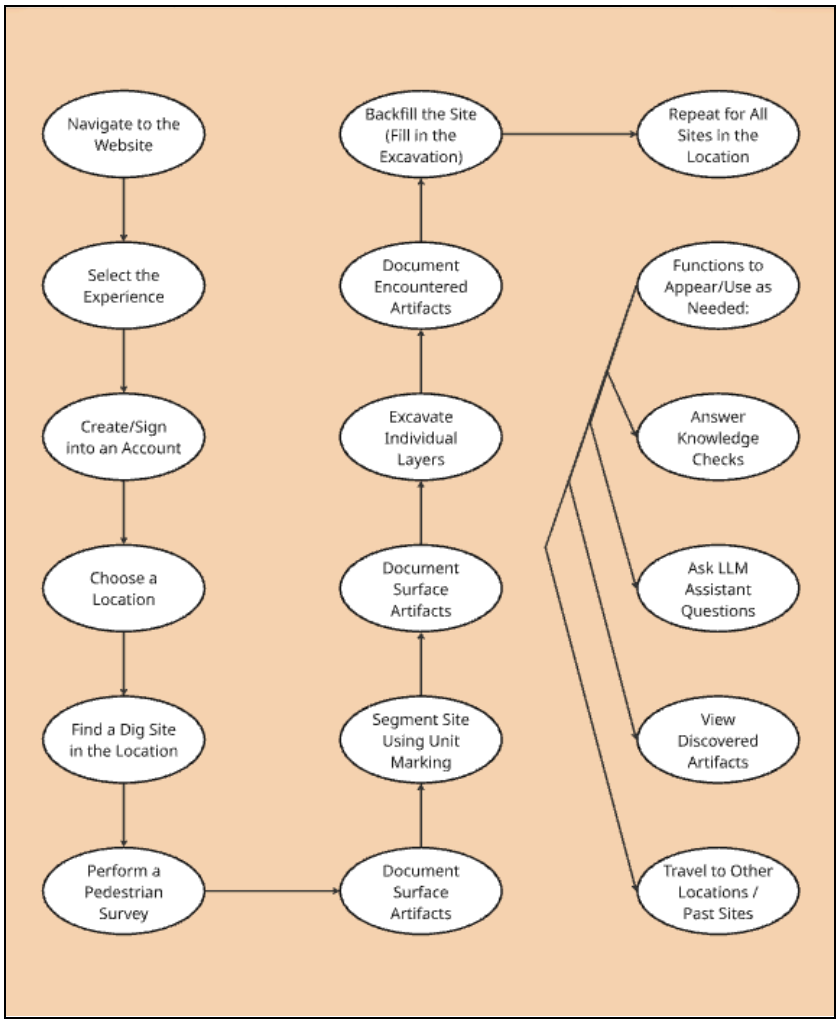
Identified Issues:

- **Field schools are expensive:** The cost of traditional archaeological field schools ranges from $3,000 to $15,000, making it difficult for those with less financial stability to enroll [1].
- **People with disabilities are not able to participate:** Field schools require students to work in the field and perform physically demanding tasks, which can make participation challenging or inaccessible for some individuals with disabilities.
- **Previous approaches lacked depth:** Alternatives to field schools, such as online courses and virtual experiences, do not provide students with a true understanding of real-world excavation practices, nor do they offer sufficient depth of learning.

Solution Vision

The solution we intend to create will be a virtual experience made in Unity. The experience will use data, artifacts, locations, and procedures from real-world dig sites, allowing aspiring archeologists to practice attending a real field school experience. This program will also include learning checks to ensure that the student is retaining information, as well as an LLM assistant trained to answer both general questions about the archeological process and cultural questions about the sites they uncover. This entire experience will then be deployed to the web and attached to a database for login, allowing students to keep their progress across devices and pick up right where they left off.

A general idea of how this experience will be used can be seen in the flowchart below:



Overall, this virtual experience will allow students to practice and understand the procedures they will have to perform if they ever go out into the field. This will change the education industry by allowing more people to participate in and gain an understanding of archeology in the field.

Project Requirements

1. Domain-Level Requirements

Domain level requirements are the high-level requirements that make up our minimal viable product. These requirements outline the features that our users need from a technical point of view.

