Introduction

All ages and genders play video games (VGs) across multiple platforms, from smartphones and tablets to dedicated handheld devices, consoles, and personal computers. These games offer playful experiences that engage players, who spend countless hours immersed in single and multiplayer worlds. Interest in VGs has been steadily growing, so much so that there is significant research focused on the usefulness of these games for education and training. In effect, the use of VGs in learning contexts has been examined across several ostensible separate fields, with their potential in education, healthcare, industry, and public administration commonly recognized to the extent that it has created a new area of business [1].

Known as “serious games” (SGs), they differentiate themselves from traditional VGs by infusing instruction with the gameplay as part of their inherent design. Thus, the objective is not winning but learning from the experience [2]. Commonly likened to simulation games, which mimic real-life situations that might not otherwise be feasible due to several considerations, such as cost and safety, SGs are said to stimulate experimental learning (i.e., learning through experience; [3]) or learning-by-doing, ingraining them in the learning process [4]. The idea that games can be part of the learning process has been around for some time, with adventure games, for example, said to be particularly suited to this hands-on approach to learning, which is related to constructivism [5], where learners do not passively acquire information but interact with their environment to adapt and learn. Players actively construct new knowledge by finding information in the game, comprehending it, and then applying the newly gained knowledge to progress the gameplay [6].
One area of particular importance where the application of SGs has been extended [7] and increasing in interest [8] is the cultural heritage (CH) field. These games have been studied for their ability to raise awareness about cultural heritage matters [8], with considerable effort expelled into examining how they can be used for learning [9]. While some readers may be intimately aware of such efforts, others may be unfamiliar with the study of SGs in archeology and heritage contexts [10]. This is not surprising because these studies emerged slowly, primarily through unplanned initiatives and passion projects charting the potential of research in and on these games [10].

Numerous examples can be found of SGs based on or containing heritage content [11], with many in recent years aimed at maximizing positive museum experiences [12]. These efforts have included conceptual ideas and proposed projects (e.g., [13–16]), working demonstrations and proof of concepts (e.g., [17–26]), as well as playable games (e.g., [19,27,28]). These efforts have been demonstrated in educational settings, such as classrooms and museums (e.g., [18,29]), in public places, including city streets, neighborhoods, and boroughs (e.g., [19,27,28,30]), as well as culturally significant locations, which have predominately comprised historical and heritage sites and the like (e.g., [18,20,22,24–26]). Several technologies have also been explored, with most efforts focused on the use of virtual reality (VR) and environments (e.g., [7,31,32]) and augmented reality (AR) (e.g., [13,15,17,18,21–26,28,33]).

It can be argued that AR has been predominately used alongside mobile games [8], often taking advantage of the location-finding characteristics of smart devices. Commonly referred to as “location-based games” (LBGs), many examples can be found that demonstrate their promise at augmenting and enhancing the CH experience. This form of SG is valuable because it provides ubiquitous access, promoting learning in cultural contexts at heritage sites and institutions through rich interaction [8] with the physical space augmented with virtual assets. However, as much potential as SGs have in bringing awareness to CH issues, these games can be generally complicated to build, with some asserting that using game mechanics with pedagogy is unclear [34]. Furthermore, although SGs in CH contexts is a novel approach that can introduce challenging and motivating elements, little research exists that has attempted to identify best practices in incorporating cultural learning scenarios [35], with even less available that has specifically looked at game mechanics in CH contexts (e.g., [36]).

1.1. Purpose

Hence, this work aims to identify design practices and considerations in the research that take advantage of the immersive qualities of SGs to raise CH awareness. Cultural institutions have been drawn to SGs because of their ability to produce interactive experiences. Still, their use has also shown to be expensive and time-consuming compared to most CH-related activities’ low-budget characteristics [37]. As a result, emphasis is placed on design considerations in creating LBGs, because these games have advantages compared to other types of SGs. This work is intended for educators, researchers, instructional designers, game developers, practitioners, and those in the CH field interested in game-based learning and would like to explore LBGs to embody a deeper understanding of and appreciation for CH.

The remainder of this work is structured as follows. First, related work on using VGs in CH contexts is offered. This includes a discussion on the need to explore technological innovations in the preservation of cultural and historical heritage; the interest in VGs among those in the CH field and their perceived educational value; the promises of SGs and supporting research; the growing application of VR and AR among heritage initiatives; and the potential of LBGs in CH contexts alongside the challenges in their development and use. Second, the rationale for the aim of this work is expanded upon, outlining the need to identify design practices and considerations in creating LBGs for CH. Third, the method by which the design practices and considerations were identified and organized is presented. Finally, the practices and considerations are individually discussed, alongside examples of LBGs that have spoken to the concerns and recommendations.
1.2. Terminology

Moreover, several terms are used throughout this work, warranting further explanation. “Cultural heritage” (sometimes “heritage”) is a broad term that refers to a wide range of matters [38] alongside having seen change [8] in its thinking. Early views of CH often ended with tangible heritage, which included material culture, from artifacts and monuments to buildings and entire sites, but has since grown to include intangible heritage [6, 8] and aspects of nonmaterial culture, such as beliefs, customs, and traditions [8]. Cultural heritage goes beyond objects’ inherent qualities to include their values and identities [8]. As a result, CH in this work refers to tangible and intangible aspects that contribute to the identity of a people that may have been inherited through generations. While “to raise CH awareness” is the exposure to tangible and intangible attributes that results in consciousness, appreciation, and overall respect for the different values of people from diverse cultural backgrounds.

Numerous attempts have also been made to explain SGs. This work adopts the definition of Michael and Chen [39] for its simplicity, clarity, and broadness, which views SGs as those “that do not have entertainment, enjoyment or fun as their primary purpose” (p. 21). It is also important to mention that several terms have been used to identify SGs used in CH contexts. These have included, for instance, “serious heritage games” [40], “historical serious games” [41], and “cultural heritage games” [9]. This work hereafter uses the term “serious heritage games” (SHGs) by Anderson et al. [40], to denote the approach of studying games for reasons other than entertainment that are focused on augmenting virtual heritage applications with game elements intended to motivate and challenge.

As the last point, location-aware technology has existed for over two decades, but its study in the context of games and learning is relatively new. Consequently, there is yet to be an agreed-upon terminology [42]. Many terms have been used to identify this form of SG, including “geo games”, “global positioning system (GPS) games”, “location-based augmented reality games”, “location-sensitive games”, “location-aware games”, “hybrid reality games”, and “mixed reality games” [42]. Although these terms technically represent distinct types of games [43], most of the research has used the term “location-based games” as a synonym [42]. To avoid ambiguity, the term “mobile, location-based games” (mLBGs) is used hereafter because “mobile highlights how game players rely on their mobility in their interaction with the game, and location-based emphasises [sic] how the appearance and characteristics of different physical locations are part of the game constellation” [44] (p. 57).

2. Related Work

There is an urgency to preserve cultural and historical heritage. Built CH has seen deterioration, destruction, and dramatic alterations from natural and human causes [45]. Globalization [8, 46] and social [8] transformation has also put intangible heritage at risk [8, 46], especially among Indigenous communities [46]. These factors have long challenged preservation efforts [6] while at the same time underscoring the increasing importance of protecting CH [8, 16, 46].

