



Digital heritage interpretation: a conceptual framework

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ABSTRACT

'Heritage Interpretation' has always been considered as an effective learning, communication and management tool that increases visitors' awareness of and empathy to heritage sites or artefacts. Yet the definition of 'digital heritage interpretation' is still wide and so far, no significant method and objective are evident within the domain of 'digital heritage' theory and discourse. Considering 'digital heritage interpretation' as a process rather than as a tool to present or communicate with end-users, this paper presents a critical application of a theoretical construct ascertained from multiple disciplines and explicates four objectives for a comprehensive interpretive process. A conceptual model is proposed and further developed into a conceptual framework with fifteen considerations. This framework is then implemented and tested on an online platform to assess its impact on end-users' interpretation level. We believe the presented interpretive framework (PrEDiC) will help heritage professionals and media designers to develop interpretive heritage project.

KEYWORDS

Digital heritage; guidelines; interpretation; conceptual framework; end-users

1. Introduction

Heritage has often been perceived as a 'conveniently ambiguous' concept (Lowenthal 1998); a set of attitudes to, and relationships with, the past (Walsh 1992; Harvey 2001, 2008). 'Heritage' is formed in the present (Tunbridge and Ashworth 1996; Graham and Howard 2008) and reflects inherited and current concerns about the past (Harrison 2013). It is a process of engagement (Smith 2006) rather than a condition; 'it is a medium of communication, a means of transmission of ideas and values and knowledge that includes the material, the intangible and the virtual' (Graham 2002). On the other hand, the word 'digital heritage' itself is a popular word in peoples' daily language, which is apparently a buzzword. To avoid any confusion, this paper has adopted UNESCO's (2003) definition, which refers 'digital heritage'

as unique resources of human knowledge and expression '*created digitally or converted into digital-form from existing analogue resources*'. According to this definition of UNESCO, any digital content i.e., both 'born-digital' and 'digital surrogate' which possesses cultural values, either in the form of 2D (such as text, image and motion pictures), or 3D (such as navigational virtual environment, three-dimensional objects), belongs to 'digital heritage'. In addition, 'virtual heritage' (VH) is commonly used to describe works that deal with virtual-reality (VR) and cultural-heritage (Roussou 2002) and by definition, falls under digital heritage. Depending on the point of creation, digital heritage can be either 'born digital' (e.g., electronic journals, worldwide webpage) or 'digital surrogate' (made from analogue resources such as 3D scanned objects or digital video of a ritual).

Even though there is a flux of technological development and efficacy in dissemination, digital heritage projects are mostly designed and developed in a non-user-centred and non-descriptive manner. They are exclusively focused either on ‘process’ (authentication of data, site survey to epigraphy) or on ‘product’ (re-presenting closer to reality and presentation of technical artistry) but rarely consider the ‘end-users’ (end-users’ perception of the content) (Rahaman and Tan 2011, 2010). Most digital heritage content is developed with an ‘ocular-centric’ tendency, an approach to visually describe the physical appearance of heritage in its digital form. Due to lack of adequate literature, which focuses explicitly on the theory and methodology of interpretation (Affleck 2007b; Tan and Rahaman 2009) including critical discourse (Cameron 2008).

While there are charters available for ‘Interpretation and presentation of cultural heritage sites’ (ICOMOS 2007), nothing similar exists for ‘digital heritage’ domain. The Venice Charter (ICOMOS 1964) first signified the recording of paradata. Recording both paradata and metadata later has been indicated by the Burra Charter, 1979 (Australia 1981). Motivated by widespread popularity and driven by the risk of losing intricate data, UNESCO (2003) had adopted the Charter for ‘Preservation of the Digital Heritage’. However, this only expresses its concerns for the protection of digital resources without making any indication to its presentation or interpretation. There is also The London Charter (Beacham, Hugh, and Francesco 2009) and the Principles of Seville (Lopez-Menchero and Grande 2011). Whereas the former focuses primarily on computer-based virtualization methods and their implication only, the latter is intended to improve the conditions of applicability of the London Charter.

Interpretation of heritage largely depends on an individual’s spatial literacy, subjectivity and cultural positioning (McCullough 2004). Therefore, the perceived value of specific content is

not the same to everyone and often results in heritage dissonance (Tunbridge and Ashworth 1996). This is why, with linear narratives, users fail to grasp the inherent significance of heritage such as place-specific physical artefacts or architectural monuments, and their relationship with much broader ‘non-visible’ cultural processes that they are part of.

Heritage objects such as monuments or artefacts can elicit multiple meanings or perspective to us due to the uniqueness of our subjective interpretation. For example, The Taj of India can be seen either as the ‘Muslim invasion of India’ or as a ‘symbol of love’ or even as ‘architectural artistry of the Mughals’. Similarly, digital heritage cannot also avoid the charges of subjectivity. The media experts (e.g., modellers, animators, programmers) who remain involved in reconstruction processes may not be aware of the intrinsic cultural values of a particular artefact or environment although having a myriad of technical know-how. This way, the ‘apparent’ cultural preservationists and their implemented methods may well reflect their personal ‘inappropriate’ assumptions that Kalay (2008) referred as ‘image of practice’ and may appear as a ‘partial model’ as ‘part of the mosaic of understanding’ (Dave 2008, 49). A comprehensive understanding and reconstruction of history may be only possible when the interpretation framework will allow multiplicity in content level. Capturing of various perspectives from various end-users can, therefore, create multiplicity in the narrative or content (Roussou et al. 2015), which can later lead to a broader understanding of cultural heritage by end-users (Tammaro 2016).

In this context, this paper aims to develop a conceptual framework for interpretation of digital heritage, which would help the end-users to attain the desired perceptual sense of place and culture. This paper addresses the issues by investigating theories and methods of heritage interpretation from real-world context; followed by further enquiry on Human Computer Interaction (HCI) and Human

Behavioural Studies. This way, issues regarding embodiment, sense of place, co-experience, meaning making and inter-subjectivity have led this research to consider digital heritage interpretation as a ‘cultural synthesis’—a continuous process rather than a product. Instead of pre-determined instructional sequences or descriptive interpretation, this paper tries to merge the concept of ‘re-construction’ (Uzzell 1989) and ‘popular interpretation’ (Fitch 1982), which opens up the possibility of exploring the interaction setting as participatory and contributory, where the end-users and the environment can engage in dialogue and interaction or ‘dialogic interaction’ (Witcomb 2003; Rahaman and Tan 2011).