D1. Archaeological Methods: The system must allow the user to perform archaeological field methods such as the pedestrian survey, unit marking, excavation, and backfill.

D2. Artificial Intelligence Learning Assistant: The system should include an artificial intelligence assistant that allows the user to ask any questions, specifically questions about the methods they are using or the sites they are exploring.

D3. Knowledge Checks: The system shall provide users with knowledge checks at regular intervals throughout the learning experience to reinforce retention of the methods taught.

D4. Artifact data collection & analysis. Users must be able to record detailed information about the artifacts they find based on a set of criteria provided by Dr. Sharp. The database must store all this information so it can be analyzed at a later time.

D5. User Interface: The user interface must be easy to navigate and understand to ensure this solution is not equally challenging for those with disabilities.

D6. Account Management: The experience must allow users to create an account and sign-in across multiple devices. The database must host this information and allow users to save their game progress.

2. Functional Requirements

Functional requirements outline all the specific functions that our application will have based on the domain-level requirements spelled out above.

F1. Archeological Methods

Use Scenario: As a user, I want the virtual sites I interact with to be comparable to the real ones, so that I can perform the same procedures on them as I would perform at an actual dig site.

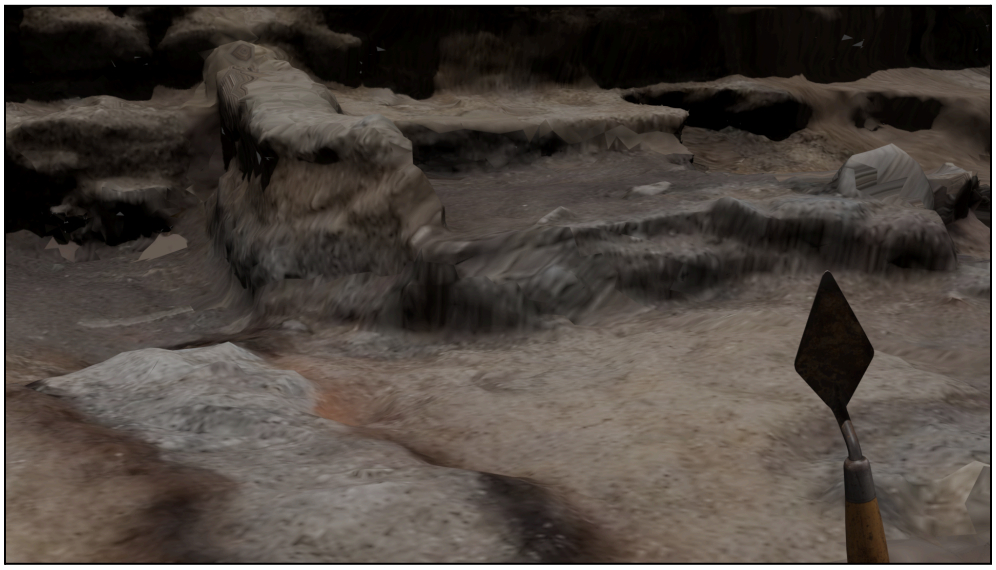
> **F1.1 Environment:** The assets used to create both the site and surrounding terrain will be modified files from drone and LIDAR scans. The scenes created will be compared against the sites they are based on in order to ensure authenticity.
>
> **F1.2 Procedures:** The procedures used in the excavation process will be taken directly from journals written during the real-world excavations of these sites. These will be presented in a step-by step list so the user can know how far along they are and what they can expect their next steps to be.

F1.3 Tools: Each procedure will require a different array of tools. The user will need to select the correct tool from those provided in order to perform the given procedure.

F1.4 Artifacts: The artifacts will be placed in similar positions to where they were discovered in the real-world sites to ensure the virtual excavation plays out similarly to the real one.

F1.5 Loss Conditions: It will be possible to perform the necessary procedures incorrectly, resulting in potentially broken artifacts. This will be reflected in an overview screen after the excavation is complete.