Moreover, resources have been suffering, furthering the need to combine assets that can provide educational, social, and economic returns regarding social cohesion and more sustainable cultural tourism alongside meaningful CH resources [47]. To meet such aims, innovative technologies [29] and approaches [29, 46] are needed to preserve CH and create ways that can promote conversations with future generations [46]. In addition, cultural institutions, such as museums, are said to serve a critical role in safeguarding and exhibiting CH to the public [29] and have been considering the use of information and communication technology to enhance the visitor experience [48] as well as promote a greater understanding and appreciation of CH among larger audiences [29]. Among these technologies are VGs, which have also been widely investigated to enrich CH environments [49].
2.1. Video Games in Cultural Heritage

It is easy to see why there is such an interest in VGs among those in the CH field. Along with their overwhelming popularity [38,50] and frequent use of historical themes, settings, characters, and events [50], create ways for players to explore ancient places, experience lost cultures, and view ancient works [35]. That is, VGs have shown to be popular in CH projects because they are viewed as a novel way to transmit knowledge and culture [51], with the belief that they can be used to promote meaningful and significant understandings of the past [52]; essentially reawakening history [6]. Furthermore, it has been asserted that VGs have surpassed their original entertainment aims and can be used to engage and aid with the comprehension of content that learners might otherwise struggle with [53].

There have been many reasons why VGs are effective in learning contexts, with engagement and motivation often cited. Motivation is thought to be the main driver in effective learning [54], which is supported by educational research finding that the more active learners are engaged, the more impactful and memorable the experience [55]. Such findings have contributed to the interest in VGs and their perceived ability to captivate students and encourage learning in critical analysis, problem-solving, and strategic thinking [54]. This has also fueled the consideration that these games may be well-suited to meet the educational goals of cultural institutions [55].

It may seem obvious that these games can serve as valuable teaching tools [56] through their ability to enrich experiences and enhance learning motivation in cultural contexts [8]. However, it is understood that VGs have long had a contentious relationship in education. By and large, VGs have developed a bad reputation, often linked to negative topics when mentioned in the popular press [35]. It has also been asserted that there is little empirical evidence that these games can do any better than what traditional teaching methods have offered, raising questions about their ability to produce dependable, valid, and long-lasting educational results [56].

2.2. Serious Games in Cultural Heritage

In fairness, VGs are characteristically entertainment mediums and not created for didactic reasons. Serious games, on the other hand, are explicitly educational by design [51] and directly funded (i.e., commissioned) by organizations [37,51]. Furthermore, it is believed that these games can help in understanding CH in ways that traditional methods (i.e., written text and images) cannot [35], serving as a bridge for communication with scientists [53] alongside involving the public [51,53]. For instance, they serve a crucial role in accessing history and heritage, creating methods for the public to explore and understand heritage sites that otherwise would be unsafe or inaccessible [4], endanger conservation efforts [32], or have been lost to history, but can serve to help experience nonmaterial culture.

Notwithstanding their importance and potential benefits, SGs have yet to reach the popularity of commercially available VGs [51]. Furthermore, although SGs are defined in this work as games that are not primarily driven by entertainment, enjoyment, or fun, it has been asserted that these games must entertain; otherwise, they will not be able to provide the level of engagement needed to motivate students and encourage learning [8]. This makes SGs more challenging to create than traditional VGs because they need to be fun and playable, all the while designed with pedagogy as a key ingredient. For instance, SHGs must render environments and built heritage, so they are as visually appealing as what is found in modern VGs, but the content must be historically correct [57].

Unfortunately, it has been asserted that most SGs lack “fun” [8] because the emphasis is placed on their targeted learning objectives. Consequently, less consideration is put on their playability [51]. However, increasing evidence suggests that these games can successfully merge entertainment and education [12]. Many have attempted to classify SHGs, presenting taxonomies that can be used to explain and define this game application [50]. For example, Anderson et al. [40] grouped these games as prototypes and demonstrations, virtual museums, and commercial historical games; Antoniou et al. [58] defined a model
based on the game- and player-based as well as organizational characteristics to include cognitive skills and game enhancements, single and multiplayer, and the organization’s gameplay aims; while Mortara et al. [6] emphasized groupings by educational objectives, as cultural awareness, historical reconstruction, heritage awareness, along with other factors, such as genre, the context of use, technology, and learning effectiveness.

Other researchers have conducted literature surveys or compared different conceptual frameworks to define SGs further, describe their composition and how players learn from them, or present guidelines focused on their design and evaluation [50]. For example, in the context of design, Marne et al. [59] offered guidance on applying design patterns to SGs that reinforce the six facets of pedagogical objectives, domain simulation, interactions with simulation, problems and progression, decorum, and conditions of use; Tang and Han-neghan [60] presented a methodology for the design and development of SGs comprising 13 steps grouped into the phases of plan, prototype, and finalize; while Lepe-Salazar [61] proposed a model based on the categories—stakeholders, game goals, audience, game, environment, enhancing the experience, and relationship to deep learning goals—and proposed questions in each category that can be used to guide the development process. For evaluation, Paliokas and Sylaiou [62] created a mapping of games from 2009 to 2015 that included the games’ goals, purpose, market, audience, and educational outcomes; Malegiannaki and Daradoumis [63] emphasized genre and plot related to SHGs while mapping context, the number of players and game outcomes; whereas, Tsita and Satratzemi [12] expanded on all of these, emphasizing in the evaluation, study types that are being used to extract the learning outcomes. They also looked at measuring tools, samples, and acquisition assessment. Finally, to offer an overall picture of the games they reviewed, they examined the goal, the context of use, the target group, and the technology.

2.3. Virtual and Augmented Reality in Cultural Heritage

Technology is a common factor of importance in SHG studies. Several examples of SGs designed to learn about CH [48,50] can be found that have demonstrated the use of different technological platforms [48]. This includes games trialed in past years exploring the importance of integrating learning with meaningful environments (see [64–66] for a review). As discussed, virtual and AR are among the most attractive technologies used to preserve history while contributing to a positive learning experience [37].

At the turn of the new millennia, using games in serious contexts to support CH efforts, including teaching and learning about history, or augmenting museum experiences, was significantly less considered [40] and largely untouched by researchers [35]. However, at this time, the use of VR in CH settings showed promise. It unlocked opportunities for archaeological, art history, and other academic pursuits, including public education and interpretation activities, which were perceived as impressive and entertaining [67]. To demonstrate its impact, Anastasovitis et al. [7] spoke to the ten-year critical review by Mikropoulos and Natsis [68] of empirical research on the educational applications of VR. Mikropoulos and Natsis [68] found that although the majority of the 53 articles they reviewed referred to science and mathematics, researchers from social sciences were among those who appreciated the educational value of VR and were interested in incorporating their learning goals into virtual educational environments.

Exploration of AR in CH contexts was also growing in popularity during this era (e.g., [13]), particularly in CH contexts [8], in part due to the cost and logistical considerations associated with VR. Unlike VR, which often requires dedicated equipment and sometimes a designated location to be experienced, AR lends naturally to existing smartphone (and similar mobile) devices and can be experienced just about anywhere. This created many opportunities to explore mobile devices and games in various contexts, warranting serious study regarding their educational value [64,65]. This possibly explains why there are so many efforts that have predominately focused on the use of mobile devices, their unique capabilities (e.g., GPS), and games frequently constructed as treasure hunts [8] (e.g., [14,21,24]) to connect virtually with physical environments.
Think of AR as a middle ground between VR and the real world [38], where, unlike fully virtualized spaces, digital content can be infused with the physical location in an expanded reality that blurs the boundary between the virtual world and real life, resulting in a blended experience [30]. Games played on mobile devices have shown to be beneficial because they can bring together the physical world augmented with virtual assets. These games provide ubiquitous access that allows learning to occur in cultural contexts, at heritage sites and institutions, and everywhere and at any time [6] while affording rich interactive experiences to facilitate learning [6,8]. For example, they can be used to draw attention to specific artifacts that guide players towards certain actions [43], effectively communicating the historical significance of heritage sites and assisting with the understanding of cultural context [12].

