Fostering Heritage Awareness in Schoolchildren through Digital Preservation and Engaging Learning Experiences

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Abstract

Preserving cultural heritage sustains the delicate threads of historical identity, yet public awareness, especially among the young, remains fragile. Traditional education often overlooks the importance of heritage conservation, underscoring the need for innovative, immersive learning pathways. This paper presents an innovative educational outreach model that intertwines digitalization with interactive learning to engage schoolchildren in heritage preservation. Inspired by spontaneous participation during fieldwork at Fort Belgica, a Dutch colonial fort, this approach matured into a structured event at the Science fair "Science is Wonderful!" in the Africa Museum, Tervuren, Belgium (March 2025). Over the course of two days, 600 children immersed themselves in a dynamic process of creating replicas of fortifications using accessible tools, such as iPads and 3D puzzles. Through guided stages—theoretical introduction, hands-on digital reconstruction, and analytical assembly of fortification elements—participants developed both technical skills and historical consciousness. Qualitative assessments, supported by observational data, consistently point to heightened participant engagement and a positive reception of the intervention. This practice not only bridges digital innovation with heritage studies but also nurtures a generation of culturally aware citizens, capable of appreciating the intertwined legacies of European fortification traditions and colonial narratives, in harmony with the EU’s 2030 Digital Decade vision.

1. Introduction

The preservation of cultural heritage is a critical component in sustaining historical continuity, shaping collective memory, and reinforcing cultural identity across generations. While the expertise of conservators, restorers, and historians remains central to these efforts, public awareness and active participation continue to represent significant challenges in ensuring the long-term safeguarding of heritage assets. Many cultural sites face gradual degradation, often exacerbated by insufficient public engagement, limited educational outreach, and constrained resources for comprehensive documentation and conservation.

In this context, early educational interventions assume a pivotal role. Instilling an awareness of cultural heritage and its fragility from a young age not only fosters individual appreciation but also cultivates future custodians of heritage. Personal experience underscores this trajectory: growing up within a Renaissance fortified ideal city, where remnants of bastion walls still punctuated the urban fabric, I was confronted daily with silent testimonies of history. As a child, I wandered beside these massive structures, their scale and presence provoking persistent questions: *What are these walls? Why do they remain?* A school excursion to a partially ruined castle at the age of eight brought the vulnerability of these monuments into sharp relief and sparked a formative resolution—to protect these vestiges of the past. This early encounter eventually evolved into a professional commitment as an architect-restorer and scientific expert in fortifications. Such experiences vividly illustrate how early exposure to cultural heritage can profoundly shape personal development and professional trajectories.

Non-formal education, characterized by its emphasis on participatory, interactive, and experiential learning, offers a powerful complement to conventional pedagogical approaches. By engaging children directly with tangible heritage and its complex narratives, non-formal educational frameworks can nurture both cognitive understanding and emotional attachment, laying a robust foundation for sustained engagement with cultural heritage preservation.

Knowledge production and learning in the twenty-first century must increasingly reflect the evolving practices, tools, and epistemologies that characterize contemporary heritage professions. Children, as active and perceptive participants, now encounter cultural heritage not only through traditional site visits and curated exhibitions but also within the expanding sphere of digital environments. Technologies such as immersive virtual reality, serious gaming platforms, and, most recently, digital twins, are fundamentally transforming the ways in which heritage is interpreted, experienced, and transmitted. For instance, platforms enabling virtual exploration of interior spaces, such as the digital rendering of Łańcut Castle, allow users to engage with architectural heritage independent of geographic and physical constraints. Simultaneously, initiatives such as the *Polonika Minecraft* project exemplify how game-based learning can offer younger audiences accessible and interactive avenues for engaging with complex cultural narratives—a subject that will be explored in greater depth in subsequent sections.

These technological innovations—including digital reconstructions, participatory crowdsourcing, and interactive visualization—are no longer peripheral but are emerging as integral instruments for ensuring the sustainability, accessibility, and public relevance of cultural heritage in the decades ahead. The younger generation—frequently referred to as "digital natives"—exhibits cognitive profiles and learning modalities shaped by continuous immersion in interactive, multi-sensory, and technology-mediated environments (Prensky, 2001). Consequently, contemporary educational frameworks must undergo parallel transformation, not merely incorporating digital technologies as ancillary tools, but rather embedding them at the core of pedagogical design. Such integration is essential to cultivate both technical competencies and a deeper, enduring commitment to heritage stewardship among future generations.