Considering existing gaps in literature and practice; this paper recommends four objectives for digital heritage interpretation, i.e., (i) to *satisfy* the end-users’ enquiry and expectation of the visit, (ii) to *provoke* the end-users for further conservation/protection of the heritage site/object, (iii) promote *learning* of the past history and culture, and (iv) to present the past from *multiple perspectives*, so that the end-users may have a wider overview of the past. A conceptual model is proposed and further developed into a conceptual framework to achieve these objectives. This framework consists of fifteen ‘considerations’ under four ‘aspects’ (or factors) which are likely to be managed and designed by the media or user experience designer.

This paper also presents a comparative experiment, which has been conducted among controlled groups to compare the effectiveness of the conceptual framework with conventional linear interpretation method. The results show a positive impact of the presented framework.

2. Exigencies at media crossroad: setting the objectives

Heritage Interpretation has often been considered to indicate storylines, adapted to help the visitors to engage with and understand the

place or objects (Beck and Cable 1998; Howard 2003; Goodchild 2007). A compilation of definitions from various heritage scholars and institutes by Rahaman and Tan (2010) elucidates that, disciplines such as history, archaeology and heritage management consider heritage interpretation as a learning, communicating and management tool to increase visitors’ awareness and empathy in regards to the heritage site or artefacts. Correlating the ambivalence among various interpretive principles from the two matrixes presented by Rahaman and Tan (2017) also explicitly unfolds that, traditionally heritage interpretation is aimed to facilitate, (i) Learning (convey symbolic meaning), (ii) Provocation (promoting attitudinal or behavioural change), and (iii) Satisfaction (enhancing enjoyment of place and visit).

In a digital heritage site or an environment, while people are interacting with the system or interface, they are primarily interacting with ‘information’. Kaptelinin (1996) referred to the human mind as a specific type of information processing unit, where someone’s selection or decision-making process follows a series of information processing steps, which depend on the capabilities of individual’s visual perception, attention, memory, learning and mental model (Preece et al. 1993). An individual also recognizes information through an unpredictable pattern, which is dynamic, ever-changing and, at the same time, unique to that specific person (Bateson 2000). The feedback from the digital environment between the individual and context simulates the various levels of perceptive and cognitive interactions, which later helps internalization and knowledge formation. The Oxford Advanced Learner’s Dictionary (Oxford University Press 2009, 711) defines interpretation as ‘*the particular way in which it is understood or explained*’. This definition points to an inherent duality underlying the terms. ‘Explained’ indicates ‘presentation’ to or ‘communication’ with the visitors, i.e., more as an act of the interpreter or interactive devices or systems, while ‘understood’ indicates self-

interpretation or self-understanding, or rather, a reflexive phenomenon. Thereby, the understanding of *interpretation* may vary between Cognitive Science and Archaeology.

Usage of digital devices at heritage site or museums to support any interpretive services provided by an interpreter, guide or self-guided tour is not new. However, the scenario is unique when someone uses a hand-held interactive device (such as a mobile phone), or a head mounted display (such as a HoloLens), or an installation (such as CAVE) to explore a remote physical or a virtual heritage site. In this situation, the device or installation becomes an 'interpreter' to the visitor/end-user, and therefore its' acts can be referred to as 'interpretation'.

The definition of '*interpretation*' in digital heritage theory and discourse is still vague, wide, and, so far, no significant method and objective is evident (Affleck and Kvan 2008; Tan and Rahaman 2009; Rahaman and Tan 2010). Driven by widespread popularity and coupled with the vulnerability of losing intricate data, UNESCO (2003) adopted the Charter on 'Preservation of the Digital Heritage', which recognizes the significance and value of digital resources and expresses its deep concerns for safeguarding any potential loss of valuable digital resources. However, it is still unclear what progress has been made to utilise technology for presenting and interpreting digital heritage. Again, like the charter for 'Interpretation and Preservation of Cultural Heritage Sites', there is no such charter or guidelines for digital or virtual heritage.

Digital heritage scholars, researchers and professionals are working to enhance the end-users' interpretation by using various digital tools and media such as (i) game engine to achieve a hermeneutic environment (Champion and Dave 2002; Champion 2003), (ii) Somatic impulse (Flynn 2008) or haptic devices (Rousou 2008) for embodied interaction, (iii) artificial agent and dynamic content (e.g., Second Life, the virtual Forbidden City) with multiple user virtual environments (MUVes) for more

believable virtual environments, (iv) augmented stereographic panoramas (Kenderdine et al. 2008), immersive displays (Tan 2007), and holographic displays with augmented reality application (Pedersen et al. 2017) for higher immersion. Although these efforts may accentuate experience and visual fidelity, however, they can only provide a partial interpretation, as they rarely offer the past from multiple perspectives.

Due to these inadequacies, the present trend of digital heritage is predominantly descriptive, technology-driven and imposing; rather than user-centric. Fortunately, recent concerns among scholars for 'virtual heritage infrastructure' (Champion 2016b) and standard guidelines (López-Menchero Bendicho et al. 2017) along with the development of social software and web 3.0, are demonstrating the possibility of an extensible, referential and interpretive digital heritage environment. These changes represent a fundamental shift in attitude, from being passive spectators or receptors of information to active contributors, through social engagement.

Based on the previous discussion, this paper understands the term 'digital heritage interpretation' as an act of an interpreter; a method or tool of presentation or communication with end-users and sets four objectives for an effective and engaging interpretation -

- (1) *Satisfaction*: Users need to be satisfied. The interpretive process should support the inquiries and interest of the end-users'; also should focus in enhancing their enjoyment of the place and visit.
- (2) *Provocation/Empathy*: The process should increase the awareness of heritage protection, preservation or conservation. It should facilitate attitudinal and behavioural change among the end-users about the heritage site, people and culture throughout the process.
- (3) *Learning*: The process should aim to convey the symbolic and cultural meaning to

the end-users through some learning activities.