2.4. Mobile, Location-Based Games in Cultural Heritage

This means that mobile games have shown enormous potential because these games can be used to bring together the physical world augmented with virtual assets, illustrating the attractiveness of mLBGs in CH contexts. Numerous studies have examined these games to re-experience history, highlighting, for instance, their potential to recreate history to help learn about past people and events or align educational institutions with local communities [69]. For example, Huizenga et al. [30] demonstrated the game, Frequency 1550, transforming the city of Amsterdam into the Middle Ages, using smart and video, Internet-, and GPS-enabled phones to help students learn about the medieval city through the completion of different tasks (e.g., looking for holy relics). In contrast, Holden and Sykes [27] introduced the game Mentira, which used iPod Touches to help students practice Spanish while solving a prohibition-era murder throughout Los Griegos, a neighborhood in Albuquerque, New Mexico. Huizenga et al. [30] showed the value of mLBGs in promoting awareness about historical places, while Holden and Sykes [27] showed how such games could strengthen relationships between educational institutions and surrounding communities.

There have been many mLBGs developed over the past two decades that have shown their value in CH contexts, albeit some might be considered linear walkthrough tours or guides more so than games, that have adopted innovative mobile technologies [19]; e.g., Archeoguide (see [25,26]); “The Voices of Oakland” (Oakland Cemetery) (see [20]). Other examples include Arbela Layers Uncovered (see [15]), Avebury Portal (see [24]), Carletto the Spider (see [33]), The Heraklion Fortification Gates (see [28]), Oracle of Delphi (see [21]), REXplorer (see [19]), Sutton Hoo (see [18]), “Una giornata di Gaio ad Egnathia” (Gaius’ Day in Egnathia) (see [14]), and Viking Ghost Hunt (see [23]). Mobile, location-based games have also been explored in other contexts, including promoting physical activity (e.g., [42,70]), increasing geographical and cartographical knowledge (e.g., [42,71]), and encouraging social interaction (e.g., [42,72]). Then, there are the commercial instances of these games created for entertainment, with Geocaching [73], Ingress Prime [74], Pokémon GO [75], and Zombies, Run! [76] among the more popular titles.

While Pokémon GO came late to the mobile, location-based gaming scene, its overwhelming popularity has helped further exemplify the potential benefits of these games, particularly in CH contexts. The game morphs virtual Pokémon characters with physical locations using smartphones and GPS capabilities, creating an environment where players can hunt for these characters in real-world settings [77]. It has been presented, for instance, that the game can help with personal development and promote city appreciation among children, encouraging cultural education [78]. To demonstrate this thinking, Estefam [78] offers the request by the then mayor of Rio de Janeiro to have the game released in Brazil before the 2016 Olympics [79], as well as the tour “Chasing Stories and Pokémon” at Fernando Costa Park (commonly known as Água Branca Park) in the city of São Paulo in August of 2017, which was part of the Cultural Heritage Journey, an event that the City Office for Culture organized to raise awareness about the city.
As successful as Pokémon GO has been, it has also been said that the educational goals of museums and similar institutions are often at odds with the creative forces found in traditional games developed for entertainment [55]. As a result, their efforts have usually settled on SGs that have either diminished entertainment value or relied on historical fiction that has blurred reality and fantasy [55]. To some degree, this should be expected; SGs have been described as a relatively new concept, with little known about how to use these games in museums [11]. However, the matter is further compounded by the assertion that the game mechanics found in Pokémon GO and similar games can be problematic in CH contexts [36].

Perhaps the most significant issue is the fact that the real-world site is meaningful to the CH experience, even when importance needs to be put on nonmaterial heritage, such as the representation of traditions and other cultural norms unique to a people. Unfortunately, this is not always the case for mLBGs designed solely for entertainment, as the emphasis is typically put on virtual assets over the player’s physical surroundings [36]. This is a crucial notion that has often been missed, with early research on mLBGs primarily motivated by the technological innovations of mobile devices [80] (e.g., [81–83]). Said a different way, to fully appreciate the potential of these games, the emphasis should be on their ability to promote learning beyond conventional scholastic settings rather than concentrating on individual devices or certain functionality [80].

Consequently, if not designed with care, these games can have the opposite or undesired effect regarding the CH experience, where the presence in the physical world is sacrificed for the immersive appeal of the virtual [36]. For instance, Pokémon GO emphasizes capturing, training, and battling the various Pokémon characters, not the real-world locations where they are found. Instead, these games must immerse players in the rich story and interactive gameplay that encourages deep engagement with the physical place through augmented virtual assets that are directly relevant [36]. Then, there are the challenges with the physical spaces themselves, particularly when it comes to heritage sites because each has its unique characteristics [36], ranging in atmosphere to include indoor and open-air spaces; in scope, from single monuments to entire sites; and in condition, with some in ruin while others well-preserved [21].

3. Method

Therefore, it is essential to explore design practices and considerations for mLBGs that aim to create an expanded reality that blends the virtual and real world to create a profound experience designed to raise awareness about CH. In other words, approaches and factors that augment and heighten what would typically already be experienced at a location, stressing the importance of exploration and learning. This aim is predicated on the argument that there is little research conducted to identify practices to best integrate cultural learning scenarios [35] and that there are few practical recommendations on how to recreate the motivational elements found in commercial VGs and leverage these elements in educational game contexts [56]. It is also based on the assertion that despite the number of frameworks created to aid with the design of SGs, little guidance has been afforded for designing the low-level mechanics and content of SGs [50].

3.1. Inclusion Criteria

To ensure scholarly rigor, the findings presented herein were compiled in a staged approach like that of primary research [84]. While a considerable effort was made to capture peer-reviewed content, other materials were sought to include conference proceedings as supplemental information befitting their academic stature and to provide context regarding “practicing real-world examples or an in-the-trenches view” [85] (p. 161). Adopting the approach of Hiriart [52], this work encompasses a wide selection of sources, not restricted to academic content but considered a heterogeneous collection of historical engagements, including research from experimental archaeological reconstructions and heritage sites. To begin, the Educational Resources Information Center (ERIC) and IEEE Xplore online
databases were searched, with Google Scholar subsequently utilized to assist in locating hard-to-find sources, such as papers published in conference proceedings. Combinations of terms represented by the statement (“location-based games” OR “mobile games” OR “serious games” OR “video games”) AND (“archaeology” OR “cultural heritage” OR “heritage”) were applied, which resulted in the identification of 103 sources.

The abstracts were next examined with the sources selected for review if: (a) an SHG effort was described, irrespective of whether it comprised a conceptual idea, proposed project, working demonstration or proof of concept, or playable game; or (b) design principles, practices, considerations, recommendations, or lessons learned were described in the creation of mLBGs or similar games. Of the 103 sources, 33 met one or both above criteria. Still, upon reading these sources, nine were eliminated because the contents did not reflect either criterion (i.e., the abstracts did not represent the contents). Other sources were also identified if they were cited in two or more of the remaining 24 sources (i.e., found in the references) and if their titles included the combinations of terms represented by the earlier statement. As with the 103 sources, the abstracts of these newly identified sources were then examined and selected for review if they met one or both above criteria. This process was repeated until no further research was identified, resulting in the inclusion of 32 sources for analysis.

3.2. Data Extraction and Analysis

Data was next systematically extracted from the 32 sources. Namely, each source was independently read five times, with specific information extrapolated during each review. The data extracted amounted to information related to (a) the technologies used, including devices and related equipment; (b) the pedagogical objectives and evidence regarding learning effectiveness; (c) insights into the graphical user interface (UI) and player experience (UX); (d) navigation and details of the heritage site, alongside points of interest (POIs) relevant to the experience; and (e) the game mechanics adopted. These five types of information, or factors, were derived from the authors’ review of literature surveys and other works that compared different conceptual frameworks or proposed their methodologies in the design, development, or evaluation of SGs (e.g., [6,12,58,61–63]). The factors represent the types of information most sought or mentioned in these literature surveys and related works.

