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Design and Instructional Use of a Multi-Terminal Virtual Reality Platform for Civic Education

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Abstract Access to historical sites, staffing, and equipment can constrain practical civic education. This design paper describes a multi-terminal virtual reality (VR) platform for presenting reconstructed historical settings in a guided lesson. The design brings together source collection, terrain and character modeling, Unreal Engine 4 scene visualization, cloud-managed resources, headset exploration, shared-screen presentation, mobile access, navigation, narration, and formative questions. A classroom scenario shows how teachers could relate scene exploration to documentary evidence and discussion. The paper distinguishes design features from demonstrated learning outcomes and proposes a verification framework for historical fidelity, system performance, usability, accessibility, and educational evaluation. Its contribution is a documented architecture and an instructional workflow for adapting immersive content to different classroom conditions. Performance and learning effects have not been measured in the materials available for this report; controlled evaluation remains necessary.

Index Terms virtual reality, civic education, historical reconstruction, instructional design, immersive learning

I. Introduction

Practical civic education can connect historical narratives with sites, artifacts, and primary sources. Visits to a heritage location may be difficult to schedule for a large class or inaccessible to students who cannot travel. A digital reconstruction offers another way to inspect spatial relationships and contextual materials, provided that its interpretive choices are made explicit. The central instructional question is not whether a simulated site looks persuasive, but how an activity helps learners examine evidence and reason about it.

This paper describes a multi-terminal VR platform for civic education. It specifies the arrangement of source resources, reconstruction tools, user interfaces, and classroom access modes. The paper also develops an instructional sequence and a framework for future validation. The platform description includes no artificial intelligence teaching assistant or measured teacher professional-development outcome, so those topics are outside its scope. No questionnaire-based effectiveness result is reported here because the available aggregate graphics lack respondent counts, item-level records, and documented consent procedures.

The contribution is therefore a design case. The architecture can help teachers and developers plan historical content across headsets, shared displays, and mobile devices. The account identifies claims that require later empirical tests: whether the content represents its sources accurately, whether students can use the interface reliably, and whether a defined lesson leads to better learning than an appropriate alternative. These outcomes must be examined separately.

A review of immersive VR in higher education found that application designs do not consistently connect learning theories and intended outcomes [1]. A meta-analysis has examined learning effects across immersive VR studies [2]; its pooled result cannot establish an effect for this particular civic education platform. Studies of VR-based problem solving [3] and desktop VR in technical education [4] illustrate the importance of matching instructional tasks and outcome measures to the domain. Research on teachers' use of VR and augmented reality (AR) highlights the practical conditions for adoption [5]. An AR mobile touring study [6] provides a related example of guided encounters with place-based content, although AR overlays and immersive VR differ in display and interaction.

The present design is organized around three distinct choices: what historical claim a scene represents, what action a learner takes in that scene, and how a teacher checks the learner's interpretation. Figure 1 depicts immersion, interaction, and imagination as conceptual VR characteristics. These properties do not by themselves demonstrate historical fidelity or educational value. For a civic lesson, the platform should also expose the documentary basis of a scene and provide an alternative route to essential material for students unable to use a headset.

II. Platform Design and Implementation

A. Design scope and delivery modes

The platform design combines a resource layer with three presentation routes: an all-in-one headset for individual exploration, a locally rendered large screen for group viewing, and a mobile stream for temporary access. These modes have different requirements and should not be treated as interchangeable experiences. Table 1 gives qualitative design trade-offs; it does not report measured latency, cost, learning, or user satisfaction.

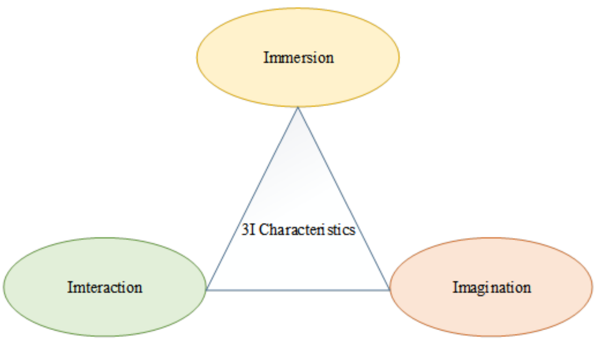

Figure 1: Conceptual VR characteristics used to frame the design; the graphic is not an outcome measure.