- (4) *Multiple perspectives of the past*: The interpretive process should present the past from possible multiple perspectives; thus, it would provide the opportunity to have a broader and alternative understanding of the past.

By accumulating these four objectives, this paper, therefore, primarily sets the aims/goals in designing and planning of interpretive processes of a digital heritage project. Secondly, it opens the possibility for using these objectives as indicators for assessing the effectiveness of the interpretation at the same time.

3. Digital heritage, interpretation and the interpretation paradigm

This section explores scientific literature and experiments (or cases) to attain both theoretical and practical foundations of the digital heritage discourse. The Quality of Reporting of Meta-analysis (QUORUM) statement method presented by Moher et al. (2000) has been followed for selecting literature. The study process is explained in Figure 1.

Several interpretation models and guidelines based on real-world heritage site, from Tilden (1977), Fitch (1982), Uzzell (Uzzell 1989), Moscardo (1999), Tim Copeland (1998, 2004), Thompson (1981), Brooks and Brooks (1993), Harrison (1994), and Beck and Cable (1998) are studied. Subsequently, a comprehensive comparison of interpretive principles is examined. This study, however, reveals that the principles from the various scholars are mostly an elaboration of Tilden's principles with a few additions. As such, these models or principles have been developed for the physical realm; only a handful of them being immediately applicable to digital heritage realm (Rahaman and Tan 2017).

Based on Fitch's (1982) and Uzzell's (1989) framework, two distinct groups of interpretive

approaches on (i) information presentation; and (ii) information flow are identified. Referring to information flow, Fitch's (1982) interpretation model places public at the second level of the interpretive process; as a consumer of the filtered information produced by the professional. This model, therefore, does not recognize public contribution as a possible source of information that can complement 'professional interpretation'. On the other hand, from the point of information presentation, David Uzzell (1994) mentioned two types of heritage interpretation: 're-creation' and 're-construction'. According to him, 're-creation' is mainly developed for economic consideration for commercially driven leisure sites such as theme parks where history is presented as a 'slice of past'. Visitors enjoy events and site visiting as they are in a leisure mode while being triggered by nostalgia. The 're-construction' approach, on the other hand, is more objective and presents history as a whole. This method shows aspects of domestic and working life from different periods so that the visitors can get a holistic idea of the past and have empathy for the site. Instead of being a voyager, visitors are expected in the later approach to become part of the continuing story (Uzzell 1989).

Affleck (2007a, 2005) for the first time attempted to develop an interpretation model for a digital heritage project titled as '*popular, reconstructive, discursive approach to heritage interpretation*', through merging the two concepts - popular interpretation and re-construction. This unique endeavour, however, had to face multifaceted issues from human-computer interaction and behavioural studies to reinvent the research context and to validate its position within the broader discourses of digital heritage. Ultimately, this endeavour proved unsuccessful to present a workable framework for supporting the idea.

Embodiment as being the property of our engagement that makes our world meaningful (Dourish 2001), has been used differently by scholars in contemporary HCI studies.

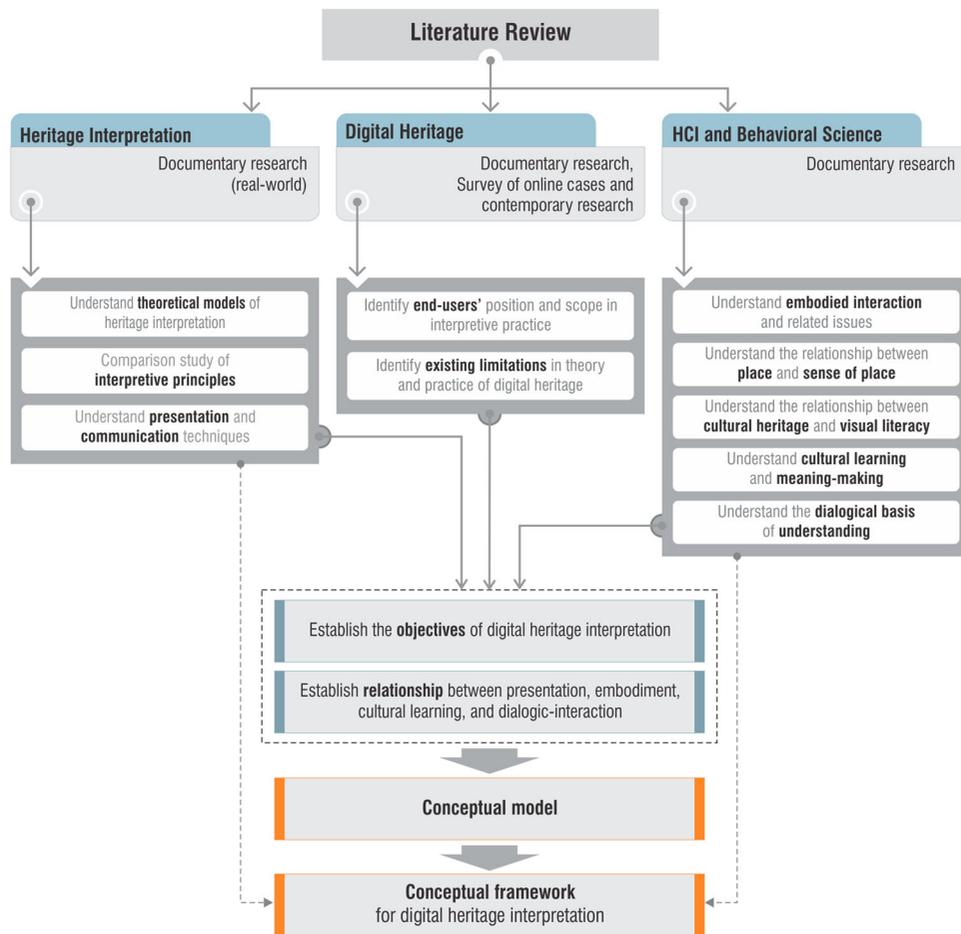


Figure 1. From literature review to conceptual framework.