Next, the data collected for each factor were logically grouped by like items to identify patterns. That is common themes across the 32 sources in the context of each factor to help reveal possible design practices and considerations. For example, data extracted regarding the technologies used showed three common themes focused on using existing devices, their compatibility and reuse. In contrast, data on game mechanics yielded the frequent use of maps, badges (and other types of rewards), inventory systems, multimodal cues, and non-player characters. Proposed design practices and considerations were then derived from these common themes. For instance, the practices and considerations—Adopt Devices That Players Already Have (see Section 4.1), Maximize Device Compatibility (see Section 4.2), and Utilize Core Technologies That Support Reuse (see Section 4.3)—were derived from the three common themes focused on the use of existing devices, their compatibility and reuse. The findings from this analysis are depicted in Table A1.

3.3. Inter-Coder Agreement

Inter-coder agreement was assessed on the extracted data using a checklist developed by the authors. The list comprised the five questions representing each of the factors: Is the statement describing—(a) the technologies used; (b) the pedagogical objectives and learning effectiveness; (c) UI and UX; (d) navigation, location, and POIs; and (e) game mechanics—accurate and clear? A total of 160 items (the 32 sources by the five checklist questions) were assessed, with an initial agreement rate of 92.5% on 148 of the 160 items regarding the belief that the extracted data from the 32 sources were accurately and clearly captured. The authors deliberated on the 12 remaining items until a consensus was reached.
Whereas the grouping of items into common themes within each factor revealed 100% agreement; that is, a comparison showed similar named themes between the authors that conveyed the same meanings upon further examination. The exception is that two themes—describing the need for games to be “fun” (as well as educational) and the framing of competition during gameplay in the context of learning—were noted in different factors by the authors. Consequently, the proposed design practices and considerations—Balance Fun with Learning (see Section 4.7) and Encourage Healthy Competition Through Knowledge (see Section 4.12)—were derived from multiple factors (see Table A1).

As stated, the proposed design practices and considerations were derived from these common themes, with the authors pulling from their own experiences in creating mLBGs during the collaboration process. Finally, to acquire further validation, these practices and considerations were presented and socialized at educational conferences (e.g., [69,86]). The constructive feedback from these conferences and similar events were then used to refine further and shape the practices and considerations found in Table A1.

4. Design Practices and Considerations

These proposed design practices and considerations in designing mLBGs for CH are discussed further. Whenever possible, the discussion is enhanced with examples and lessons learned from the respective sources selected for inclusion.

4.1. Adopt Devices That Players Already Have

Early pioneers of mLBGs used dedicated portable devices and supporting equipment. Vlahakis et al. [25,26], while experimenting with Archeoguide—a personalized AR guide and tour assistant for visitors of heritage sites—implemented three different “mobile units” based on a laptop, pen-PC, and palmtop, with the laptop configuration designed to work with other dedicated equipment in a backpack-like setup, to include a head-mounted display (with camera and compass). Dow et al. [20] also introduced a similar wearable system while demonstrating “The Voices of Oakland”—a dramatic, audio-based mixed reality experience situated in Oakland Cemetery in Atlanta—which comprised headphones and a backpack with a small computer for their initial proof-of-concept, later introducing a controller as well as a GPS receiver and head-orientation sensor for the second iteration of their mixed reality experience. While Ballagas et al. [19] explained that REXplorer—a mobile, pervasive game designed to raise interest in the history and culture of Regensburg, Germany—used a unique, handheld audio device.

However, using dedicated devices often results in repair, replacement, and eventual technical refresh challenges on the part of the heritage institutions, with costs also imposed on the player; for instance, to experience REXplorer, Ballagas et al. [19] explained that visitors had to rent the special device from the tourist information center for EUR 12. Fortunately, recent investigations into the benefits of mLBGs in CH contexts have already used mobile devices and capabilities in most individuals’ hands. Using commonplace devices, such as smartphones, has been described to mitigate the problems of maintaining dedicated equipment and easing associated costs. Players are also most likely familiar with operating their devices [21], so they can focus on the experience instead. Furthermore, it has been asserted that these devices are easier to adopt because they do not require a physical infrastructure (e.g., local area network) to implement, can be downloaded directly to the device (e.g., the heritage site can display a QR code), and necessary updates can be made through the game itself [36].

4.2. Maximize Device Compatibility

The research has revealed that mLBGs using smartphones have been released for both Android (e.g., [22]) and iPhone (e.g., [18]), with some, such as the Herbert Virtual Museum—two games aimed at establishing an interactive relationship between the museums and galleries—made available on several devices, to include Android, iPad, iPod, and iPhone [29]. Findings such as these help corroborate the practice of adopting devices that
players already have, which is undoubtedly based on the presumption that most players will have a smartphone (or tablet). While this may be the case in most situations, predicting device specifications is challenging. Therefore, to address such variations and reach the largest audience possible, a good practice may be to build to minimum system resources (i.e., memory and storage) while supporting devices running maintained versions (i.e., receiving security updates) of the Android and iOS mobile operating systems.

Other considerations found in the research include limiting the need for Internet connectivity because the availability of mobile network services may vary from site to site. It has been recommended that developers make no assumptions about the supportive infrastructure; for example, a practice may be to ensure that the AR framework used is configured to operate independently on the device to avoid network disconnects and roaming charges [22]. The reality is that every physical location must be evaluated on a case-by-case basis for infrastructure support because some heritage sites, for example, might be near base stations. In contrast, others may be completely void of cellular towers altogether.

4.3. Utilize Core Technologies That Support Reuse

A recurring theme in the research is the need to keep costs reasonable, as SGs can be expensive to create [37]. That is, equally as important to handling variations in device specifications and infrastructure resources is selecting the right core technologies in the development of mLBGs to help mitigate costs. This can be achieved partly through reusability, supported by the finding that many efforts in the literature promoted the use of existing assets in developing SGs (as well as those intended solely for entertainment) [1]. Many mLBGs, for instance, have been developed with the Unity [87] cross-platform game engine (e.g., [24,28,29]) as well as the cross-platform augmented and mixed reality recognition technology, Vuforia [88] (e.g., [24,28]). In addition, an often-touted benefit of the Unity engine is the Unity Asset Store, a library of free and commercial assets that can decrease development time and ultimately drive costs by reusing existing game objects, such as textures and models.

Overall, this finding suggests benefits in adopting the practice of leveraging core technologies with few expenditures, including royalty-free game engines that support reusable assets [35], taking advantage of libraries and authentic data sources [35,37], models, animations, and code [37]. Another cited advantage in the adoption of this practice is that the time saved through reuse can be subsequently spent focused on the user experience [1] as well as on other aspects of development unique to SGs; namely, the infusion of instruction with the gameplay, which as explained, is part of the inherent design of these types of games [2].

4.4. Accurately Model the Learning Objectives

As discussed, SGs are different because there must be an intrinsic balance between learning and play, which means that the interactions and the mechanics must be more than a layer of “fun” added to the game [6]. The same can be said of the graphics, particularly in CH contexts, as the environment and respective heritage objects must be historically correct [57]. However, modeling historically accurate assets can be labor-intensive and costly, mainly when reusability is impossible due to the absence of libraries and data sources. Thus, while it is essential to faithfully and respectfully represent CH so that it embodies an authentic experience, it is equally important to consider and take advantage of the real-world location as much as possible. To strike a balance, the practice of only accurately modeling the learning aims while creating a sense of believability for everything else may be advantageous.