Despite the growing recognition of the importance of early engagement with cultural heritage, scholarly research specifically addressing children's experiences within this domain remains surprisingly limited. In the existing academic literature, studies that directly explore the intersection of cultural heritage education and children's learning are scarce. Among the few notable contributions are Puolamäki's (Puolamäki, 2017) investigation into children's cultural landscape values using participatory geographic information systems; Çiftçi's (Çiftçi, 2020) examination of the influence of historic environments on children's cultural identity through the Erasmus+ C.A.T.C.H. (Children-Architects to Create Homes) project; and the study by Haddad (Haddad, 2016) addressing multimedia and cultural heritage in the context of children's edutainment and serious gaming. Additionally, while still limited to conference proceedings, innovative projects such as Polonika in Minecraft (Brzostowska & Chmara-Pokrzywka, 2023) demonstrate emerging interest in the application of digital tools for engaging young audiences in cultural heritage education.

Nevertheless, research dating back to the 1990s consistently highlights the significant educational benefits of non-formal learning environments for children. Studies have shown that school-aged students derive substantial cognitive and affective learning outcomes from museum visits and science-based interactive activities, which offer hands-on, inquiry-driven experiences beyond the conventional classroom setting (Anderson, 1999; Anderson et al., 2000; Anderson & Lucas, 2000; Ayres & Melear, 1998; Ramey-Gassert et al., 1994; Rennie, 1994; Wolins et al., 1992). These findings further underscore the potential value of developing specialized, research-informed frameworks that integrate cultural heritage into non-formal and digitally enhanced educational contexts tailored to children's unique learning profiles.

Non-formal educational environments—such as museums, children's science fairs, and heritage site visits—represent particularly powerful platforms for fostering early engagement with cultural heritage. In many cases, these experiences remain closely linked, as museums are often embedded within or directly associated with heritage sites themselves. Within the specific context of defensive heritage, which constitutes the primary focus of this study, forts and castles frequently serve not only as historical monuments but also as living educational spaces. During field observations, I have personally witnessed the potential of such encounters: children, observing my work as a heritage architect and conservator engaged in digital documentation, exhibited genuine curiosity, often approaching to inquire about the process, and expressing interest in participating. In many ways, these spontaneous interactions function analogously to informal career exploration activities, offering children an early, tangible introduction to the specialized practices of conservation, digital documentation, and architectural heritage preservation—fields that are typically distant from standard curricular exposure.

Despite the evident educational potential of such informal encounters, there remains a remarkable paucity of empirical research addressing children's experiences within these non-formal heritage learning environments. As a consequence, current understanding of how children interpret, internalize, and are influenced by such experiences remains significantly underdeveloped.

Moreover, the methodological challenges inherent in studying young children's learning experiences further contribute to this gap. Collecting reliable and meaningful data from young participants is often complicated by their still-developing communication skills, limited capacity for introspective reflection, and potential discomfort in interacting with unfamiliar adult researchers. These obstacles necessitate the development and application of innovative, child-centered research methodologies capable of capturing authentic insights into children's perspectives on cultural heritage experiences. Future investigations must therefore prioritize the refinement of methodological approaches in order to advance a more nuanced understanding of children's engagement with cultural heritage in non-formal educational settings.

Given the current paucity of empirical studies examining children's direct experiences in the digitalization of cultural heritage, there is a clear need for preliminary exploratory research to begin addressing this gap. Small-scale, qualitative investigations—such as the one presented in this paper—can serve as a crucial first step in generating initial insights into how children perceive and engage with heritage preservation processes, particularly in relation to digital technologies. Observational methods (both structured and unstructured), alongside various forms of interviews, offer valuable tools for capturing the nuanced and often tacit dimensions of children's experiences in these contexts. The findings derived from such exploratory studies may ultimately serve as a foundational knowledge base upon which more extensive, theory-driven, and quantitative investigations can be developed in the future.

This study contributes to this emerging field by examining an innovative outreach initiative designed to introduce school-aged children to the principles of cultural heritage preservation through active participation in digital documentation processes. By integrating hands-on activities with accessible, user-friendly technologies, such as iPads, 3D-printed puzzles, and a printed real photogrammetric outcome model, as well as related applications, schoolchildren are provided with opportunities to engage directly in heritage understanding, recording, and conservation practices. In doing so, this approach not only enhances children's cognitive and emotional connection to cultural heritage but also aligns with broader policy frameworks, such as the European Union's 2030 Digital Decade agenda, which emphasizes the role of digital transformation in advancing the accessibility, preservation, and public engagement of cultural heritage. Through these efforts, this study aims to contribute to both the scholarly discourse on children's cultural heritage education and the practical development of inclusive, future-oriented heritage conservation strategies.