However, the theoretical reflections define embodiment not merely as an individual's consciousness of experience of bodily aspects (Johnson 1987; Lakoff and Johnson 1999, 1980) of being or acting (Merleau-Ponty 1945; DiSessa 1983); but rather, as a phenomenon that provides a rich understanding of what human ideas are and how they are organized in vast conceptualized systems (Maturana and Varela 1992)—grounded in both physical and lived reality (Forte and Bonini 2010; Quek 2011).

Dourish (2001) first coined the term 'embodied interaction' based on a platform of phenomenological philosophy in relation with artefacts. J.J. Gibson in his theory of affordances

marked a vital link between bodies and environment (Gibson 1986, 130). He believes, in an embodied environment, one can directly perceive without requiring much learning. Gibson (1986) mentioned the tools as the extension of our hands. The concepts of 'ready-to-hand' and 'present-to-hand' by Heidegger (1977) or the idea of 'mediation' by Vygotsky's (Daniels 2005) similarly explains how involvement and embodied action helps a tool to become an extension of the body. In line with Dourish's (2001, 125) perspective, the system that contains digital heritage and demands successful *embodied interaction*; should allow active participation, task accomplishment, and practical action/feedback from end-users.

Parry (2007a, 10), believes meaning making is culturally and historically contingent. In a virtual environment, to enjoy the travel and the place a visitor needs to become a part of the context, which eventually requires to have a 'sense of the place' (Hall 1969; Tuan 2001). A sense of place or a sense of being there is related to a sense of presence (Slater 1999), which not only comes from 'self' but from 'co-presence', and 'social-affinity' (McCullough 2004). Alternatively, memory is an essential element that helps to create the identity of a community in return; a community constantly creates its knowledge by capitalizing on the social values in term of memory. Community memory is thus intrinsically narrative, and sharing those memories is, in itself, an experience that unfolds particular contextual and spatial experiences (Michelis 2006). Additionally, built-form as a small part of the vast domain of culture is also embedded in it (Kent 2000). This is why; it is always difficult to understand the way in which culture transforms into built-form. Considering architecture as a social product (Ankerl 1981), a collective memory device, and manifestations of collective cognitive background (Lawson 2001), this paper highlights the means to achieve perceivable meaning through association and social sharing.

Learning is a process of active engagement with experience (Preece et al. 1993). Knowledge can be created through the transformation of experience (Kolb 1984), which occurs in a reticular way instead of a linear pattern (Bateson 2000). Meaning, on the other hand, is a dynamic process that emerges within semiosis (Holquist, Lotman, and Johnson 1977), as '*something that is contextualized, from some kind of reflection emerging from being involved in action*' (Forte and Bonini 2010). Following the constructivist view of learning (Jonassen and Rohrer-Murphy 1999), engaged interaction works as a key to learning and meaning-making. The meaning of cultural heritage is not confined within itself but begins with the relationship from the observed (Holquist, Lotman, and Johnson

1977). Based on the embodied perspective of cognition (McCullough 2004), this paper highlights both the collaborative and participatory modes of interaction to enhance contextualization and social knowledge sharing. Here these modes of participation should signify co-presence and shared-experience in an inter-dependent world so that, it can accentuate the social dimensions. Moreover, co-presence lifts our experience to the level of shared attention, and we become part of a social meaning-making process (Forlizzi and Battarbee 2004). As a result, this aids our experience in producing 'meaning'.

Besides, a 'dialogue' influences us to immerse in discussions and to acquire a new understanding (Snodgrass and Coyne 2006). Individual's memory and understanding of culture or artefacts may also socially improve by engaging in dialogue and interaction (Kaptelinin and Nardi 2006; Mattioda and Vercellone 2006). Through the process of constant negotiation and dialogue, one understands another's emotion and cognition (Vygotsky 1978). Being able to reach beyond own perception and accept another's way of thinking thus facilitates the construction of 'inter-subjectivity' and enhance inter-subjective understanding (Ligorio, Talamo, and Pontecorvo 2005; Rothfuss 2009). However, a dialogue begins in the realm of perception (Roberts 2010) and our mind is intrinsically connected to culture and society (Kaptelinin and Nardi 2006, 41). An individual's relationship with and orientation towards an objective is, thus, not only mediated by the tools (to attain the objective) but also by the community that participates in the activity and the division of labour that exists in the community (Engeström 1999). This philosophical understanding underpins that individually impaired memory and knowledge can be socially improved through interaction and participation in a dialogue.

In this way, a dialogic interaction can accentuate transmission, accumulation of social knowledge and internalization (Vygotsky 1978). In museum settings, Witcomb (2003, 130) suggested 'dialogic interactivity' as a

shared dialogue between museum authority and visitors to enhance interpretation. In this perspective, the interpretive process can also accentuate dialogue, so that the inquirer can be involved in reciprocity by asking and receiving feedback, or sharing knowledge of any artefacts, cultural events or historical monuments with others, as acts of a social process (Nardi 1996).

Nevertheless, heritage is dynamic, and knowledge is multi-vocal, fragmented (Thorn-ton 2006), and evolve through participation with the environment (Bonini 2008). Therefore, proper communication with end-users by effective presentation, activities to promote cultural learning and embodiment, and ensuring an environment to support dialogic interaction can promote transmission and accumulation of cultural knowledge; hence should enhance interpretation of digital heritage.