The architecture in Figure 2 distinguishes the resources that define a historical scene from the interfaces through which users encounter it. Photographs, text, video, and geographic data are inputs for modeling and interpretation. Scene assets and narration are assembled into a package that can be distributed or rendered for different terminals. The diagram represents the proposed organization; it does not document a particular server configuration or measured capacity.

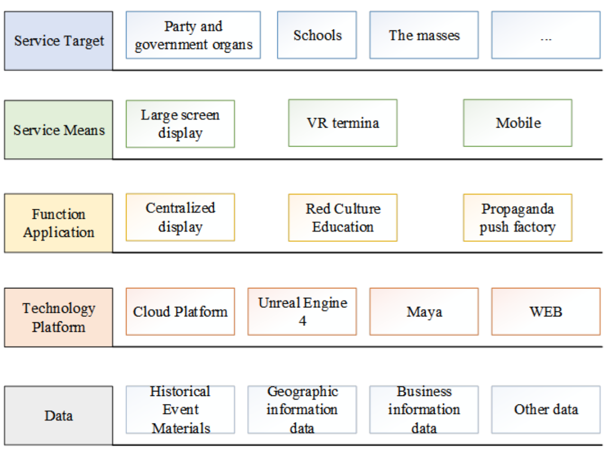

Figure 2: Functional layers of the proposed platform architecture.

B. Resource management and deployment

A shared repository can reduce duplication of models and text across device-specific presentations. Each resource should carry an identifier, source citation, date or period, revision number, and usage permission. Teachers need to know which historical episode and scene version were presented to a class. Because no asset inventory or deployment log is reported, this paper treats provenance and version recording as design requirements rather than verified operational features.

Figure 3 illustrates access from cloud-managed resources to different terminals. For a fixed exhibition display, locally cached assets and a rendering workstation can support a larger visual scene. An all-in-one headset can use locally downloaded assets for interactive exploration. A mobile client can receive a rendered stream when its hardware cannot run the complete three-dimensional scene. Each route has a different failure mode: an outdated local cache, an insufficient headset rendering budget, or interrupted streaming. These should be tested on the actual devices and network before classroom use.

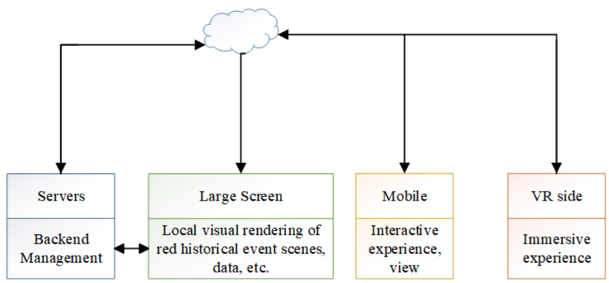

Figure 3: Multi-terminal application model and resource access.

C. Immersive and shared viewing

A headset presents separate images to the eyes and updates the view as the user turns. The controller can select a scene, move between designated locations, and activate an information point. Figure 4 depicts the intended viewing effect. Comfort depends on hardware, scene motion, and session length; this design report does not include a measured frame rate, motion latency, headset specification, or comfort assessment. The teacher should therefore provide a non-headset route to the essential sources and questions.

A shared display lets an instructor pause at an artifact and ask students to compare the reconstruction with a photograph or document. It is better suited to collective discussion than to individual immersion. A mobile view can extend preparation and follow-up work outside a dedicated VR room, but a small screen may make details harder to inspect. A fair comparison of delivery modes would keep the historical sources and questions constant while documenting each mode's available controls and presentation quality.

Table 1: Qualitative comparison of presentation modes used in platform planning.

Mode	Intended classroom use	Principal constraint
All-in-one headset	Individual, stereoscopic exploration with a handheld controller	Device availability, orientation time, comfort, and hygiene
Workstation and shared screen	Whole-class demonstration and teacher-led pauses	Viewers do not control navigation or receive stereoscopic depth
Mobile streamed view	Preparation, review, or access when a headset is unavailable	Screen size, connection quality, and reduced interaction
Stereoscopic projection	Group display with depth cues where facilities exist	Dedicated equipment, room configuration, and capacity

Figure 4: Illustration of the headset viewing mode.

D. Scene construction and source fidelity

The documented workflow uses digital elevation models (DEMs) and digital orthophoto maps (DOMs) for terrain, with Unreal Engine 4 (UE4) vegetation tools for ground cover. Figure 5 depicts a large terrain scene. A geographic base is useful for spatial context, but a terrain model cannot validate the date or placement of buildings, clothing, vegetation, or actors. Those claims need a separate source ledger. If the reconstruction includes an inferred feature, the lesson should label it as such.