2. Methodology

This study employs a systematic, multi-stage qualitative design to investigate how digital technologies, when integrated with experiential learning, can democratize access to cultural heritage and promote deeper engagement among young audiences. At its core, this research addresses the pressing need to integrate digital tools into cultural heritage education in a manner that aligns with the cognitive, emotional, and technological realities of 21st-century learners. Yet, the methodology reaches beyond mere engagement with technology: it invites children into the rich narrative of fortification heritage, exposing them to the fragility of cultural memory, introducing precise architectural terminology, unveiling the diversity of fortification schools, and illuminating the role of architects in preserving what is vulnerable. I believe that for cultural institutions to have a future, truly, they must be from the future—listening to young audiences, building with them rather than for them, and embracing a shared space of authorship, curiosity, and imagination.

2.1 Theoretical Framework and Contextual Rationale

The ongoing advancements in digital space and communication technologies are profoundly transforming how cultural heritage is studied, interpreted, and disseminated. Digital innovations have introduced unprecedented opportunities for research, documentation, and preservation, yet they also expose a growing generational gap. While professional curators, conservators, restorers, and art historians continue to refine these methods, younger cohorts—including children and students—often remain on the periphery of these technological revolutions, insufficiently exposed or trained in their application.

This growing reliance on digital media within heritage studies contrasts sharply with the relatively limited use of 3D heritage tools among younger users. This paradox is striking, particularly in light of the widespread availability of affordable, efficient devices, such as tablets capable of generating 3D models within minutes, and lightweight drones that facilitate rapid, high-resolution data acquisition. Although many multidisciplinary heritage teams face substantial challenges in integrating these tools into conservation practice, these challenges are further amplified when adapting them for pedagogical use with children. Nevertheless, this research embraces the challenge, seeking to advance methodologies that foster digital engagement from an early age, thereby cultivating future digitally literate heritage professionals.

Building on the work of scholars such as Haddad (Haddad, 2016), who warns that without integrating cultural heritage and edutainment multimedia into education, we risk failing to prepare future generations for the complexities of the 21st century, this study positions itself at the intersection of technological innovation and educational theory. Schank and Kozma (Schank & Kozma, 2002) similarly envision a future learning ecosystem in which schools, homes, museums, libraries, and public institutions form an interconnected educational fabric. While Heeter (Heeter, 1999) highlights that much of this potential for connectivity remains unrealized, this study aims to contribute to the evolving model of distributed, participatory learning.

2.2 Study Context and Participants

The case study is based on the Science is Wonderful! event, held at the Africa Museum in Tervuren, Belgium, on March 13–14, 2025. This large-scale science fair brought together over 5,000 pupils and teachers from across Belgium, alongside 150 leading researchers from more than 25 countries. Each researcher presented innovative ways to engage children with their work across a variety of scientific fields. The event was open-access and free of charge, designed to be inclusive and accessible to a broad public audience. As a result, participation extended beyond the school groups formally registered for the event, attracting families, retirees, and individuals with a general interest in science and cultural heritage. Over the course of two days, approximately 600 children took part in the specifically designed workshop presented in this article. The precise number remains an approximation due to the presence of spontaneous attendees from the general public. Among the participants were unregistered pupils who joined some registered group to observe the study, and one university-level historian who attended out of personal interest; this individual was not included in this study. The children were organized into small, rotating groups of 10–20 children each, participating in 15-30 minute sessions, except for one group that visited several times during the afternoon hours of the second day. Linguistically, the sample was composed of approximately 45% Dutch-speaking, 45% French-speaking, and 10% international school participants.

The research sample was intentionally stratified to reflect key developmental stages in children's cognitive and emotional growth, consistent with established frameworks in developmental psychology (Poria & Timothy, 2014). This approach ensured that all activities and data collection methods were appropriately tailored to the participants' varying capacities for comprehension, communication, and engagement.

Three age-based cohorts were identified:

- **Early Childhood** (3–6 years): This subgroup consisted of five participants aged 3–4 years (n = 5; 0.008% of participants). Given their limited verbal abilities and nascent abstract reasoning, activities for this group were simplified to focus on basic motor and perceptual engagement. Participants were invited to construct simplified fort models using physical puzzle components that represented bastions and walls, with parental guidance provided. Following model assembly, children were introduced to basic digital scanning using iPads under close adult supervision.
- **Middle Childhood** (7–10 years) – 70% of participants: Representing the majority of structured school groups, this cohort engaged more fully with both theoretical and practical components of the workshop. They demonstrated sufficient cognitive maturity to grasp fundamental concepts of fortification, including fortification schools and terminology, while independently executing basic digital documentation tasks using mobile scanning technologies.
- **Adolescence** (11–18 years) – 30% of participants: This group consisted of older students who attended primarily in small peer groups. Adolescents exhibited the highest levels of autonomy, enabling them to engage more deeply in discussions on heritage preservation, architectural terminology, fortification typologies, and the application of digital technologies in heritage documentation.