4. The proposed conceptual framework

This paper believes that ‘popular participation’ in the interpretive process as reflexive dialogue and interaction (i.e., dialogic interaction) may overcome the linearity and subjectiveness in past reconstruction, and hence, will enhance the interpretation. Furthermore, dialogic interaction as a key aspect of the interpretive process can also promote social activities to evoke an awareness of heritage conservation. At this point, this paper suggests a non-linear interpretation, where the process allows active participants in discursive content creation (i.e., collective knowledge formation) and dialogic interaction (i.e., communication and dialogue among participants and experts) to leverage multiplicity and inter-subjective understanding of the past cultural heritage (Figure 2). In light of the above understanding, in order to achieve a comprehensive interpretation of digital heritage, the process must consider four aspects: (i) *effective presentation* (or communication), (ii) *cultural learning*, and (iii) *embodied interaction*—within an

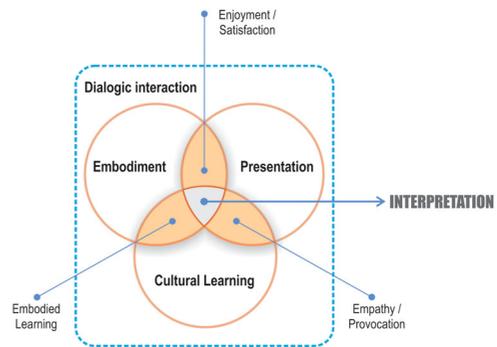


Figure 2. Conceptual model for digital heritage interpretation.

environment that supports (iv) *dialogic interaction* among the participants and experts to generate a collective knowledge base through cultural disposition of a common spatial experience (Rahaman and Tan 2010, 2011).

(a) *Effective presentation:*

Tilden (1977) suggested a set of six principles for ‘effective or correctly directed’ interpretation practice. Later different heritage professionals and scholars, including Richard Harrison (1994), Beck and Cable (1998), Gianna Moscardo (1999, 1996), and Tim Copeland (2006, 2004) have proposed their own principles, which are actually an elaboration and clarification of Tilden’s principles. These interpretation principles, however, have been developed initially for presenting history and archaeological remains, some of them are found applicable as a source for developing possible guidelines of presenting and communicating with the end-users in the digital heritage domain. This paper, suggests six (06) considerations for effective presentation:

(i) *Variety in content with consumer-led approach:*

End-users are varied people with varied interests, modes, and expectations. Therefore, the design of interface and content delivery must satisfy the end-users’ needs and interests, i.e.,

follows a consumer-led approach (Uzzell 1994) with variety in content and presentation (Moscardo 1996). Adopting a game-style interaction (Champion 2016a); the level of expertise of the user (such as beginner, intermediate and expert) can be asked prior to entry to the environment, or it can be acquired through the activity during exploration, and level of complexity (dynamic difficulty adjustment or DDA) or thematic environment can be offered accordingly. Variety in content can be achieved through using 360° panoramas, interactive maps, VRML models, images, videos, and animations on a 2D platform. For 3D environments, it may differ according to the means offered by the media/tool in presenting information (such as 3D stereoscopic projection of the project Palace Hampi, <http://www.place-hampi.museum>, dated 23.07.2018). This way, offered various options in exploring the environment and solving multifaceted challenges based on own preference, therefore, will support a consumer-led approach. Manipulative and interactive contents, therefore, may act as a catalyst in this process. Additionally, the end-users can explore the various content, in terms of levels, preferences, time and need.

(ii) Novelty, conflict and surprise in content presentation:

A study from Moscardo (1999) shows that exhibits/displays that are different from the traditional museum exhibits (such as static objects with labels) increase the visitors' 'attracting power' and 'holding time'. Considering this, any presentation that is novel and can surprise the end-users may also induce mindfulness (Moscardo 1996, 1999; Faulkner, Moscardo, and Laws 2001), which eventually can lead to a greater interpretation. However, too much surprise may also lead them to distrust their acquired knowledge and detail observations (Champion 2016a). The introduction of new digital media/tool such as haptic devices for simulating the sense of touch (such as CREATE project) or the re-use of the old media for

creating a new experience (such as 'Hole in the Earth' in Bullivant 2007) can serve this purpose.

(iii) Setting cognitive dissonance by challenges to explore:

Repetitive or conventional presentation or environment leads the end-users to a situation of mindlessness. On the other hand, mindfulness occurs in a novel and unfamiliar situation where individuals require considerable effort or cost to take control of the activity (Langer 1989). In a situation where a breakdown occurs, the users have to consciously shift their attention to handle the situation, thus correcting or improving the involvement (Riva 2004). An effective interpretation process can help to mediate the present experience of end-users with a new complex historic environment by involving them in the engendering of cognitive conflicts and challenging them to explore the environment; while allowing them to collaborate and share knowledge. Digital heritage platform based on both 2D and 3D installation can offer online competition, challenge, points and awards for successful task completion, and can help to enhance exploration and participation. Featured members can be highlighted or rewarded to stimulate others to engage more. Using augmented reality (AR) or mixed reality (MR) media through handheld devices or HMDs; a 'Pokémon GO' game type exploration can be offered. The Pokémon Go uses location-based and AR technology to promote physical activity for the gamers to explore, find and play with virtual objects embedded in real-world.

(iv) Easy orientation and freedom of visit:

The visitors' own choice of exploration is highly recommended in real-world heritage interpretation practice (Brooks and Brooks 1993; Uzzell 1994; Copeland 2006). The usage of guide map and signs for directions are often used in real-world heritage sites to support the visitors' own choice of exploration (Moscardo 1996). Additionally, visitors in a new and unfamiliar setting spend a significant portion of their

time and energy in getting oriented, and consequently learn less from the site (Falk 1991; Orion and Hofstein 1994). Same way, for digital heritage, the end-users need to get themselves easily oriented, in the new virtual environment or interface. Long waiting time for data loading, complex navigation system and heavily loaded graphical details may also disappoint their expedition (Tan and Rahaman 2009). Similarly, some end-users may not have enough time and interest to visit the whole project. Interactive maps, navigational maps, virtual agents and visual guidance can be used according to the media or platform. Moreover, the end-users should be allowed to save their experience, quit anytime from the tour or re-start their journey at the previously saved point/location to ensure full freedom of the visit (such options are available in 3D games such as Tomb Raider, Crysis, Call of Duty).