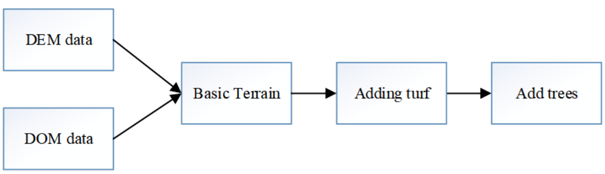

Figure 5: Illustrative terrain reconstruction. Historical accuracy requires independent source checking.

Maya is used in the described workflow to model characters and scene objects; UE4 supports visualization and interaction logic. High-detail source models can be baked into textures and normal maps applied to lower-complexity meshes. This can reduce geometry load, but the manuscript supplies no polygon counts, rendered frames-per-second, or visual-equivalence measurements. The design should set explicit performance targets only after selecting target devices and testing representative scenes.

Figure 6 illustrates a reconstructed historical scene. The content workflow starts with source selection, then models the location, assigns materials and light, adds character motion and narration, and tests how the user encounters the evidence. The appearance of a scene must not be confused with documentary certainty. A teacher or subject specialist should review dates, place names, costumes, quotations, event sequence, and the distinction between documented elements and artistic interpretation before a version is used for instruction.

Figure 6: Example of a reconstructed historical scene in the platform material.

E. Sound, navigation, and interaction

Sound can mark events, locate a narrator, and convey context not visible in an image. Ambient sounds and event-specific audio should be distinguishable from recorded historical evidence. For example, a recreated conversation should not be presented as a verbatim archival recording unless it is supported by a source. Students also need control of playback and a readable text alternative where possible.

The three-dimensional menu shown in Figure 7 provides an entry point to scene selection and controls. Menu actions should be consistent across scenes, with visible prompts for returning, recentering, pausing, and exiting. Navigation through a historical site can be guided by marked stops rather than unrestricted movement when the learning task requires attention to particular objects. Interactions such as opening a door or activating an artifact should have a clear instructional purpose and should not obscure the provenance of the content revealed.

A virtual guide may play narration at designated points, as illustrated in Figure 8. The guide can introduce an episode, direct attention to an object, and invite a source comparison. A post-visit quiz is described in the original system account; its pedagogical role is formative unless the item wording, scoring

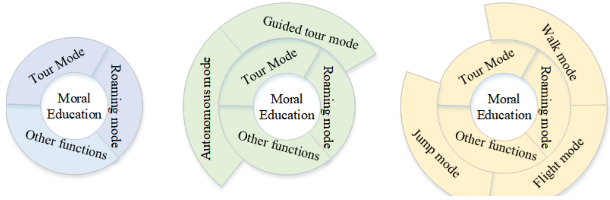

Figure 7: Illustration of the three-dimensional menu.

rules, and validation are documented. A report card generated by software is not itself evidence that learning occurred. The instructor can use quiz responses to revisit misunderstandings and connect the virtual tour to primary sources.

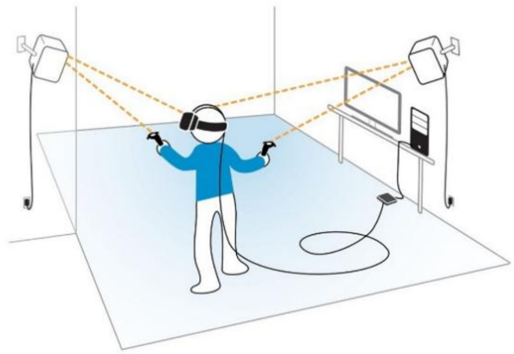

Figure 8: Illustration of a location-triggered navigation prompt.

III. Classroom Design Case

A lesson can begin with a teacher introducing the historical question, the sources used to build the scene, and the limits of the reconstruction. Students then inspect a short primary-source extract or photograph and make an initial observation. During the virtual visit, they locate the corresponding place or object, record what the rendering adds spatially, and identify which visual details are directly documented. A closing discussion compares the digital scene with the original evidence. This sequence is a proposed classroom use of the platform, not an observed learning outcome.

For a class with few headsets, groups can rotate between a guided headset station, a source-analysis station, and a shared-screen station. Each route should expose the same core historical question. A learner who cannot use a headset should still be able to inspect the relevant source and participate in the discussion. The instructor can allot a fixed orientation period and exploration time; the exact duration depends on equipment and classroom logistics and was not specified in the source material.