This stratified design enabled age-appropriate instruction, maximized participant engagement, and facilitated the systematic collection of observational and qualitative data suitable for exploratory analysis.

2.3 Inspiration and Insights for Methodology

The inspiration for this initiative emerged during fieldwork at a Dutch colonial fort, Belgica, where schoolchildren unexpectedly engaged with the digitalization process out of curiosity. Their spontaneous participation in field documentation highlighted the potential for integrating heritage preservation with interactive learning.

Also, the study's design was further informed by contemporary museum practices discussed at Europeana's *Digital Storytelling Festival* (May 2025) and *Preserve, Protect, Reuse conference* (June 2025), where professionals such as Jemima Montagu (Art Explora, UK) and Birgitte Aga (MUNCH, Oslo) underscored the transformative role of digital technologies in reshaping children's engagement with museum collections.

2.4 Multi-Stage Systematic Approach

The entire process of the workshop was subdivided into four stages:

2.4.1 Stage 1: Introduction and Theoretical Framing (S.1.)

Participants were introduced to the fundamental concepts of fortification architecture and the preservation of cultural heritage. They were also acquainted with the architectural profession and encouraged to engage creatively by designing their own forts during the workshop. The facilitator provided an overview of digital modeling techniques, presented a 3D-printed model of Fort Belgica, and discussed its key architectural features. Particular emphasis was placed on raising awareness about the vulnerability of fortifications, the terminology associated with defensive heritage studies, and the cultural significance of different fortification traditions. The session began with a series of guiding questions intended to stimulate curiosity and discussion: "Have you ever visited a castle or a fort?", "Do you know the difference between a castle and a fort?", and "Do you know the name of the profession that designs forts?"

An additional mapping activity was conducted for older children, where participants were shown a historical map of Brussels with its former ring of fortifications. Initially unfamiliar with the city's fortifications, their recognition increased upon seeing photos of remaining structures integrated into modern urban landscapes. This activity helped situate their learning within the context of real-world, multi-layered urban heritage, emphasizing the ongoing relevance of historical preservation.

2.4.2 Stage 2: Hands-on Digital Reconstruction (S.2.)

Children were invited to replicate the physical model using iPads equipped with an intuitive free scanning application – *Modelar* (Figure 1). The participants received guidance on basic data collection techniques (see Figure 2) and learned that the printed fort model they were scanning had been documented using a similar method—photogrammetry—but with the assistance of a drone. This technique enabled the creation of a 3D model of a full-scale fort, now exhibited in front of them. The printed result of this process offered a tangible connection to real fieldwork, allowing them to observe the remarkable level of detail captured.

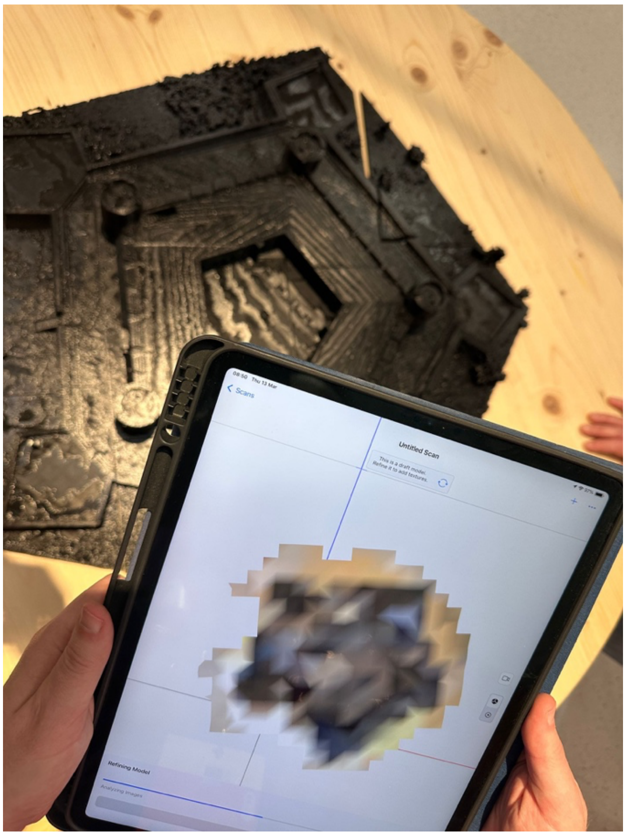

Figure 1. Digitalization process of a 3D printed model of a fort using an iPad and free software, Modelar.