Prototype:



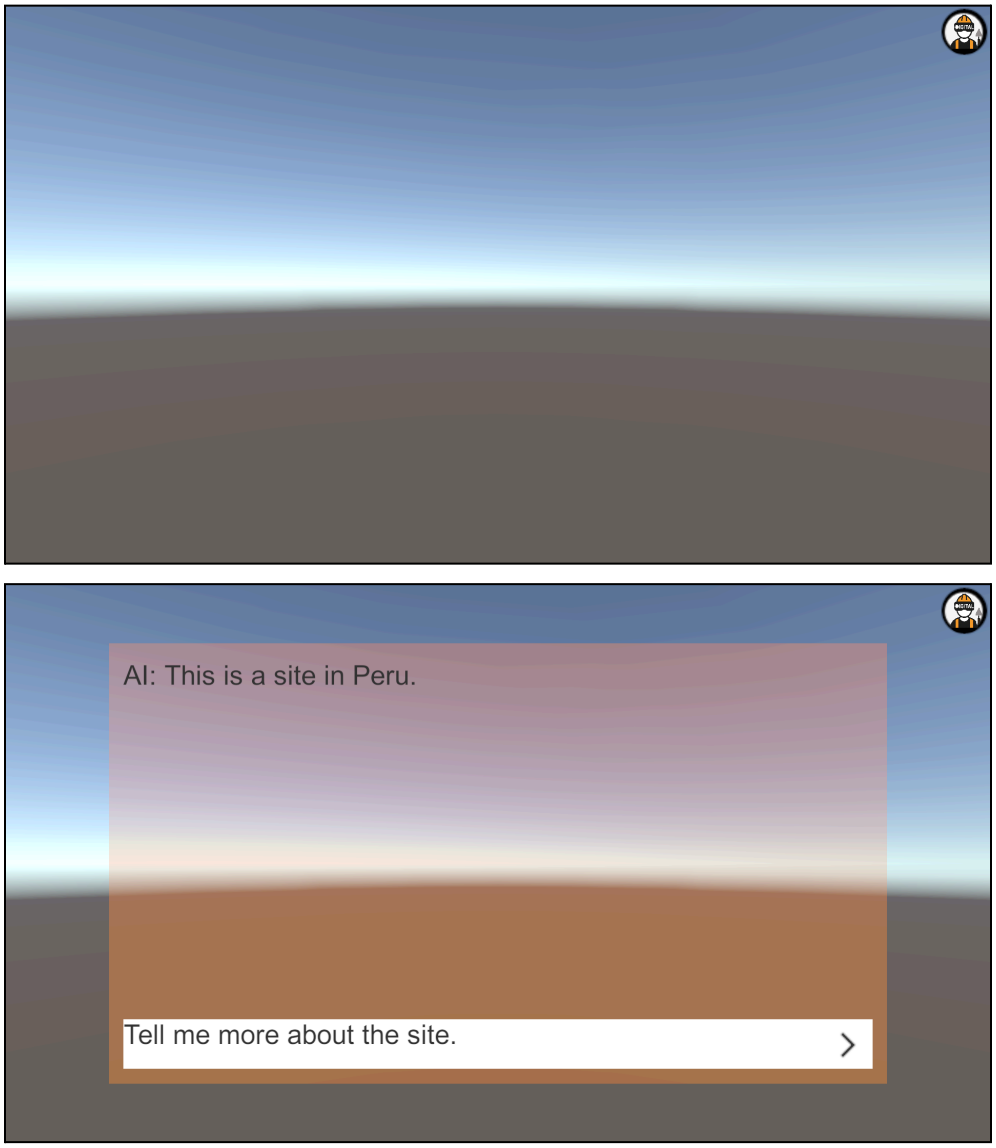
F2. Artificial Intelligence Learning Assistant

Use Scenario: As a user, I want to be able to ask questions about the experience, the archaeological methods, and the sites I explore, so that I can get the most out of the experience and learn more.

F5.1 Assistant Interface: At any time during the experience, users will be able to click a button shown on the screen to display the assistant interface. They can also press the assistant hotkey to bring up the menu. It can also be closed using either method.

F5.2 Querying: With the assistant interface open, users will be able to ask any questions they may have pertaining to the experience, for example, the methods they are learning or the sites they are exploring.