Said a different way, consider emphasizing the cultural and historical importance of the physical space, using as much of the real world as possible, and only creating accurately portrayed augmented assets when vital to the learning objectives. For example, many mLBGs have enriched the experience with nonplayable characters (NPCs) as guides.
(e.g., [18,21,33]), often shown as historical figures in period clothing and dialogue. While it is important to depict real-life historical figures as accurately as possible, unless the level of detail is vital to meeting the learning objectives, a better use of development resources may be to create a believable representation of the NPCs and focus on realism and historical accuracy on other aspects of the game relevant to learning, such as the story. This example is significant because it has been asserted that narrative in VGs can help form emotional connections between the player and places, cultural objects, and landmarks [89], igniting interest in cultural values and respective customs alongside geographic locations [90].

4.5. Collaborate with Experts

Examples can be found in the research describing SHGs comprising teams of researchers, game developers, and cultural institutions, with the goal of creating digitally based learning tools that demonstrate the value of SGs in the context of cultural paradigms and innovative approaches to learning [41]. For example, Ballagas et al. [19] described that local tour guides and history experts carefully chose the historical buildings and characters used for REXplorer. While professional travel journalists were also hired to help construct the dialogue of characters with oversight from content experts to ensure the stories were engaging and historically accurate [19]. In comparison, Huizenga et al. [30] explained that the content for Frequency 1550 and the regular project-based lessons series of two class hours was similar, with the lessons designed by the researchers in cooperation with five history teachers from participating schools. Having the right expertise on a team is essential because, among other reasons, they can help determine what aspects of the game to accurately model; that is, these professionals can assist with striking the right balance between accurately modeling the learning objectives versus what can be left to a sense of believability.

The importance of this collaboration cannot be overstated, as it has been asserted that when academics do not consult with game developers and vice versa, the outcome is often either boring drill-and-practice games or games that are fun to play but lack pedagogical soundness [6]. That is, these CH experts can assist with further validating that the learning goals are met and that a meaningful link exists between the real world and the virtual assets shown on the device [6]. There are other advantages as well, as cultural heritage experts, for instance, can offer insights into how best to represent objects of heritage that promote a deeper consideration of history and culture that may not necessarily align with cursory accounts found in traditional forms of media but could also provide reassurance and caution that the game does not include inaccurate representations of culture that stereotype or could be viewed as offensive. Altogether, there are numerous benefits to the practice of bringing together teams that comprise many of the disciplines typically found in the creation of commercial VGs, such as art directors, game designers, graphic and sound designers, software developers, and scriptwriters [6], but also include instructional designers [91], CH experts [6], as well as educators and researchers.

4.6. Make the Gameplay Simple and Intuitive

It has been asserted that player input should be rare and limited [22], the UI should be simple so that time is not needlessly spent understanding how to play the game [2], with instructions clear and unambiguous as to what to do [21], and navigation requiring minimal learning [15]. For example, in Oracle of Delphi—a location-aware game designed for secondary school students aimed at learning about sacred monuments at the Delphi archaeological site—Ekonomou and Vosinakis [21] explained how instructions were provided via an icon upon first launching the game; whereas Shakouri and Tian [24] took a different approach in Avebury Portal—an mLBG designed for the heritage site, Avebury in England—in which players were guided through the first treasure hunt, essentially teaching them how to play while playing. Then, there is Arbela Layers Uncovered—a mobile AR proof of concept intended to present the complex history of the ancient site of Arbela, Iraq—with Mohammed-Amin et al. [15] proposing the use of buttons that of-
ferred immediate access to the UI and related components that presented cues regarding certain functionality.

Although different approaches can be found in the research regarding the simplification of the UI, what is certain is the common goal to provide user-friendly and intuitive interfaces that do not distract from the main objectives, allowing players to begin exploring immediately [22]. As a result, given the complexity of SGs, it is vital to consider the UI, making the gameplay as straightforward to learn as the coin-operated arcade games of yesteryear, because among the many reasons, players will have different skill levels, and site staff may not be available to provide technical support.

4.7. Balance Fun with Learning

Perhaps one of the most common aims found in the research is the importance of balancing fun with learning (e.g., [21]) (recall, this was a theme identified in the analysis across two factors). While the intent of SGs is to learn from the experience, it has been asserted that these games must also be entertaining. Fun is important because it is considered a driving factor in motivating and engaging students in active learning [37]. To offer an example, Galatis et al. [22], in describing KnossosAR—a mobile, AR guide intended to create an immersive and engaging experience for the archaeological site of Knossos, in Crete, Greece—suggested that the guided tour be delivered in a playful manner that increases the player’s commitment and engagement in actively exploring the site. All told, several factors are called out in the research that contributes to a game being entertaining, including the player’s involvement and game mechanics, such as graphics, narrative, usability, and cooperative and competitiveness elements [6].

4.8. Turn the Heritage Site into One of Active Discovery

A thinking found early in serious heritage projects is the importance of engaging players in the physical location rather than only passively communicating information [77]. For example, while investigating “The Voices of Oakland”, Dow et al. [20] found that the participants asked about nearby graves, suggesting the need for more ancillary content that profoundly connects the physical space, thereby helping promote the idea of learning through active discovery. However, to encourage active exploration, it has been offered that opportunities must be created for players to become acquainted with the heritage site [41]. Then, players can explore the POIs, experiencing as much of the site as possible within the context of the learning objectives.

This has been demonstrated in several mLBGs in past years, with players navigating between various POIs to find clues, answer questions, and solve puzzles (e.g., [28,29]). For instance, Shabalina et al. [16], who presented the concept behind a group of AR games intended for high school students to learn more about local cultural and historical heritage, described navigation comprising a planned route rather than players being afforded the ability to explore on their own. Many more projects, however, have demonstrated the concept of putting players in control of the exploration, with Galatis et al. [22] asserting that players should be able to follow their path and discover at their own pace. For instance, in the game, AGAMEMNON—a mobile phone e-guide designed to provide dynamic historical and cultural information about archaeological sites customized to visitor preferences—Ancona et al. [17] explained that multiple proposed personalized paths were calculated based on the visitor’s interests and available visit time. This also prevented overcrowding and congestion at monuments (an idea similarly offered by Ekonomou and Vosinakis [21]), but visitors could have chosen their path of self-discovery if they so desired. Altogether, there are advantages to affording players the ability (or at least the option) to explore actively, targeting educational objectives that motivate players to seek information about the location [22] and enhance the overall experience.
4.9. Display a Map of Useful Information

A way active discovery has been promoted in the research is through using maps, which are particularly useful in mLBGs for several reasons. For example, it has been explained that they can assist players in identifying their current position for the entire site [21], facilitate navigation and exploration [36], help in the identification and location of POIs, and provide an ongoing snapshot of player achievements [2].

Many games have adopted maps (e.g., [14,19,21,28,30]), using these forms of navigation in diverse ways. For instance, Ballagas et al. [19] explained that a map was built into REXplorer, but players predominately used a game brochure that had a map of Regensburg printed on it; in Viking Ghost Hunt—a location-aware game demonstrating the use of soundscape at different historical locations in Dublin, Ireland—Paterson et al. [23] described the integration of Google Maps to show the location of ghosts while also contextualizing historical information on a modern landscape; Huizenga et al. [30] referred to the use of multiple maps in Frequency 1550 between the groups walking Amsterdam and those at headquarters, which were designed to help guide players through required learning tasks; while Shakouri and Tian [24] used “smart” maps in Avebury Portal to identify treasure and show marker images directly linking POIs for players to scan while exploring the Avebury Henge site. All these variations showed different degrees of success, alongside lessons learned, with Shakouri and Tian [24], for instance, finding that players experienced confusion when using the map to pinpoint their location, suggesting that using a navigation system (e.g., GPS) should be considered.