The physical model (75cm in diameter), designed as a puzzle, encouraged children to pick up individual pieces and examine features such as entrance gates, staircases, bastions, and towers (Figure 3). The model also included interior elements, giving them insight into the internal organization of the fort.

In sessions with adolescent participants, the same interior elements of the fort were presented in digital 3D format using *Modelar* (Figure 4), serving as an additional engagement part. This allowed them to compare the virtual models with their physical printed versions. It was also explained that the final assembly of interior and exterior components into a complete model had been carried out using Blender, a free and open-source modeling software. Two pupils spontaneously shared that they already use Blender recreationally outside of school. Their curiosity was piqued, and they asked more in-depth questions about the post-processing phase of photogrammetry, particularly the final refinement and scaling of obtained photogrammetric models. This stage of the workshop sparked both technological interest and a deeper, embodied understanding of architectural forms and heritage documentation practices.

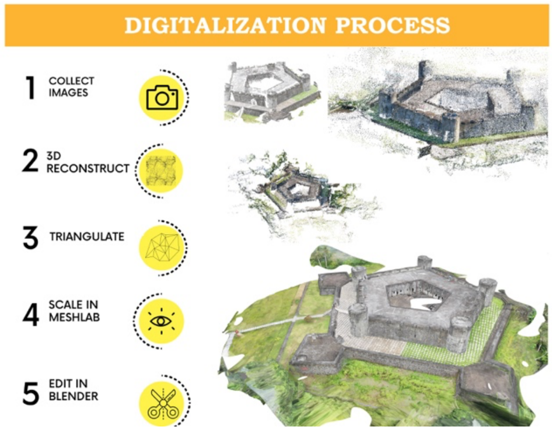

Figure 2. Illustrative scheme of the digitalization process, shared with children as part of the learning experience.

Figure 3. A 75 cm diameter physical model of Fort Belgica, designed as a puzzle with interior spaces.

2.4.3 Stage 3: Interactive Puzzle Assembly (S.3.)

Simplified, digitally printed puzzles representing various elements of bastion fortifications from different architectural schools were provided. Children assembled these modular elements to construct their forts (Figure 5), fostering analytical thinking and historical awareness while simultaneously reinforcing theoretical knowledge. By assembling these puzzles, children were encouraged to identify and categorize fortifications based on different architectural schools (Figure 6) and choose which school they wanted to represent in their creation. It was also mentioned that they can mix schools, as such a practice can be found in real cases too, when castles and fortresses underwent transformations over time, with some parts being upgraded. For preschool-aged participants, simplified instructions were used: the fort elements were introduced as puzzle pieces representing walls and bastions, which they assembled with parental assistance.

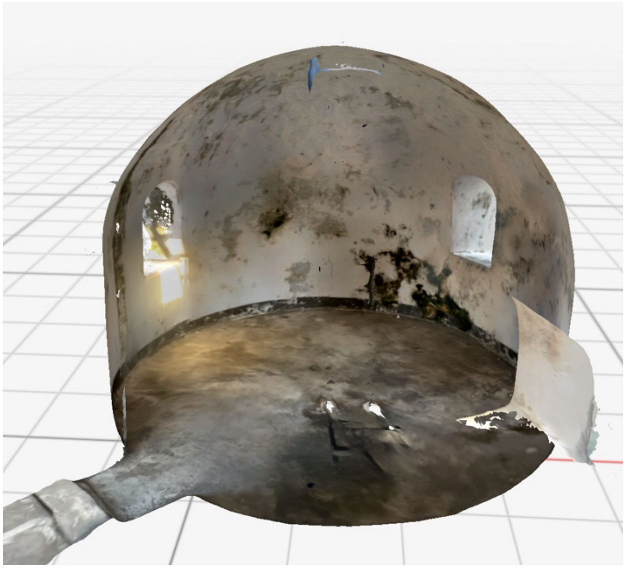

Figure 4. Scanned interior of a real fort using *Modelar*—the same software children used to scan printed models during the workshop.

Figure 5. Process of assembling a 3D-printed puzzle to illustrate the differences in fortification schools in the 17th century.

2.4.4 Stage 4: Assessment and Feedback

Evaluation was conducted through a combination of structured observations, a short questionnaire at the end of participation, and analysis of the digital models created. Key indicators of engagement included participation rates, observable enthusiasm, time-on-task, and peer collaboration.