Prototype:



F3. Knowledge Checks

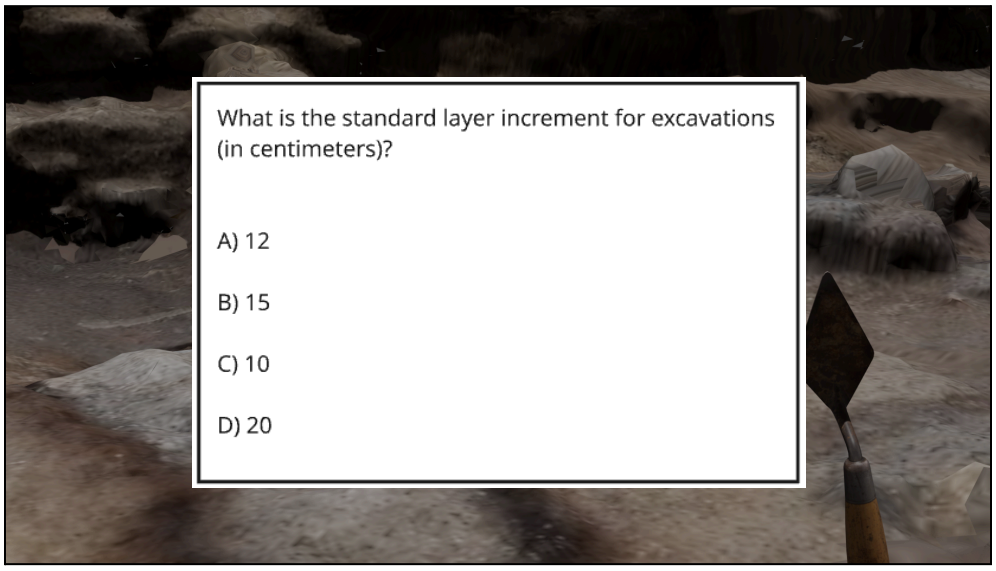
Use Scenario: As a user, I want regular checkins, so that I can ensure I am retaining all the information I am learning.

> **F4.1 Tutorials:** For the first time each procedure is presented for the player to follow, they will be given a step-by-step guide to complete it. This will mainly be used to familiarize the player with the game's functions and how to perform those actions in the experience.

F4.2 Frequency: After the player performs a new procedure for the first time, they will be prompted with a learning check to evaluate how well they absorbed that information. If the player got answers wrong, the incorrectly answered questions will be recorded. Additional checks will then appear after future instances of those tasks until the question is answered correctly.

F4.3 Review: A text form of the tutorial and all previous (correctly answered) knowledge checks will be available to the player at any time following the completion of the tutorial.

Prototype:



F4. Artifact Data Collection & Analysis

Use Scenario: As a user, I want an easy, fill-in-the-blank database where I can quickly enter artifact information, so that I can go back to excavating and reference the artifact recordings at a later time.

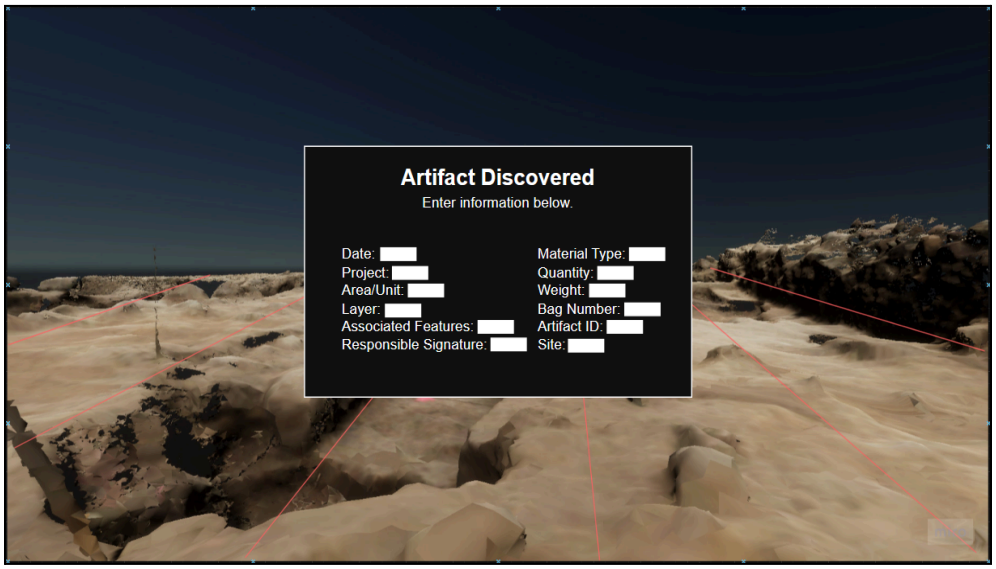
F4.1 Discovery: Upon discovery of an artifact, users will be prompted (via pop-up) to enter predetermined information about it.