One example objective is to distinguish a documented feature of a site from a plausible reconstruction. A student could identify an object in the scene, locate the underlying photograph, and explain which aspects of the virtual representation can be verified from it. A second objective could concern chronology: students could arrange two events from a narration track using dated documentary evidence. The quiz would then ask about those specific objectives, not about general enjoyment of VR. No quiz responses, student observations, or achievement scores are claimed in this design case.

IV. Source Audit and Lesson Specification

A. A provenance record for reconstructed content

A digital heritage scene combines evidence of different kinds and strengths. A photograph may establish the appearance of one facade at a known date, while a map provides a wider arrangement of streets; a written account may describe activity that no surviving image depicts. In a reconstruction, these sources must be linked to individual modeling decisions. A practical record would assign each scene element a source identifier, date range, location, creator or repository, permitted reuse, and a short statement of what the source supports. When several sources disagree, the record should preserve the disagreement rather than silently merge them into one confident image.

The simplest source audit distinguishes three statuses. A documented element corresponds directly to a traceable source; a constrained reconstruction fills a spatial or visual gap using evidence and an explicit rationale; and an illustrative element is introduced to help users navigate or understand the scene without claiming historical authenticity. The teacher can use these statuses in a classroom discussion. For instance, students can compare a rendered doorway with an archival photograph and then identify whether its color, dimensions, and location are equally well supported. This exercise turns a potentially persuasive visual into a question about evidence.

Version control matters because a revised scene may change the claims presented to a class. A version record should state which assets, narration files, and interaction scripts were included in each release and which sources motivated a correction. If an instructor discovers a date error, the correction should be reviewed and distributed across headset, mobile, and shared-screen versions. Otherwise, different groups may encounter inconsistent accounts of the same event. No versioned asset register is provided with the current platform materials; the procedure here describes what would make a deployment auditable.

Images of historical people and events also require interpretive restraint. Visual details can carry emotional weight even when the available evidence is thin. The platform should avoid presenting speculative dialogue as a quotation, treating reenacted sound as a recording, or using a dramatic camera angle to imply that a historical account is uncontested. An accompanying source note and a teacher's prompt can make this distinction legible to students. Such transparency is especially important when the lesson has civic aims and the interpretation of an event is itself a subject for discussion.

B. Linking scene actions to assessment

A classroom use case should specify the objective, the evidence students will examine, the action they will perform, and the response that would demonstrate understanding. Table 2 illustrates that alignment without claiming that the activities were tested. The first task concerns spatial orientation; the second concerns the evidentiary status of a depicted object; the third concerns chronology and interpretation. All can be completed with a guided shared-screen path if a headset is unavailable, though the interaction experience will differ.

For a formative quiz, each item should have a documented answer or scoring rule and should be associated with one objective. A multiple-choice question about a date can test recall, whereas a short explanation comparing an image with a model can test source reasoning. The latter requires a rubric that describes the quality of the evidence cited and the handling of uncertainty. These different outcomes should not be combined into a single score without a stated rationale. If the platform records answers, the teacher should have access to the question wording and know whether a student's response followed a complete tour or an interrupted session.

Teachers also need a pre-visit and post-visit sequence. Before entering the scene, students can record a prediction based on a primary source. At a designated stop, they inspect what the visual representation clarifies and what it does not. After leaving, they revisit the prediction, cite a source, and explain any revision in their interpretation. This structure makes the purpose of interaction explicit. The platform's menus and navigation prompts can support the middle stage, while source packets and teacher-led discussion support the stages around it. A future study should record whether all stages were actually delivered.

C. Operational checks before a classroom session

A content review and a device review should be conducted separately. The content review examines place names, chronology, quotations, captions, permissions, and the distinction between documentary and illustrative elements. The device review checks whether each scene loads, whether the menu can be operated, whether narration and captions can be accessed, whether users can exit, and whether navigation recovers after an interruption. A problem in either category can change the activity students experience, but the remedy and the responsible reviewer differ.

A technical log should identify the headset or workstation model, software build, scene version, network path, and observation period. The evaluator can record loading times, dropped connections, sustained frame rate, controller tracking errors, and failures to resume. To make results comparable, the log should describe a representative route through the same scene and note which visual settings were used. It should also include the number of devices tested and the variation between them. The present report does not provide these measurements; it sets out the checks needed before claims of performance or scalability are made.