(v) Openness to new information:

Our knowledge of the past is limited (Lowenthal 1985; Dave 2008), and end-users are varied people with varied expectations (Oliver 1997; Brawne 2003; Higgs, Polonsky, and Hollick 2005). In order to make every visit unique, new and updated information is required to be frequently added (as we see on Facebook). Instead of considering ‘interpretation’ as a tool, it needs to be considered as a ‘process’ that allows the narrative to evolve through collective participation (Bonini 2008; Forte and Bonini 2010) or by the systems’ own deep learning (artificial intelligence) process. End-users contributing at the narrative level will help them to be contextualized and a feeling of ownership at the same time. Additionally, this participation will enrich the collective content as well as participants’ inter-subjective understanding and learning.

(vi) Affordances and connection to the visitors’ experience:

Interpretation as a process must somehow relate the presented information with the

personality or experience of the visitor. Otherwise, it will be sterile (Tilden 1977). Tilden suggested a personal connection with the visitors and proposed guides on presenting such information (Tilden 1977, 13–4). A simple approach with a conversational style to initiate a connection with the visitors is also found effective (McManus 1989; Rand and Center for Social Design 1985 ; Volkert 1991). Analogies and metaphors from everyday experience can be used to link with the interpretive content for better understanding. For example, understanding the size of an area with a ‘football field’ is much easier with compare to an area of 42,599 square feet. Some pre-visit information may be asked, and the system may then provide the sorted or filtered information according to the preference or last visit of the end-users, as the same way as Google presents its information to us.

(b) Cultural learning:

In most cases, 3D environments are typically reproductions or reconstructions of archaeological sites or monuments. Therefore, it is essential to understand how a digital object can express cultural values and how those values are perceived by the end-users. From the cognitive science perspective, our learning occurs in a reticular way rather than in a linear pattern (Bateson 2000). Concerning the ‘ecological approach’, Maturana and Varela (1980) and Bonini (2008) describes ‘learning’ as a process that starts through perception and interpretation of the differences between the ecosystem and us. Hence, the interface should allow the user to establish ‘some relationship’ with the context and, at the same time, it should have the ‘feedback’ capability to satisfy the viewers’ query. For real-world heritage sites, the constructivist interpretation approach proposed by Balantyne (1998) and Copeland (2004, 2006) also suggests active participation of visitors to enhance cultural learning. To promote cultural learning from a digital heritage site, hence it is necessary to allow participants to:

(i) Collect, personalize and communicate through artefacts:

To increase the visitors' attention to a real-world heritage site, it is often recommended to allow them to touch and handle real artefacts (Brooks and Brooks 1993; Moscardo 1999). Moreover, visitors like to take photographs and souvenirs for their collection to make the event memorable. Studies from Champion (2003, 2006) showed that the collection and trading of digital artefacts in a virtual heritage environment helped to improve participants' social role and cultural learning. The cultural setting, usage of artefacts and tasks that motivate their use - can help in understanding the original cultural significance of the object. Therefore, the interpretive process needs to encourage the end-users to collect and share information, digital artefacts or local knowledge throughout their visit such as in the Forbidden City project and Palenque project (Champion, Bishop, and Dave 2012).

(ii) Reveal symbolic meanings of artefacts and signs:

Tilden (1977) defined heritage interpretation as provocation, that is, to encourage the visitor to learn and know more about the site. David Uzzell (1994) suggested the interpretive process to be an interactive and involving experience. By interactive he meant to encourage the visitors to interact with the interpreter and other visitors; i.e., they can learn from each other. Digital heritage interpretation similarly can provoke the end-users not only to collect digital artefacts but also to reveal symbolic meanings of those artefacts through their investigation (Palenque project, Champion 2011) or asking questions in an open forum. Intelligent agents in a virtual heritage environment may also help to interpret cultural cues and place specific local cultural significance (Champion 2015).

(iii) Encourage the discovery of new information:

Visitors should be encouraged to explore. Strategies should be used in such a way that the

system could engage the visitors in experiencing their own hypothesis and encourage more expeditions in resolving the prevailing contradiction. Understanding occurs when individuals revisit and reformulate their existing perspective. Comfort is another factor that can help to extend the visitors' stay times and encourage them to return to the site for further exploration. Interaction sequences or challenges need to be designed in such a way that the end-users can get some rest or pause during the expedition. It will help the visitors to seek relevance in their query or ambiguity, and to return to solve or carry out further investigation. Asking questions and providing answers to others on the online forum and participation in online competition may also engage the end-users in discovering new information.

(c) Embodiment and embodied interaction:

Embodiment is the property of our engagement with the world that allows us to make it meaningful (Dourish 2001), while meaning making involves both the practical action and active perception. In this way, embodied interaction is the creation, manipulation and sharing of meaning through an engaged interaction with the artefacts (Gibson 1986; Dourish 2001). Embodiment plays a key role in designing interaction as the users' response to the environment, their engagement and understanding of space, and enjoyment depends on it (Maturana and Varela 1992). Interaction, on the other hand, builds up the meaning to a user in a virtual environment and is mostly dependent upon the embodied interaction (or situated action) and the inherited cultural background of the individuals (Parry 2007b; Forte and Bonini 2010; Quek 2011). Therefore, an effective embodied interaction for digital heritage should:

(i) Promote active participation (at the narrative level):

An embodiment is a participative status, a way of being rather than a physical property.

Opposing the positivist approach, where visitors are considered as an observer; heritage scholars like Ballantyne (1998) and Copeland (2006) suggested the constructivist approach to enhance the visitor's participation in a real-world heritage site. Visitors' participation can be encouraged by engaging them: in problem-solving, helping them to construct their own meaning, by encouraging and accepting their initiatives, allowing online competition and highlighting the best contributors or winners. It is also important to provide online visitors to have instant access for uploading digital content, sharing content or task, allowing comments or receive feedback from others, and opportunities for collaboration in solving any common task. Real-time chat, communication and collaboration may also help to promote active participation. Additionally, the 3D virtual environment can adopt a 'serious game style interaction' as suggested by Champion (2016a) to enhance participation.