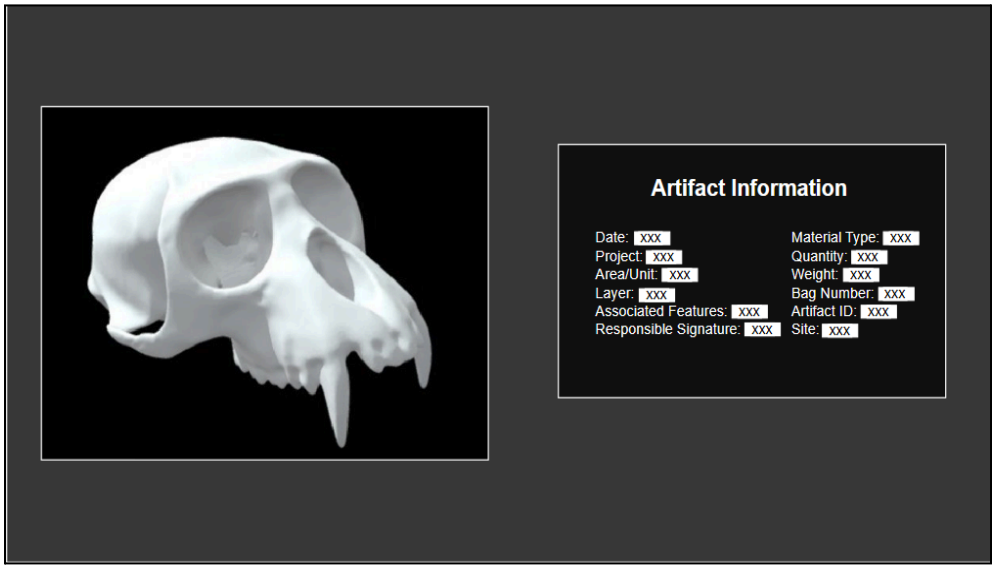
F4.2 Recording: All the recording information will be provided, and includes, but is not limited to the date, area/unit, excavation layer, material type, quantity, weight, bag number, and artifact ID.

F4.3 Saving: Once the artifact information has been recorded, the data will be saved in a table in the PostgreSQL database so it can be revisited when needed.

F4.4 Analyzing: After the backfill portion of the excavation process has been completed, users will be able to view any artifacts that they have previously discovered. The analysis will contain a 3D model of the artifact and will be accompanied by the information previously recorded by the user.

Prototype:





F5. Front End and User Experience

Use Scenario: As a user I want to experience a visually appealing landing page that will have easy navigation, allow me to learn more about the product and team, and be my launch pad for the rest of the product.

F5.1 Landing Page: When going to our website users will be able to see an appealing and thematic webpage that will be the base for all aspects of the product

F5.2 Navigation: Users will be able to navigate between digsites, their learning page, and information for the team and Dr. Sharp

F5.3 Accessibility: Users will also be able to change account information, web-page settings, and more in the final build

Prototype:

F6. Account Management

Use Scenario: As a user, I want to be able to create an account so I can login across multiple devices that share my saved progress. I also want to be able to load previously saved progress, so I don't have to restart the excavation process each time I log in.