A dry run with the teacher can expose instructional failures that a device benchmark misses. The teacher should be able to bring a class to the intended evidence point, pause the narration, display the underlying source, and return to a common discussion. A feature may operate correctly in isolation yet take too long to explain in a class period. Recording the time for orientation, interaction, and discussion would help establish a realistic rotation schedule. The same check can show whether the non-headset path permits a student to complete the core task.

D. Interpretation of a future comparison

A comparative study should define its primary outcome before collecting data. If the goal is to improve source reasoning, the main outcome should assess the quality of arguments from evidence, not only a preference for VR. If the goal is spatial orientation, a map-based task may be more appropriate. The VR lesson and comparison lesson should use equivalent sources, instructor time, and assessment conditions wherever possible. Otherwise, a difference may reflect the content or teaching time rather than the display mode. Randomization, if feasible, should be described at the student or class level, with analyses matching the assignment unit.

The study should also record exposure and implementation. A student who could not load the scene did not receive the same intervention as one who completed the tour; a comparison class whose teacher provided extensive additional explanation may differ in more than technology. Reporting these events alongside the number recruited and analyzed would make an observed result easier to interpret. A delayed task could test whether any advantage persists beyond the immediate novelty of the session. Qualitative interviews, with appropriate consent, could help explain why a particular source or interface caused misunderstanding.

The possibility of harm or exclusion should be evaluated alongside potential benefit. Some students may experience motion discomfort; others may have visual, auditory, or mobility needs that change how they access the material. A plan should provide equivalent sources, captions, adjustable audio, and a way to stop immediately. Collecting these experiences during a pilot would inform design revisions before an outcome trial. A favorable average response must not conceal a group that could not complete the activity. These are evaluation principles, not results claimed for the present system.

V. Instructional Workflow and Evaluation Framework

A. From source material to a teachable scene

A historical simulation has at least three layers: the source record, the reconstruction decisions, and the experience presented to students. Photographs, site plans, oral accounts, written descriptions, and topographic records may differ in date and reliability. Before a scene is modeled, a teacher and a subject specialist should identify which elements are necessary to the lesson and record the origin of each element. The modeler can then distinguish observed geometry from reconstructed geometry, label uncertain features, and maintain a version record. Such a record would let another team inspect how a specific rendered object was derived. The supplied platform description identifies photographs, videos, text, and

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Table 2: Illustrative alignment of civic education tasks and assessment evidence.

Learning objective	Activity in the platform	Evidence of understanding
Orient within a site	Follow a marked route and compare the scene with a dated plan	Locate two features and justify their positions from the plan
Evaluate a reconstruction	Activate an artifact and inspect its linked source photograph	Separate visible source details from inferred or illustrative features
Reason about chronology	Listen to a narrated sequence and inspect dated documents	Order events and cite the document supporting each step

geographic information as inputs, but does not include an inventory of source items or a provenance ledger. This proposal specifies a quality requirement rather than asserting that the existing scenes have already satisfied it.

The learning objective should be more precise than "experience history." For example, a lesson might ask students to locate two features of a historical site, identify what each source establishes, and explain why a particular feature in the simulation remains uncertain. An interaction can direct the learner to an artifact and allow comparison with its source image. A narration track can provide context while making clear which statements are historical facts and which are interpretive choices. The post-visit discussion can then ask students to distinguish observation, inference, and value judgment. These steps provide a mechanism by which the visual experience could support inquiry, although its effect has not been measured for this platform.

Scenes also require practical content review. Spelling on signs, dates in narration, costume details, and the order of events should be checked against the source list. A teacher should be able to correct a factual problem without rebuilding every device package. The resource architecture described in this manuscript could facilitate updates, but its implementation details, version control, and editorial roles have not been documented. A future implementation report should identify who approves scene revisions, how updates are distributed, and which version is used in a future assessment.

B. Classroom delivery across terminals

The delivery modes in Table 1 address different constraints. A shared screen can introduce an episode to a whole class, show a route through the setting, and pause at key evidence points. It provides a common reference for discussion but cannot reproduce the headset's depth cues or private navigation. A headset offers individual control, yet throughput depends on the number of devices, length of use, cleaning and setup, and assistance for first-time users. A mobile view can support preparation or review; its smaller display and the quality of its network connection may change the experience. These distinctions should be preserved when comparing results across modes.

A lesson plan could set a short orientation period, show the primary source, assign a question for the virtual visit, allocate equal exploration time, and close with an evidence-based discussion. If there are fewer headsets than students, groups can rotate through headset, source-reading, and discussion activities. An equivalent route through core materials should be provided to students who cannot use a headset. A future classroom trial should record the rotation scheme, session length, teacher script, and degree of exposure to each mode so that any outcome can be interpreted in context.