4.10. Create a Casual and Safe Experience

Although active exploration was described as an important consideration in these games, it has also been proposed that such self-discovery must be curbed in the context of the physical location and potential safety concerns. For example, Ballagas et al. [19] found that even though they deemphasized the visuals in REXplorer, some players became so engrossed in the gameplay that they neglected safety and stumbled into a construction zone. Ballagas et al. [19] pointed out that this demonstrated the dangers of such games in public settings and proposed that future gameplay should avoid areas where there is traffic, limiting the gameplay to places designated for only pedestrians.

Thus, even though there is a serious tone to mLBGs because of their focus on learning, it is important to consider the level of commitment to the gameplay. It may be advantageous, for instance, to adopt the practice of giving players the freedom to enter, leave, and rejoin the game at any time, picking back up where they left off without interrupting the experience of others; and, in doing so, promoting a casual and safe experience.

4.11. Accommodate Single and Group Gameplay

A consideration found in early investigations spoke to how players participated in these games, showing the need to support single and group gameplay. For example, the participants of “The Voices of Oakland” expressed concern that the game would be unsuitable in group settings because of the prototype’s audio-only narrative [20], suggesting changes to the design (or technology) in favor of group play. Whereas Ballagas et al. [19] reported that—although REXplorer was designed to be played with others (using a loudspeaker) because it aimed to create a social and shared experience (and due to the cost of renting the device)—some of the participants felt that the game should support the use of headphones so that individual players could experience it. These findings suggest that players should be able to participate independently and in groups because those visiting heritage sites, for instance, can comprise individuals, families, and students from single classrooms or entire schools.

4.12. Encourage Healthy Competition through Knowledge

Furthermore, games demonstrating group play have touched upon the game mechanic of competition (so much so that this was the other theme identified in the analysis across
two factors). For example, in Frequency 1550, Huizenga et al. [30] explained that the different groups exploring the city were permitted to not only confront one another, with the victor gaining the points of the losing side, but players could drop virtual medieval rats on other groups causing their mobile screens to go dark for a short period, placing that group at a disadvantage. Then, there is the work of Angelopoulou et al. [18], who presented the game, Sutton Hoo—a mobile, AR experience for a group of Anglo-Saxon burial mounds—which could be played by individual ad hoc visitors or with others in a coordinated manner between the Sutton Hoo site and the British Museum. Angelopoulou et al. [18] noted that players could win in either the standalone or networked game version by identifying the most artifacts in the shortest time.

Although it has been said that competition is generally healthy and a contributing factor to entertaining games [6], with advantages reported in the research, including group spirit (e.g., [21]), consequences have also been reported. For instance, Ballagas et al. [19] found that some REXplorer participants saw themselves competing against other groups and ran between the different POIs to increase their scores. Even though the authors did not intend the game to be competitive, the scoring mechanic brought out the aggressive nature of some players while also illustrating safety concerns in the design of such games (i.e., the participants potentially falling) [19].

Thus, making players compete on factors such as physical ability or speed may lead to fatigue or injury [21]. As a result, it has been presented that such activities should be avoided. However, again, the aim of SGs is not to win but to learn from the experience [2]; so, a practice in the design of these games to consider is to promote healthy competition through knowledge.

4.13. Motivate with Rewards

There are other ways to stimulate the level of interest often seen in players because of competition, with investigations experimenting with incentive systems to motivate players (e.g., [19,28]). Scores and badges are perhaps the most found in the research, both of which are staples in traditional VGs, with scores typically assigned as points. In contrast, badges are often represented as trophies for accomplishing a task or completing a mission. Scores and badges are important because they can motivate players to complete, achieve, discover, and reflect, but they should be used with care, as they may have unexpected results. While badges are considered a commonly used recognition mechanism, there has been debate concerning their use and respective learning benefits (see [92]), with findings suggesting both positive and negative outcomes (e.g., [93,94]). For instance, research has shown their benefits are contingent on elements, such as the type of badge and the users themselves [95], as well as the level of contribution and time spent engaged in the system [96].

Other interesting mechanisms have included selfies, certificates, and souvenirs. For example, players of REXplorer were given a souvenir (i.e., URL) upon completing the game that pointed to a travel blog showing the player’s personal experience (i.e., a map of the path they followed during discovery alongside the pictures taken) [19]. A similar idea was implemented in The Heraklion Fortification Gates—an mLBG aimed at teaching about the Venetian walls of the city of Heraklion in Crete—with Vassilakis et al. [28] describing the use of selfies as the reward for achieving immediate goals. Namely, upon finding the respective AR object at a POI, players could take a selfie (before moving on to the next POI) and, at the end of the game, were given a certificate depicting all the selfies taken [28].

Ballagas et al. [19] used this mechanism because they wanted players to remember the experience and what they had learned, finding that their multi-stage approach conveyed the needed information to players. This illustrates the use of an incentive that does not necessarily coincide with the concept of winning but recognizes the player’s accomplishments and offers a way to remember the experience in the context of the learning objectives.

Another essential motivator in the research is the collection of in-game items, a familiar game mechanic found in many VGs and mLBGs, often represented as inventory management. One of the aims of Pokémon GO, for instance, is finding and capturing (i.e., collecting) the various Pokémon characters. Other examples include Viking Ghost Hunt, with Paterson et al. [23] speaking to “casebook mode”, which allowed players to review all the evidence they collected (e.g., images, recorded dialogue) at any point during gameplay, while Ekonomou and Vosinakis [21] implemented “The Treasury” in Oracle of Delphi, which they described as a digital inventory where players could store the virtual items they collect during the game. Although inventory management can add a layer of difficulty, requiring players to manage in-game items, they can also be helpful because it has been shown that they can be used to track missions and tasks [41], helping players stay focused on learning objectives.

This is an important design consideration identified in the research, with players incentivized to “collect” items in the context of the educational aims, with the award being learning. This was demonstrated to a degree in The Heraklion Fortification Gates, which provided educational information about the location represented as text, mini-videos, and audio, as players moved around the city, navigating to POIs [28]. Otherwise, players may get in the mode of “looting”, only interested in finding items to advance the game rather than learning from the artifacts they find, which ultimately takes away from the overall experience. Thus, when an in-game item is found, it has been offered that players should be presented with a summary of the object’s physical features as well as other properties, such as its cultural importance [41], so that the focus remains on the educational aims.

4.15. Challenge Players during Gameplay

Challenges are an essential consideration commonly cited in the research that is said to help players stay engaged and advance in the game, but also help stop players from quitting early; more importantly, challenges assist players in meeting the individual learning objectives and the eventual educational aims of the game. Often represented in mLBGs as tasks or missions, players are typically sent on a quest (e.g., find a POI), which requires they answer questions or solve puzzles that can only be completed with information (e.g., clues) found through the active discovery of the site. Angelopoulou et al. [18] demonstrated this, describing that in Sutton Hoo, players were engaged with quizzes and puzzles in the context of the artifacts excavated at the heritage site, while Vassilakis et al. [28] implemented something similar, explaining that in The Heraklion Fortification Gates, players were presented with a question regarding the different locations they were expected to find throughout the city in Crete.