(ii) Encourage task accomplishment:

Uzzell (1994), Gianna Moscardo (1996) and Tim Copeland (2006), suggests the interpretive process to act as a catalyst to encourage visitors to be involved in activities, interaction and discourse. To enhance interaction, digital heritage environments (either 2D or 3D) should encourage the end-users to complete some tasks or actions. It may be achieved through level accomplishment or taking part in an online competition (Marsh 2007; Marsh, Champion, and Hlavacs 2016). Best contributor or winner may be highlighted to encourage others. Allowing the end-users to contribute, create and share content with others can also enhance the interaction process (Parés and Parés 2001) and may promote a sense of ownership as well (Tamaro 2016).

(iii) Ensure real-time feedback and practical action:

Real-time feedback coming either from the virtual environment (through tactile or haptic

devices, e.g., CREATE project), agents (e.g., in 'The forbidden city', virtual agents help the end-users to have guided tours and receive response to query), or from other participants (e.g., Memory capsule Affleck and Kvan 2008) may encourage engagement and deeper involvement. The system could support real-time feedback from a virtual agent, chat functions and forums.

(d) Dialogic interaction:

Dialogue is a quintessential hermeneutic event, a process where two people try to understand each other, and both immerse in a discussion (Snodgrass and Coyne 2006). In this perspective, interpretation is a dialogic process which influences active participants getting involved, explore deeper and having a better understanding through shared experience or co-experience (Forlizzi and Battarbee 2004).

On the other hand, interaction refers to the process or situation where two or more entities have contact with one another. Definitions of interaction differs according to the research domain, however, according to Parés and Parés (2001) effective interaction should include any one or more of these: (a) Exploration, i.e., freedom of exploring the digital content, (b) Manipulation, i.e., allowing the users to manipulate digital objects or elements and (c) Contribution, i.e., allowing the end-users to construct or contribute digital content. Therefore, allowing multiple users with various social and cultural backgrounds and their contribution at the narrative level, heterogeneous perspectives of the past can be accommodated side by side. With this explicit or generic knowledge base as a supplement to expert content (i.e., professional interpretation), it would be possible to overcome the present limitations of 'linear interpretation' (Thornton 2006; Affleck and Kvan 2008; Rahaman and Tan 2010) and 'image of practice' (Kalay 2008) of digital heritage. To ensure effective dialogic interaction, the interpretive process should consider:

(i) Maximize interaction:

The interpretation process needs to allow the end-users not only to explore and manipulate the contents but also to ‘contribute’ at both in content and narrative level to enhance their interaction. Most of the end-users may not have expertise in 3D content contribution or knowledge of the distant past, but they may share interesting information regarding local stories, myths, beliefs, oral traditions, religious values and travellers log about the heritage site. Contributions at various levels, therefore, will enhance their interaction.

(ii) Encourage discourse:

The process of knowledge construction does not take place in a sterile place. Interpretation strategies should aim at encouraging discourse or social discourse. Therefore, it needs to allow the participants to express their extended verbal or written reflection about heritage related practical topics through comments, blog post, forum post, and chat. 3D virtual environments may also allow communication and sharing (sharing of position, object, artefacts etc.) with other peers (visitor or virtual agent) to explore the site and share their experience jointly. This will also enable and reinforce self-determination and ownership.

(iii) Promote dialogue between the locals, participants and experts:

Participant-to-participant dialogue is the foundation upon which collaborative meaning-making is structured (Lawson 2001; Kaptelinin and Nardi 2006; Mattioda and Vercellone 2006; Parry 2007b). Additionally, the sharing of insiders’ (or emic) perception of significance with outsiders’ (or etic) perception is only possible if the system promotes dialogue between participants and experts. Therefore, it is necessary to allow the most suitable means (chat, forum, comments, screen sharing, face to face video sharing etc.) to promote dialogue according to the available support provided by the media (web, VR, CAVE etc.). Various events or special

session with experts and members may help to promote this type of dialogue among diverse end-users.

Based on these four aspects, i.e., presentation, embodiment, learning and dialogic interaction with the fifteen considerations as mentioned above, this paper, therefore, presents this conceptual framework (Figure 3) for digital heritage interpretation.

According to this conceptual framework, application of these four aspects (i.e., these fifteen considerations) in the interpretation process will influence participants’ mental level, which will trigger a positive effect on their cognitive state. As a result, the overall process will work to enhance the end-users’ interpretation of digital heritage.

The interpretation process that reflects the interests and needs of the end-users’ (i.e., follows a consumer-led approach) with a variety in contents, frequent presence of new information, novelty and surprise in content presentation, and offering challenges to explore, will raise the interest level of the end-users. An easy orientation and navigation system that allows the end-users to have full control of their visit will, therefore, help them to minimize their fatigue. Possible connection to the visitors’ background and experiences, while encouraging them to become active participants with the possibility of receiving awards or feedback, will help end-users to be embodied with the *system* (i.e., tool/media which provides the gateway to the information/environment).

Motivating the end-users to collect or personalize artefacts (digital), helping them to reveal symbolic meanings of those artefacts, and encouraging them to discover or share new information, will lead them to be contextualized and culturally attached with the context. Moreover, when the end-users actively engage in the interaction process (i.e., start to explore, manipulate and contribute), and start to make dialogue with other participants, they will inevitably begin to contribute at the