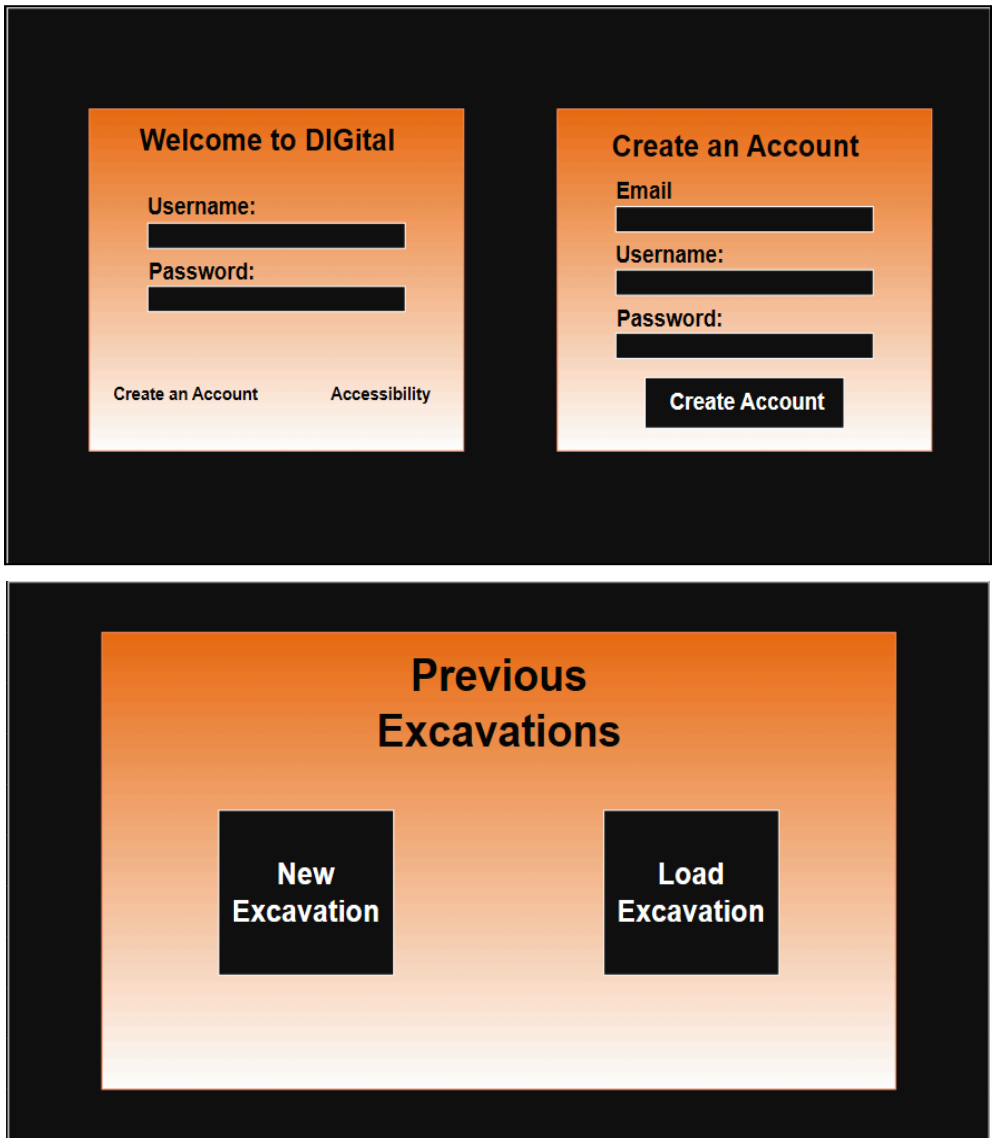
F6.1 Initial Start: When first booting the VR experience, users will be prompted to sign in, or if they don't have an account, sign up.

F6.2 Recording: All user information must be entered and saved into the PostgreSQL database for authentication purposes and later usage (logging into the experience, saving excavation progress, etc.).

F6.3 Saving Game State: Once users have created an account and have begun on their excavation process, they may at any time save their current game state to come back to later.

F6.4 Accessibility: When initially signing up, users should be able to set their language preference.

Prototype:



3. Performance Requirements

P.1 Overview

The performance of the project needs to be a top priority before the last build is deployed. As mentioned earlier these archaeologists might not have access or the money for high end equipment, might not have internet access out in the field, and will still expect a product that works well for them. In order to provide this service no matter the technology used DIGital needs to make sure our product can work on low specs and that the product works quickly in the field.

P.2 Minimum Expected Specs
The project should work effectively on any high end device but also on

- Devices that are at least 10 years old
- Laptops and Desktops as the main audience
- Possibly limited phone compatibility
- Both Linux and Windows
- Any network with a speed of at least 5mbps

P.3 Expected Speeds

CATEGORY	METRIC	TARGET
Frame Rate	Excavation Gameplay FPS	30+ FPS
Load Time	Excavation Scene Load	<8 Seconds
UI Response	Button/Menu Interaction	<150 ms
AI Response	Time to Answer	<4 Seconds
Database	Saving / Loading	1s save / 5s load
Assets	3D Artifact Model Size	10mb
Concurrent Users	Server Responsiveness	100+ users

P.4 Offline and Other Capabilities

Offline capabilities will be limited. Our product will be primarily used with a secure wifi connection however the archaeological process game will still be available as well as the AI assistant. The game should be able to be played with no internet connection but can't be saved or loaded while the AI assistant will be available but might have slower answer times.