3. Activity Learning Outcomes

This section outlines the pedagogical outcomes derived from the heritage education activities, with a specific focus on reasoning, cultural awareness, and the integration of digital tools into the learning process. The program was structured to follow a progressive sequence, beginning with theoretical framing and culminating in hands-on digital engagement. The learning outcomes were mapped to individual activity components, as summarized in Table 1. The table represents the targeted cognitive and skill-based goals aligned with each session. Activities ranged from basic urban heritage recognition to advanced digital scanning. Through this design, children not only encountered core architectural and preservation concepts but also

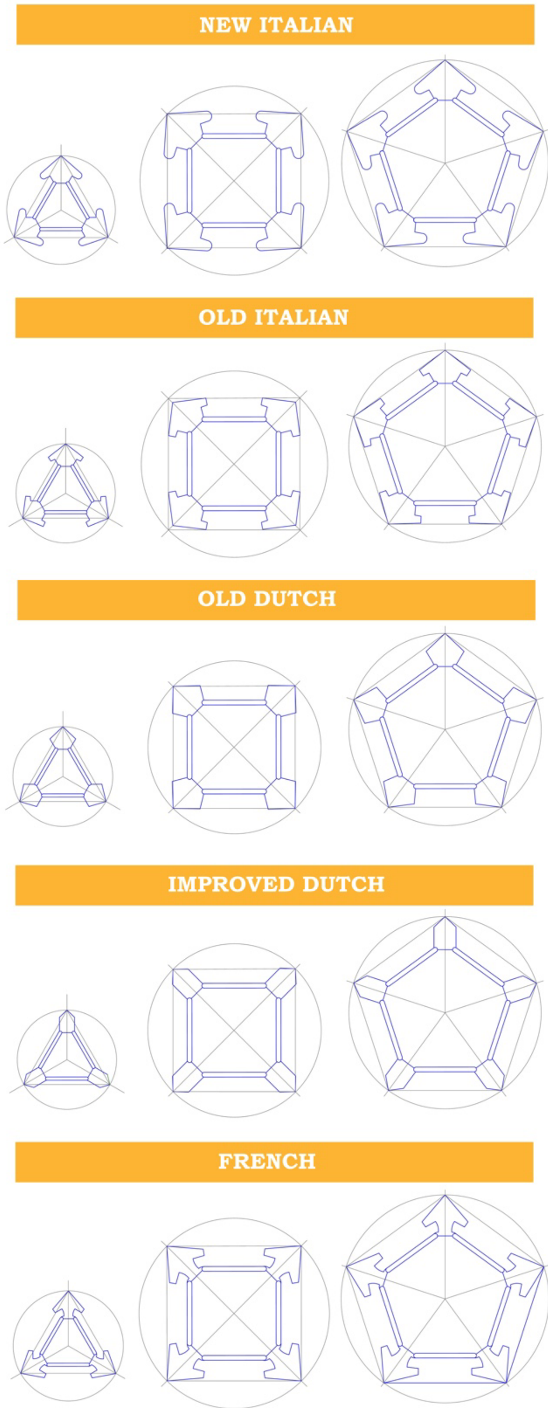

Figure 6. Visual materials illustrating the concept of fortification schools and their representation across various formats. The outlines of walls and bastions correspond to printed puzzle pieces designed for children. All graphics and printed materials were created by the author of this article.

engaged in practical exercises fostering analytical thinking and digital fluency.

Activity Components	Learning Outcomes
S1. Map recognition & photo identification	Understand multi-layered urban heritage and locate remains of fortifications
S.1. Historical context (Why protect forts?)	Cultivate preservation awareness
S.1. Fortification schools & terminology	Distinguish fortification schools and elements
S.2. Digital scanning & preservation	Introduce digital documentation and professional conservation practices
S.3. Fort model creation & puzzle assembly	Enhance analytical, spatial, and architectural reasoning

Table 1. Activity Learning Outcomes

By integrating intuitive tools and visual narratives with interactive tasks, the program served not only as an awareness-raising platform but also as a prototype for cross-disciplinary educational frameworks in heritage studies. It effectively bridged generational gaps between heritage professionals and young digital-native learners.

4. Engagement Overview

While only 15% of the total cohort (90 out of 600 children) actively participated in scanning or puzzle assembly, observational data revealed that many others contributed as assistants or remained attentive observers. This extended form of engagement suggests that heritage learning can be effectively transmitted through collective, rather than exclusively individual, participation. Table 2 outlines the levels of active engagement, verbal participation, and translation from English requirements across various school categories, including international, local francophone/Dutch, and special needs groups.