The quiz described in the implementation should be treated as a formative tool unless it has been validated for research. Its questions need an answer key tied to learning objectives, consistent instructions, and a way to distinguish incomplete exposure from incorrect reasoning. The platform description includes the ability to generate report cards and graphical summaries, but it contains no item set or scoring rules. This paper therefore does not report a learning score.

C. Technical verification and accessibility

A deployable VR lesson should be checked on the actual hardware and network used in class. Relevant measures include scene loading time, motion-to-display latency, sustained frame rate, headset tracking loss, asset download failure, and recovery from interrupted sessions. For cloud-streamed mobile content, bandwidth and packet loss affect the quality available to students. These measures can be recorded for each device and scene version before a teaching session. None of these performance results is present in the supplied study, so descriptions such as "real time" are design intentions rather than verified benchmarks.

Interface review should include readable captions, controllable audio, clear navigation prompts, and a route that does not require prolonged standing or unrestricted physical movement. Students should know how to recenter the display and leave a scene. A teacher should be able to pause a task and resume it without losing essential context. Accessibility is not established merely by providing a mobile version; the alternative must carry the same essential historical sources and questions. The interface images illustrate navigation and reconstruction; they do not establish usability or accessibility.

D. A testable research design

A future evaluation can separate feasibility from educational effects. Feasibility questions concern whether students can access the scene, complete the assigned route, understand the controls, and tolerate the session. Perception questions might concern satisfaction, perceived usefulness, and willingness to use the system again. Learning questions concern specific, assessable changes in historical knowledge or the ability to reason about sources. Each construct requires its own instrument and prespecified interpretation; one satisfaction question cannot stand in for all three.

For a classroom comparison, the same learning objectives, core sources, contact time, and teacher guidance could be offered through VR and a conventional digital presentation. Assignment and potential baseline differences should be documented; if classes rather than individuals are assigned, analyses should account for that grouping. A knowledge assessment could include identical or parallel questions before and after the lesson plus a delayed task to examine retention. Raters assessing open-ended historical reasoning should use a rubric and report agreement. These recommendations specify what a reproducible comparison would require; no comparison is reported here.

A report of that later study should specify the number eligible, invited, enrolled, and analyzed in each condition. It should state how missing responses and incomplete VR sessions were handled, report actual counts alongside percentages, and present uncertainty around effect estimates. Qualitative comments should be described with a transparent coding approach and examples that do not reveal students' identities. Device and scene versions, teacher preparation, and the exact questionnaire should be archived. These details would clarify whether any measured difference is plausibly related to the instructional mode and whether another classroom could reproduce it.

E. Measurement and reporting matrix

Table 3 separates platform verification, usability, historical learning, and longer-term attitudes. Drawings can communicate the architecture, but device performance needs measurements. A student may navigate successfully yet misinterpret a source; both outcomes should be recorded separately. The framework identifies evidence needed to assess distinct claims without assuming that a favorable interface rating establishes civic learning.

A staged evaluation would begin with review of historical content and system behavior, followed by a small usability exercise. A teacher and a subject specialist could inspect the same scene with a checklist covering source attribution, chronology, narration, and explicit uncertainty. Pilot users could then attempt assigned navigation tasks while researchers record completion and obstacles. Only after these problems are addressed would a comparison of learning outcomes be interpretable. This sequence helps distinguish a failure to encounter the relevant evidence from a failure to reason about evidence that was encountered.

A later outcome report should provide both counts and percentages, define every denominator, distinguish multiple-choice from mutually exclusive categories, and archive the assessment and analysis plan. Uncertainty should accompany estimated effects. Open-ended responses require a documented coding approach and suitable protection of student identity. The platform description alone cannot supply these results; this table serves as an evaluation specification.

VI. Design Decisions and Reproducibility

The system's three delivery paths solve related but different problems. The headset offers the strongest sense of being in a spatial scene; the shared display supports a common teacher-controlled viewpoint; and the mobile view extends access beyond dedicated equipment. Keeping a common content layer across those paths reduces the risk that they teach different historical accounts, but does not guarantee identical learning opportunities. The application should specify which objects, source links, narration passages, and questions are present on every path. A mode-comparison checklist would reveal whether a task assigned to the whole class can actually be completed by everyone.