4. Environmental Requirements

E.1 Software & Development Tools

The environmental requirements that this project is subjected to are mainly self-regulated. Our client has given us full discretion in regards to what software we use to create the experience, and while we are taking inspiration from previous software, we will be building the framework from scratch.

E.2 Academic Integrity

As we are working with education, it is worth mentioning that we will not be in danger of violating academic integrity when it comes to grades. This is because the learning checks will not have an influence on a student's grades and are purely a tool for self-reflection.

E.3 Consent From Affected Parties

Finally, because this project involves archeological sites from different countries, it is important to ensure that information, images, and likenesses are used with express permission of the country of origin. All of the resources regarding the sites used within this project have followed the wishes of Peruvian representatives, first being published in Spanish exclusively for a period, then released in English. All of the resources are currently open sources and available to the general public, and this project only aims to make this information more easily accessible and useful.

Potential Risks

Several potential risks for our users have been identified and could impact development or accessibility of the VR experience. These risks were identified based on likeness of occurring and the severity of the impact.

Risk	Probability	Impact
Experience Availability	High	High
Technical Complexity	Medium	Medium
Artifact Information Misinput	Medium	Low

Risk Identification:

1. **Experience Availability:** Due to the estimated size of the experience and the number of assets and scenes we plan to use in Unity, users may encounter reduced frame rates, slow client/server interactions, and even the possibility that the experience may be totally inaccessible without medium-ranged hardware and a stable internet connection.

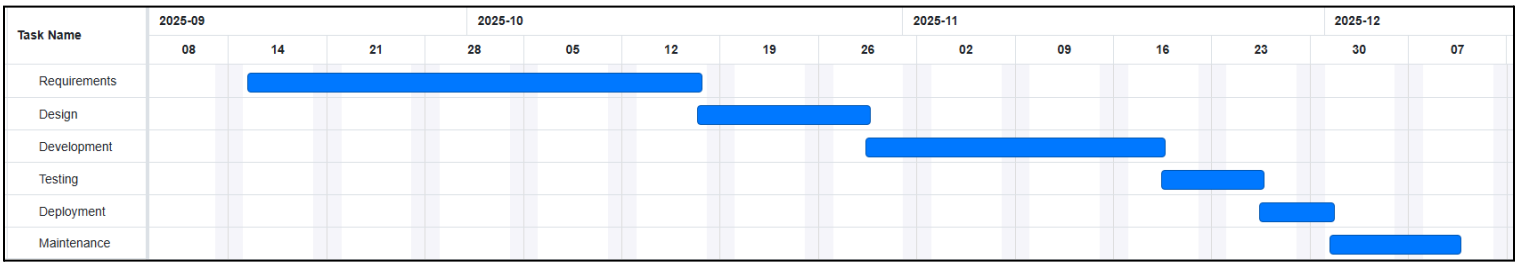
2. **Technical Complexity:** Our experience isn't geared towards users with advanced technical software development skills or knowledge, but rather aspiring or practicing archeologists. Because of this, some features of the experience may hinder user progression due to technical comprehension.
3. **Artifact Information Misinput:** While users are recording artifact information, a misinput may occur. This would result in inaccurate information during the analysis phase, and therefore may lead to inaccurate conclusions.

Mitigation Strategies:

1. **Experience Availability:** While developing, we will conduct frequent FPS tests to identify where we may be able to optimize the experience for user performance. Additionally, while creating an account, users should be able to limit their FPS to boost their machine's performance.
2. **Technical Complexity:** An additional domain-level requirement is the implementation of the AI assistant. This assistant will be able to provide users with assistance and guide them through the excavation process if technical difficulties occur. Additionally, users should be able to ask open-ended questions to the AI assistant if a specific issue arises.
3. **Artifact Information Misinput:** While users are analyzing artifacts, if they were to notice inaccurate information they should be granted the option to alter any recordings from the initial artifact discovery. If a user were to miss an inaccuracy, the experience should prompt them during the analysis phase to re-examine the recorded information. This will be made possible by cross-checking an accurate artifact information database with the user's recorded artifact database.