Group	% Actively Participated	Translator Required	Verbal Engagement	Observed Enthusiasm
International School Students	100% of group sessions	0%	90%	High
Local Francophone/ Dutch Schools	70% (engaged as observers or assistants)	30% peer-translated, others - communication through translator	70%	Moderate –High
Children with Special Needs	80% (visual/tactile observers)	100%	20%	Very High, black puzzle assembly

Table 2. Engagement Summary

Notable Observation: In most sessions, 2–3 boys per group could correctly distinguish between a fort and a castle even before the theoretical segment began. In two groups, one girl per group also answered correctly, indicating some prior familiarity with defensive heritage typologies.

5. Quality of Output

The quality of the children's outputs—namely puzzle assembly and digital scanning—varied slightly across school categories. However, all active participants successfully completed the tasks, with minor differences in the level of guidance required. Table 3 summarizes puzzle completion rates and scanning accuracy across the active groups.

Group	White Puzzle Completion Rate	Black Puzzle Completion Rate	3D Scanning Accuracy
International School Students	100%, without tips	100%, without tips	High
Local Schools	100%, with tips	100%, with tips	Moderate - High
Children with Special Needs	100%, with tips	100%, without tips	Moderate - High

Table 3. Quality of Output (Among Active Participants)

5.1 Facilitation Notes:

– Children with autism exhibited strong tactile preference, especially for high-contrast black puzzles, and remained engaged across multiple sessions.
– A drone photo printed on a T-shirt of a tutoring person helped visually communicate the top-down layout of a bastioned fortification.
– For the white puzzle, several children initially stacked blocks vertically. In almost every second group, instructors needed to explain that bastions were designed in horizontal planes, flat and low to the ground.

5.2 Scanning Accuracy

A total of 90 scans were completed during the two-day activity. Of these, a small number exhibited technical errors, predominantly due to physical limitations in scan coverage, particularly among younger participants (Table 4).

Issue Type	% of Total Scans Affected	Notes
Holes in the center of the model	5.5%	Caused by incomplete top coverage; most common among younger participants
Deformed towers	10%	Likely due to camera shake or rushed scanning
Missing bastions	2.2%	Resulted from scanning only one side; lacked full perimeter coverage

Table 4. 3D Scanning Accuracy (Out of 90 Scans Completed)

5.2.1 Note on Scanning Gaps and Educational Insight:
Scanning inaccuracies—such as holes in the center or missing architectural elements—were typically caused by incomplete top-angle coverage, especially among younger children who could not easily reach over the table. These imperfections became a valuable teaching moment, allowing facilitators to explain the necessity of combining ground-level scanning with aerial drone photogrammetry in real-life heritage documentation. This comparison between workshop activity and professional practice underscored the importance of integrating multiple documentation techniques in architectural heritage preservation.

5.3 Knowledge Retention

While the primary objective of this study was to design and implement an educational intervention for enhancing cultural heritage awareness among children, methodological constraints inherent to research with minors limited the scope for direct longitudinal assessment. The transient nature of participation, along with ethical restrictions on follow-up data collection, precluded sustained measurement within the immediate study cohort. Recognizing the importance of knowledge retention and meaningful engagement as core evaluative metrics in heritage pedagogy, a triangulation strategy was adopted. This involved the integration of external, methodologically aligned data drawn from the Time Odyssey project—an interactive, tablet-based cultural heritage program delivered across UK museums between 2023 and 2024.

Through formal collaboration and a data-sharing agreement, ethically compliant access was obtained to a non-public dataset capturing responses from over 5,000 schoolchildren and 650 adults across 150 museum visits. In Time Odyssey, children worked in small collaborative groups of two to three, each equipped with a tablet. This digital-first approach capitalized on the innate comfort today’s generation has with screens and interactive technology, lowering barriers to entry and fostering a sense of playfulness and accessibility. The learning tasks were structured as “missions” with embedded creative challenges, such as the Amulet of Power, in which children identified symbolic representations of authority—crowns, swords, or coins—within the exhibition context. This immersive, goal-oriented structure fostered both independent discovery and peer interaction.

Quantitative metrics from Time Odyssey strongly support the cognitive and social benefits of this approach:

- 84% of teachers reported that it helped pupils practice or develop teamwork skills.
- 79% said it encouraged collaboration and improved discussion abilities.
- 69% noted increased engagement among pupils who do not normally participate.
- 96% of educators would recommend the experience to others, and 92% said it met or exceeded expectations.