4.16. Offer Hints and Clues

It has been asserted that hints and clues should be provided at the appropriate time to prevent the game flow from being blocked [2]. These hints and clues are believed to be particularly important in the context of challenges because while testing players during gameplay is an important consideration, the demands of the game should not be so difficult that players get stuck, become frustrated, or, worse yet, quit the game. To help illustrate this point, Shabalina et al. [16] presented that if players could not answer a question, an interactive hint was offered, drawing players’ attention to the building’s features, which could help with answering the question, while in Avebury Portal, Shakouri and Tian [24] found that the animations presented when clues were given assisted players with remembering the information they gathered from each POI, and later apply what they had learned when solving the puzzle. As discussed, central to the design of mLBGs is creating a fun and casual experience while promoting opportunities to learn more about real-world locations and their cultural importance.
4.17. Introduce Repetition but Avoid Unnecessary Tasks

It has been proposed that repetition can help players become familiar with how to play the game. Still, this claim must be balanced with the assertion that unnecessary tasks should be avoided [2] because, among other reasons, they can distract players and lead to quitting the gameplay early. For instance, Ballagas et al. [19] found that players in REXplorer had to backtrack to POIs they had already visited in the context of completing new quests. While this practice may work in traditional VGs, where players revisit a location in an entirely different context, it may be problematic with mLBGs. Thus, although it has been put forth that walking between POIs can initially familiarize players with the physical location [41], a vital consideration brought up in the research is examining activities in the context of completing tasks or missions alongside meeting learning objectives.

Moreover, it has been discussed that players’ physical limitations must be considered. Ekonomou and Vosinakis [21] spoke to this, explaining that they expected the players of Oracle of Delphi would be students 12 to 15 years of age and, as a result, would be able to walk a relatively long distance during their site visit. However, this may not be the case for all visitors of a heritage site, with families, for instance, wishing to play the game but comprising multiple generations. Then, there are other constraints, such as time, the number of visitors, and the physical restrictions and safety concerns related to the real-world site. Thus, in addition to considering game activities in the context of completing tasks and meeting learning objectives, the equally important consideration is acknowledging the players’ and sites’ physical limitations and safety.

4.18. Incorporate Random Elements and Promote Replay

Ballagas et al. [19] explained that the backtracking issue they were experiencing was due to the random generation of quests. As a result, they proposed that the game engine do a better job logistically ensuring players are not backtracking regularly to POIs already experienced. However, while REXplorer showed that randomness could unnecessarily burden players and prevent the flow of events in the game, the introduction of random elements has been described as a double-edged sword. Namely, randomness has also been said to offer surprises and create opportunities for spontaneity, helping keep attention levels high among players [2]. For instance, while the random generation of POIs might cause players to miss a chance to explore parts of a heritage site [2], the approach is fundamental when more challenges can be completed within the time available. Furthermore, the random generation of POIs may also create opportunities to replay the game, as each subsequent playthrough could generate different POIs, order, and respective challenges, further contributing to the experience. After a field trip, for example, teachers could have their students share their experiences and what they learned, understanding that different students (or groups) were exposed to various challenges and, consequently, other learning objectives.

4.19. Evoke an Emotional Connection

Several factors are said to contribute to an entertaining game, one of which is narrative [6]. Narrative has been argued in the research to be one of the most engaging components of VGs, engrossing players and creating an emotional bond with places, cultural objects, and landmarks [89]. Narrative is believed to help promote interest in cultural values, respective customs, and geographic locations [90]. Most importantly, it has been asserted that this emotional involvement can evoke empathy and help raise awareness about problematic conditions of a people [6]. For example, Dow et al. [20] described the importance of narrative to immerse the player in the history of Oakland Cemetery and their use of audio-only narratives to educate visitors about the cemetery’s many occupants and their significant roles in shaping the American South.

However, it has also been emphasized that too much story can engross players so that they overlook the cultural content of significance. This can be easy to do because, unlike other forms of media, VGs are interactive. In other words, what was earlier described as
sacrificing presence in the physical world for the immersive appeal of the virtual, and the vitalness of immersing players in story and gameplay that promotes meaningful engagement with the physical space through augmented virtual assets of direct relevance [36]. Additionally, it is important to consider how to accurately represent CH because it has been affirmed that, at least with many commercial, historically based VGs, history is often mixed with internal VG mythology, mainly resulting in historical fiction [55]. Balancing the right amount of historical accuracy and game mythos can be challenging, however, with the focus having to be placed on modeling the learning objectives. For instance, Holden and Sykes [27] demonstrated historical accuracy and fiction in Mentira, taking advantage of the history of Los Griegos while creating a story based on fictional events surrounding a prohibition-era murder.

4.20. Engage through Non-Player Character Interactions

It was discussed that many mLBGs augment the experience with NPCs, often depicted as virtual assistants, that guide players through the experience and offer information, such as clues and hints, when players need them. Sutton Hoo and Mentira, for example, used multiple NPCs as part of the story to direct players through the gameplay experience ([18,27]), whereas Carletto the Spider—a storytelling- and mobile-based presentation aimed at guiding players at the historical site, Palazzo Chiablese in Turin, Italy—demonstrated the use of a single-character dramatic performance [33]. In addition to serving as guides and controlling the flow of the gameplay, NPCs can also be used in other ways, including assessing players in the context of the learning objectives. For example, in Oracle of Delphi, Ekonomou and Vosinakis [21] used NPCs designed to appear on landmark monuments that interacted with the players at POIs, providing information and guiding players but also asking and answering questions.

Ultimately, NPCs aim to help immerse players in the storytelling so that an emotional connection can be made with the location and its people. Shabalina et al. [16], for instance, described how in one of their games, “A day in life of merchant Lapshin”, players initiate an emotional dialogue when they reach a POI, with the game offering encouragement in the form of emotionally colored messages and praise depending on how players respond to questions. Creating this emotional bond can be tricky, though, with how best to use NPCs contingent on factors such as the history of the heritage site and defined learning objectives. For example, in “The Voices of Oakland”, Dow et al. [20] found that the participants preferred listening to the life stories (81%) over that of history (37%) and architecture (32%), even though they enjoyed having a variety of content choices; suggesting the importance of storytelling to connect players with the heritage site on a personal level, over that of merely offering facts about a location and its history. However, Ballagas et al. [19] provided a different perspective, finding that some of the players who participated in REXplorer felt the stories were too character-centric, proposing that the focus would have been better placed on the buildings and material culture being visited.

4.21. Chunk Information

Ballagas et al. [19] concluded that they should extend the information offered in REXplorer to players to include more building information. However, they also cautioned that adding such content might be too much for players to digest. This concern is expressed elsewhere in the research, with the general sentiment that material should be organized into small and comprehensible units of information to avoid cognitive load challenges [35]. For instance, Dow et al. [20] found that those who participated in “The Voices of Oakland” appreciated that the experience had chunked the audio information into small segments. Altogether, a practice offered in the design of mLBGs is to take the needed steps so that information is logically structured and layered to help prevent players from becoming overwhelmed [15]. This approach was demonstrated in Frequency 1550, which organized the city of Amsterdam into six areas of different themes, addressing matters during the medieval era, which were introduced with a video clip and clues (i.e., keywords) [30]. The
content was also structured as orientation, imagination, and symbolic assignments, with each further decomposed into three parts, all of which were concluded with a multiple-choice quiz [30].

### 4.22. Take Advantage of Multiple Modalities

Mobile, location-based games described in the research have leveraged different modalities, demonstrating the importance of emphasizing the cultural significance of the heritage site rather than the virtual environment while also considering factors such as the technologies available, player limitations, and learning objectives. For instance, in “The Voices of Oakland”, Dow et al. [20] used audio-only narratives because they felt that visual media would distract from the heritage site, instead emphasizing the cemetery rather than augmented objects. Still, they also reported that some of the participants asked that a visual interface be added so that they could see a summary of the content of the stories conveyed through the narrative. Ballagas et al. [19] argued something similar with REXplorer, wanting players to focus on their surroundings rather than the device, choosing to use audio to provide feedback, also presenting limited graphics, albeit purposely deemphasized via a device with a small screen, a black and white motif, and few details. Other considerations have included the importance of accessibility, such as supporting multilingualism (e.g., [15]), with Ekonomou and Vosinakis [21] speaking to expanding Oracle of Delphi to include additional foreign languages to make the game available to more visitors.