Resource sharing also introduces an editorial responsibility. A corrected historical description should be updated in the repository, tested in the rendered scene, and checked on each client after distribution. A source item may be licensed for classroom display but not for redistributing its high-resolution scan in a mobile package; permissions should therefore be recorded at the asset level. Audio reenactments and character likenesses need the same scrutiny. The platform design provides a location for these records, but the asset records have not been reported.

A reproducible implementation report would identify the operating system, UE4 version, major plugins, headset firmware, scene packages, rendering quality settings, and server configuration. It would also define the user route used for measurement, because a static view of a landscape and a crowded animated event place different demands on hardware. If streaming is used, the server location, video encoding, target resolution, and available bandwidth affect the experience. Reporting only that a platform uses cloud computing and real-time rendering is insufficient to predict classroom behavior. These specifications would turn the architecture diagram into a testable system description.

The teaching sequence likewise needs reproducible records. A lesson packet can include the historical question, sources, a map of required stops, narration transcript, expected student responses, and a teacher prompt for each stop. It can state which elements are drawn directly from archives and which are visual reconstructions. A comparison instructor can then present equivalent sources in a conventional format. This packet is important because teaching quality can change independently of display technology; a more detailed VR lesson may outperform a sparse comparison simply because it contains more guidance.

Finally, the strongest claim a future study can support will depend on its design. A usability exercise can identify barriers to navigation, not establish long-term civic attitudes. A small descriptive survey can characterize its respondents, not generalize to a university population without an appropriate sample. An appropriately controlled classroom comparison can estimate an effect on a specified outcome under reported conditions, though it cannot automatically separate every element of a complex lesson. The present paper offers the architecture and a testable instructional specification; it intentionally leaves those empirical conclusions open.

VII. Discussion

A. Instructional implications

The proposed architecture links source materials, reconstructed scenes, and multiple delivery modes. A shared screen supports collective introduction; a headset permits individual

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Table 3: Prospective verification framework for a multi-terminal civic education platform.

Claim domain	Current design evidence	Evidence required in a later evaluation
System operation	Architecture and interface illustrations	Device and scene versions, loading failures, sustained frame rate, and network conditions
Access and usability	Proposed navigation and alternative modes	Task completion, errors, assistance, discomfort, and equivalent access to essential content
Historical learning	Source-based lesson and formative question design	Prespecified rubric, comparison condition, baseline and post-lesson scores, missing data, and uncertainty
Civic attitudes	Instructional objective only	Defined construct, appropriate instrument, consent, baseline and follow-up, and cautious interpretation

spatial exploration; and mobile access can support preparation or review. The same lesson objective can guide all three routes, while the medium changes what students can control and see. Teachers should decide which of those differences is relevant to a particular topic before choosing a mode. An immersive representation may add spatial context, but it is not intrinsically superior for every historical question.

Historical reconstruction creates a particular risk of misplaced confidence. Realistic lighting, weather, sound, and characters can make conjectural elements appear documentary. The source record should therefore be visible in the teaching sequence, with uncertain or invented details labeled. Students can be asked to identify what the archival material establishes and which parts of the visualization remain an interpretation. This makes the platform a prompt for inquiry rather than a substitute for evidence.

The design must also accommodate classroom constraints. Device numbers determine throughput; preparation and hygiene affect the schedule; headset discomfort may require an immediate alternative; and streamed content depends on the local network. A shared-screen or mobile route can offer access to essential sources, but its functional equivalence should be checked. A future usability report should describe the class size, device inventory, lesson duration, assistance provided, and failures, rather than assuming that a laboratory demonstration will transfer unchanged to a routine class.

B. Boundaries of the design report

The figures and text document the proposed interface, modeling workflow, and application architecture. They do not supply a source inventory, code repository, build specification, hardware benchmark, fidelity audit, or validated classroom outcomes. The paper therefore makes no claims about student achievement, moral development, or teacher professional development. Nor can it attribute learning to immersion, narration, teacher guidance, or novelty without a controlled comparison. These are limits on the claims, not reasons to abandon the design question.

The usefulness of a scene also depends on the topic. A site with detailed plans and photographs can support a more constrained reconstruction than an episode documented only by contested testimony. Spatial exploration may help with orientation, while reading and discussion may be more appropriate for assessing motives or conflicting accounts. The content workflow should record both the intended learning objective and the evidentiary strength of the materials used to render it.