Qualitative feedback echoed these findings, describing the program as “fun,” “interactive,” and particularly effective in encouraging movement, dialogue, and oracy. Pupils themselves expressed delight in the hands-on nature of the activities, consistently highlighting the use of tablets, scanning technologies, and the sense of discovery as central to their enjoyment: “I love the work we do on the iPad AND I want to stay more—it’s so fun.”

These findings offer a meaningful point of comparison for the present study. In my own workshop, participants engaged in a similarly structured set of group-based, challenge-driven activities that required digital literacy, spatial reasoning, and historical interpretation. Working in small groups, they scanned a scale model of Fort Belgica using photogrammetry, identified architectural elements (e.g., bastions, towers), and assembled a black puzzle, identifying its main features during the process. Once familiar with these typologies, they constructed their own forts using a white puzzle, integrating the forms they had encountered. Just as the Time Odyssey challenge asked children to recognize symbolic artifacts of power, the workshop asked them to recognize, manipulate, and reflect on the architectural language of fortified places—an embodied lesson in both geometry and geopolitics.

Although direct follow-up data from the primary cohort was unavailable, the convergence of findings between my observations and the external Time Odyssey dataset provides compelling evidence for the cognitive affordances of digital heritage education. Both interventions illustrate how multimodal, screen-based experiences—when structured around tactile, interpretive tasks—can lead to high levels of engagement, deeper processing of spatial and historical content, and the emergence of collaborative learning behaviors. Importantly, these findings also speak to the broader concern regarding children's screen time: rather than passive consumption, such technologies can foster active, situated learning when embedded in meaningful cultural contexts.

In conclusion, this triangulated and cross-institutional approach not only addresses the challenges of evaluating interventions with young participants but also underscores the value of cooperative data sharing across heritage education projects. The evidence points decisively to the potential of digitally augmented, challenge-based learning environments to cultivate historical empathy, architectural literacy, and technological curiosity in young learners. Future studies should pursue longitudinal designs with ethically robust follow-up methodologies to better measure durable knowledge transfer and the development of heritage competencies over time.

6. Limitations of the Method

This study is subject to several methodological limitations, chiefly arising from the ethical and practical complexities of conducting research with child participants. Engaging children in empirical inquiry necessitates not only age-appropriate data collection techniques—such as storytelling, puppet-based interviews, or visual tools—but also a deep understanding of developmental psychology to ensure methodological validity and ethical sensitivity. Additionally, studies involving minors are typically subject to rigorous ethical oversight, requiring multi-tiered approvals from parents or guardians, educational institutions, and institutional or governmental review boards.

In this context, while the educational workshop successfully reached a substantial sample of approximately 600 children, the transient nature of participation—often limited to a single session—precluded the possibility of systematic follow-up. The absence of continued access to participants after the event rendered direct, longitudinal assessment of knowledge retention unfeasible.

To partially mitigate this limitation, the study incorporated supplementary data from a parallel educational initiative with a comparable target demographic and methodological framework. This triangulated approach, while offering valuable indirect insights into the effectiveness of digitally mediated heritage education, does not fully compensate for the absence of primary post-event evaluation.

As such, the lack of direct follow-up data remains a recognized limitation. Future research should prioritize longitudinal study designs with ethically approved follow-up protocols to enable a more robust assessment of knowledge retention and the sustained impact of heritage education interventions on young learners.

7. Conclusions

The findings from this study indicate that non-formal education strategies can be highly effective in raising awareness about cultural heritage preservation among children. Integrating digitalization techniques through interactive workshops fosters engagement and skill development. By introducing children to digital heritage preservation at an early age, they gain an appreciation for cultural heritage and acquire valuable technological competencies that can be applied in future academic and professional pursuits.

Furthermore, using accessible, low-cost technology such as iPads and iPhones makes digital heritage preservation more inclusive and widespread. The case study demonstrated that even young children could successfully create 3D models of historical structures, emphasizing that digitalization is not limited to professionals but can be a community-driven effort. Encouraging children to explore and document their local heritage fosters a sense of ownership and responsibility toward preservation.
This study highlights the potential for expanding non-formal educational initiatives in digital heritage preservation.
This practice collects and aggregates knowledge, enabling young learners to grasp the complexities of historic defensive heritage monuments, particularly colonial forts with intricate and multi-layered histories. By digitizing these structures and producing 3D models, children and young school pupils actively participate in a structured acquisition pipeline that enhances their understanding of architectural heritage. More importantly, this initiative contributes to the formation of responsible and culturally aware citizens who appreciate the significance of shared heritage. Through engagement with digital tools and hands-on learning, children gain insight into merging various European fortification schools in colonial contexts, fostering knowledge transfer and a deeper appreciation for the interconnected history of fortifications worldwide.

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