Project Plan

Given the project's complexity and fixed timeline, and because our requirements are well-defined with a single primary stakeholder, the DIGital team decided the best course of action to follow for the development process would be the Waterfall methodology. Waterfall's sequential phases and clear milestones will help us focus resources, reduce context-switching, and keep our development schedule predictable. Below is a timeline of the major stages of our project, with the waterfall development process outlined with well-defined milestones.



Waterfall Development Process:

- The waterfall procedure is a software engineering methodology for large-scale, complex projects. It's characterized by sequential project phases that outline clear and stable requirements. Each phase has explicit start and end dates and deliverables, with the next phase only beginning when the prior phase is complete.

- **Phases:**

    - **Requirements (9/15 - 10/17):** The goal of the requirement phase is to identify our customer and their needs. In our case, Dr. Sharp desired a web VR experience that could be used to help bridge the gap between traditional archeological field schools and a remote interactive learning environment. Deliverables included a project mini-intro and a technology feasibility document that outlined design decisions and potential technological challenges.
    - **Design (10/17 - 10/29):** The design phase aims to convert the needs of our client identified in the requirements phase into a detailed and well-designed software solution. For us, that meant creating non-functional prototypes of the domain-level requirements and their corresponding functional requirements. Those include:

        - Virtual site development with real 3D assets.
        - An interactive AI assistant to help guide our users.
        - Periodic knowledge checks after each step of the excavation process to educate our users.
        - An artifact information database where users can record information about artifacts they find to analyze later.
        - An option to create an account so users can log in across different devices and save their excavation progress.

    - **Development (10/29 - 11/19):** The development phase intends to transform those non-functional prototype designs into functioning software which can be delivered to our client.
    - **Testing (11/19 - 11/26):** The testing phase aims to test the functional prototypes built in the development phase. Multiple rounds of testing will be conducted and shall include alpha testing (testing by the development team) and beta testing (testing done by a set of customers, e.g., Dr. Sharp's digital archeology team).

- **Deployment (11/26 - 12/1):** After the software has been thoroughly tested, deployment to our client and other end users will occur. Deliverables include a minimal viable product, e.g., a solid web VR experience that includes all domain-level and functional requirements listed in this document.
- **Maintenance (12/1 - 12/10):** After our software is initially deployed, the DIGital team will work hard to maintain it. Error testing and functionality maintenance will continue along into the second semester, and more functional requirements will be added.

Conclusion

The high cost and physical demands of traditional archaeological field schools have created a significant barrier to entry for aspiring archaeologists and enthusiasts worldwide. By restricting participation to those with financial means and physical ability, the field risks losing talented individuals who could contribute meaningful work to archaeological research. Dr. Kayleigh Sharp and DIGital recognize this problem and have come together to find the solution to archaeological education.

The virtual archaeological experience outlined in this document addresses the core accessibility challenges through an immersive, web-based platform. By leveraging authentic data from real dig sites including drone and LIDAR scans, artifact positions, and excavation procedures documented in field journals, our experience will provide an interactive and genuine hands-on learning tool comparable to traditional field schools. Features like the integration of an AI learning assistant will ensure that users can receive personalized guidance regardless of their technical background, while knowledge checks reinforce critical learning outcomes. Account management and cross-device synchronization will enable students to engage with the material flexibly, fitting archaeological training into their schedules and technical/physical constraints.

With this foundation in place, the DIGital team is positioned to create a transformative educational tool that extends archaeological training. By making authentic archaeological methods accessible, affordable, and inclusive, this project has the potential to reshape how the next generation of archaeologists learns and engages in the field. We are confident that successful delivery of this virtual experience will expand opportunities for aspiring archaeologists while advancing the broader archaeological community.

References

[1] Dataintelo Consulting Pvt. Ltd. (2024). *Archaeology Field School Travel Market: Global industry analysis, growth, size, and forecast 2025-2033*. https://dataintelo.com/report/archaeology-field-school-travel-market

[2] Heath-Stout, L. E., & Hannigan, E. M. (2020). *Affording archaeology: How field school costs promote exclusivity*. Advances in Archaeological Practice, 8(2), 123-133. https://doi.org/10.1017/aap.2020.7