Future work should create a traceable inventory of assets, measure performance on named devices, assess accessibility across modes, and test learning with a prespecified rubric. If students are recruited for research, the team must document applicable ethics review, consent, recruitment, data protection, and the distinction between coursework and research participation. A separate empirical article could assess student responses only when participant counts, item definitions, data provenance, and applicable ethical procedures are documented.

C. Practical adoption and editorial oversight

An institution considering the platform should assign responsibility for its historical content, its technical build, and its lesson plan. A subject specialist can review source claims and uncertainty labels; a developer can verify that the same approved content is displayed across modes; and an instructor can check that students are directed to the evidence required for the lesson objective. These roles may be held by different people, but their decisions should be traceable. Without an approval step, a technically successful update could introduce a historical error or remove an important qualification from a scene.

A modest first deployment would use one well-documented location and a small number of source-linked stops. This provides a manageable unit for validating captions, narration, navigation, and the alternative display route before adding further sites. Expanding the repository should follow the same source-audit procedure rather than counting scenes as a measure of educational quality. The number of available locations tells readers little about whether each reconstruction is credible or useful for a defined classroom task.

Classroom preparation should include an explicit schedule for students who are waiting for a headset. They can inspect a source packet, annotate a site plan, or formulate a question to test when their group reaches the virtual scene. After each group completes the activity, the teacher can use a common evidence prompt to bring the class back together. This arrangement reduces idle time and makes the VR visit part of a lesson rather than an isolated demonstration. Its feasibility still needs to be tested against actual class size and equipment availability.

The proposed system could be adapted beyond one institu-

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tional setting, but adaptation involves more than translating an interface. Historical sources may vary in availability, licensing, and interpretive consensus. Teachers may use different civic curricula and have different expectations for discussing disputed events. A new implementation should review its content with local expertise and define outcomes appropriate to its learners. These conditions delimit the transferability of the design described here.

Finally, the evaluation record should include failed as well as successful sessions. If a headset fails to track or a mobile stream stalls, these events affect both access and any later interpretation of learning data. Excluding students who could not finish may overstate usability; combining incomplete and complete exposure may obscure an educational effect. A careful report will describe the denominator for each result and why observations were missing. This detail is essential if the platform is to be judged as a practical teaching tool rather than a set of compelling screenshots.

D. Criteria for an interpretable pilot

A first pilot should have an explicit threshold for feasibility before it is used to support a broader claim. The team could specify in advance what fraction of assigned users must be able to enter the scene, visit the required stops, access the source links, and complete the lesson within the allotted time. These thresholds would be local design criteria rather than universal standards. The pilot report should also describe the students who used an alternative mode, the reasons for switching, and whether their access to the core documents was equivalent.

Historical review can be recorded with a similar audit trail. For each scene, reviewers can list the claims made by narration, captions, and interactive objects; mark each as source-supported, inferred, or illustrative; and record disagreements and corrections. A second review after deployment can check that the released build matches the approved script. This workflow does not require assuming that every detail of the past can be recovered. It requires the platform to be candid about which claims are secure and which are provisional.

For a later learning evaluation, a pilot can also check whether assessment items distinguish levels of understanding. If nearly all students answer a factual recall question correctly before the lesson, it cannot detect improvement; if an open-ended question is scored inconsistently, it cannot support a precise comparison. Revising such items before a full study is more useful than adding an attractive graph after data collection. The present design establishes these checks as a route toward credible evidence, while leaving the outcome of that future study unknown.

VIII. Conclusion

The paper presents a multi-terminal VR platform design for civic education and a classroom workflow that links scene exploration to historical sources. It distinguishes proposed functions from verified system performance and measured educational effects. The resulting architecture and evaluation matrix provide a basis for a future implementation and comparative classroom study. The value of an immersive reconstruction will depend on source fidelity, accessibility, reliable operation, and a clearly assessed learning objective.

Author Contributions

All authors contributed equally to the conception, development, and preparation of the manuscript. All authors have read and approved the final version of the manuscript for publication.

Data Availability

No new empirical datasets were generated or analyzed in this design-oriented study. All platform diagrams and illustrative scene images used to support the discussion are included within the article.

Conflicts of Interest

The authors declare that there are no conflicts of interest related to this work.

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Declaration of Generative AI and AI-Assisted Technologies in the Preparation of the Manuscript

Artificial intelligence tools were used during the revision process solely to improve the language, clarity, readability, and presentation of the manuscript. The authors reviewed and revised all AI-assisted content and take full responsibility for the accuracy, integrity, and final content of the manuscript.

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