These examples help establish the importance of carefully considering modality in the creation of the UI, which is particularly important in the design of mLBGs because it has been asserted that players are expected to manage the digital and real world and the abstractions between them [3]. This can make exploratory learning difficult and create negative transfer due to cognitive overload, leaving the player to struggle with the additional demands of the virtual environment in the context of the physical place [3].

### 4.23. Share Information

The least mentioned theme found during the analysis was sharing information between players to enhance the experience. An example of this was found with Angelopoulou et al. [18], who described how players of Sutton Hoo could communicate between the heritage site and the British Museum through instant messaging. Ekonomou and Vosinakis [21] took this one step further. They implemented a notes capability into Oracle of Delphi, allowing players to share different feedback forms with other individuals or groups of players. While providing the ability to communicate between players is undoubtedly important, the Ekonomou and Vosinakis [21] example points to the equally significant practice of sharing information about the heritage site in the context of the learning objectives.

### 4.24. Take Time into Consideration

Finally, time has been mentioned in different contexts, as it plays a role in safety, the number of challenges that can be completed during a single site visit, and the use of repetition and incorporation of random elements. Recall that Ballagas et al. [19] spoke to safety but explicitly called out time-constrained competition (as well as player immersion) as a contributing factor in player safety. Different lengths of time have been called out in the research regarding how long an experience should last. Lercari et al. [41], for example, stated that gameplay should be limited to 20 min per session to prevent players from losing interest as well as promote replay, while Ekonomou and Vosinakis [21] asserted that keeping gameplay to 20-min sessions also considers the physical needs and potential limitations of players. These authors further discussed times regarding a complete playthrough, with Ekonomou and Vosinakis [21] stating 60 min and Lercari et al. [41] presenting one and a half hours (20 min per session).
5. Conclusions and Future Research

The growth and popularity of mobile devices and games have shown incredible potential to help raise awareness about CH, sparking many initiatives exploring mobile and AR to bring together the physical and virtual worlds. While most of these efforts have been academic, games like Pokémon GO have exacerbated the appeal of mLBGs, demonstrating that they can be as popular as blockbuster VGs. However, this form of SG can be challenging to create because emphasis must be placed on the real-world location, accurately and respectfully portraying CH while promoting a meaningful learning experience. Therefore, it should be no surprise that the mechanics found in Pokémon GO, and other games like it, can be problematic in CH contexts because their commercial aims focus on the gameplay and virtual environments more so than the physical locations [36].

Hence, the aim of this work, which identified practices and considerations in the design of mLBGs, intended to take advantage of the immersive qualities of SGs to raise CH awareness. This aim was further founded on the assertions that—there is limited research that explicitly identifies elements in the creation of these games in CH contexts [35], few practical recommendations have been proposed to recreate the motivational aspects of commercial VGs in educational game contexts [56], and that little guidance exists for how to design the low-level mechanics and content of SGs [50]. Therefore, a review was conducted—of serious heritage projects made up of a heterogeneous collection of historical engagements, to include research from experimental archaeological reconstructions and heritage sites—which revealed 24 potential design practices and considerations.

These practices and considerations were identified as “potential” because although there might be an inclination to conclude or interpret the 24 items as “best” or those that “work well” since, among other reasons, they were independently found across multiple serious heritage projects, care should be exercised in their adoption. For example, the use of challenges was identified to hold numerous advantages, including engaging players, advancing the gameplay, and helping meet the learning objectives. However, the use of challenges can tax players and extend the gameplay. Consequently, players’ physical abilities and limitations, alongside the total time needed to complete the game (and meet the educational aims), should also be considered.

Then, there are other considerations not identified in this work that warrant further study. For instance, the importance of accessibility [37] to include supporting multilingualism was found in the research (e.g., [15,21]); however, accessibility in the context of inclusion for individuals with disabilities was not discussed. In addition, taking advantage of multiple modalities was identified as one of the practices and considerations. Still, more research would be needed to explore the design of these mLBGs for individuals with visual or hearing impairments. Furthermore, the practices and considerations identified in this work indirectly spoke to player characteristics in the context of recognizing players’ physical needs and limitations or considering single as well as group play to accommodate different audience sizes (e.g., individuals, couples, families, schools). However, it is proposed that future studies explore adopting these practices and considerations in additional audience contexts, such as individual player characteristics.

In conclusion, it is hoped that the findings presented herein contribute to future mLBG efforts that utilize the latest advancements in mobile technology and AR to create truly immersive experiences that promote CH awareness. More importantly, it is urged that this work serves as a basis for subsequent investigations, with the design practices and considerations further refined, built upon, and expanded with additional factors contributing to favorable learning outcomes.

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### Appendix A

#### Table A1. Factors, proposed design practices and considerations, and sources.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Design Practices and Considerations</th>
<th>Sources</th>
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| Technology, devices, and related equipment | • Adopt devices that players already have  
• Maximize device compatibility  
• Utilize core technologies that support reuse | [1,2,18–22,24–26,28,29,35–37] |
| Pedagogical objectives and learning effectiveness | • Accurately model the learning objectives  
• Collaborate with experts  
• Balance fun with learning *  
• Encourage healthy competition through knowledge *  
• Challenge players during gameplay  
• Chunk information  
• Share information | [2,6,15,18–22,28,30,35,41,57,91] |
| UI and UX | • Make the gameplay simple and intuitive  
• Balance fun with learning *  
• Evoke an emotional connection  
• Take advantage of multiple modalities | [2,3,6,15,19–22,24,27,36,55,89,90] |
| Navigation, location, and POIs | • Turn the heritage site into one of active discovery  
• Create a casual and safe experience  
• Accommodate single and group gameplay  
• Encourage healthy competition through knowledge *  
• Introduce repetition but avoid unnecessary tasks  
• Incorporate random elements and promote replay  
• Take time into consideration | [2,6,16–22,28–30,41,77] |
| Game mechanics | • Display a map of helpful information  
• Motivate with rewards  
• Introduce capture and collection  
• Offer hints and clues  
• Engage through non-player character interactions | [2,14,16,18–21,23,24,27,28,30,33,36,41] |

* Derived from more than one factor.
45. Garcia-Fernandez, J.; Medeiros, L. Cultural heritage and communication through simulation videogames—A validation of Minecraft. *Heritage* 2019, 2, 2262–2274. [CrossRef]
54. Bissell, B.; Morris, M.; Shaffer, E.; Tetzlaff, M.; Berrier, S. Vessel: A cultural heritage game for entertainment. *Arch. Conf.* 2021, 1–6. [CrossRef]
61. Paliokas, I.; Sylaiou, S. The use of serious games in museum visits and exhibitions: A systematic mapping study. In Proceedings of the 8th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES), Barcelona, Spain, 7–9 September 2016; pp. 1–8. [CrossRef]


72. Finco, M.D.; Rocha, R.S.; Fão, R.W.; Santos, F. Let's move!: The social and health contributions from Pokémon GO. *Int. J. Game-Based Learn.* 2018, 8, 44–54. [CrossRef]


88. PTC. *Vuforia, (Multiple Platforms) [Computer Software]*; PTC: Boston, MA, USA, 2022.


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