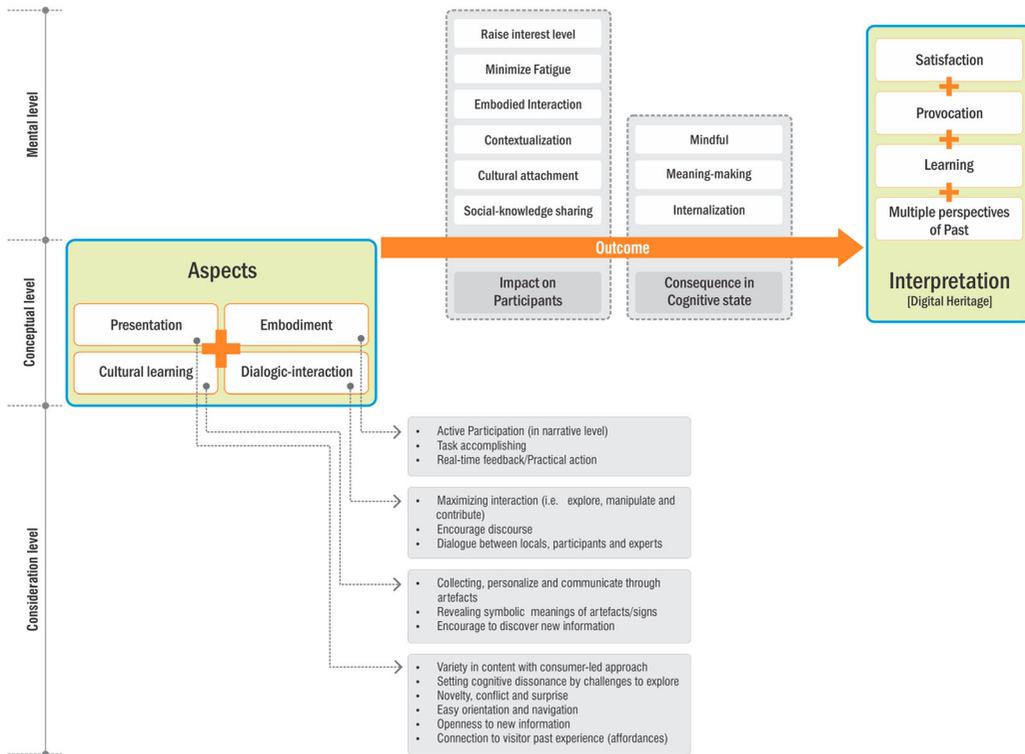


Figure 3. Conceptual framework (PrEDiC) for interpreting digital heritage.

narrative level by sharing the social knowledge and will become part of the community.

This way, the interpretive process, will influence the participants to raise their interest level and minimize fatigue. As a result, mindfulness should be stimulated. Considering architecture as a social product, meanings also come from circumstances or context rather than only from 'form'. Embodied interaction helps to be contextualized, thus will enhance meaning-making in the cognitive state. Moreover, sharing and contributing through the dialogic interaction will enhance socio-cultural activities, and lifts up an individual experience to co-experience and inter-subjective understanding. Thus, internalization and cultural learning will be elicited.

The convergences of explicated ideas based on theoretical underpinnings led to the development of this conceptual framework (Figure 3). According to this framework, a certain enhancement of end-users' interpretation of

digital heritage is possible through establishing the four aspects, i.e., Presentation, Embodiment, Dialogic interaction and Cultural learning in the interpretive process (this framework will be referred as PrEDiC throughout the article).

5. Implementation and user study

The abovementioned framework (PrEDiC) was implemented and tested on a 2D online platform to understand its impact on end-users' interpretation level. Praxis of the conceptual framework was substantiated by converging the four aspects and fifteen considerations to 'operational functions' (i.e., operationalization of the considerations, Table 1) for achieving a higher satisfaction, provocation, learning, and understanding of the past from multiple perspectives by the end-users. Based on the offered functionalities (modules) by a free CMS engine (Dolphin), the experiment

Table 1. Operationalizing the considerations.

Considerations	Operational functions (2D platform)
Presentation	
Variety in contents	<ul style="list-style-type: none"> • Introduced various file format - including pictures, text and movies; other presentation formats like VRML, and QVR.
Challenges to explore/ setting cognitive dissonance	<ul style="list-style-type: none"> • Best contributors were to be highlighted on the front page periodically.
Novelty & surprise in content presentation	<ul style="list-style-type: none"> • Arranged online competition.
Easy orientation and navigation	<ul style="list-style-type: none"> • Provided new information on the front page, updated regularly, i.e., each visit could be unique.
Openness to new information	<ul style="list-style-type: none"> • Simplicity in design/visual appearance • Search function • Tag words, Page tree and Instant help files
Connection to participants' past experience	<ul style="list-style-type: none"> • Instant access to upload digital contents (text, image, video, links etc.) • Instant access to database, access/introduction to external sites • Contents were presented in easy understandable language, rather like technical specifications. • Google translator was added for language translator. • Some popular or local words were used for describing the artefacts/building.
Cultural Learning	
Collecting artefacts/ resources and personalize them	<ul style="list-style-type: none"> • Users were allowed to create personal profile page. • They could collect other's images/info and save/use for display • Participants could change the theme of the site
Revealing symbolic meaning	<ul style="list-style-type: none"> • Provided online forum to discuss about heritage issues • Allowed to ask questions in Q/A section • Allowed to comment on other posts • Allowed to arrange online competition and take part in offered competition • Best contributor /winners were highlighted on the front page.
Encourage to discover new information	<ul style="list-style-type: none"> • Best contributor /winners were highlighted on the front page.
Embodiment	
Allowing active participation	<ul style="list-style-type: none"> • Allowed instant access to upload digital contents (text, image, video, links etc.). • Introduced online forum • Allow participants to ask questions in feedback section • Introduced real-time chat function
Task accomplishing	<ul style="list-style-type: none"> • Arranged some online competition. • Best contributor /winners need to be highlighted on the front page.
Real-time feedback/ practical action	<ul style="list-style-type: none"> • Allow comment on any post • Introduced real-time chat function • Allow participants to ask questions in feedback section
Dialogic interaction	
Maximizing interaction	<ul style="list-style-type: none"> • Allowed end-users to explore, manipulate and contribute • Allowed comment on any post
Encourage discourse	<ul style="list-style-type: none"> • Introduced online forum, blog, chat room, feedback and shout functions. • Allowed participants to ask questions in Q/A section
Dialogue between participants and experts	<ul style="list-style-type: none"> • Best contributors were highlighted in front page.

platform was developed (Figures 4 and 5), while some modifications and updates were made to the existing modules (Rahaman, Rashid, and Rahman 2010) to ensure the desired interaction and functions to support the considerations.

According to the study hypothesis, changes in end-users' interpretation occurs with the application of different interpretive methods. A comparative experimental design was chosen, to satisfy one of the objectives to compare the effectiveness of the proposed framework

with the conventional linear interpretation, using controlled groups. Concerning Kumar (2005) and Jex (2002), the comparative experiment aimed to measure dependent variables (i.e., satisfaction, provocation, learning and multiple perspectives of the past) by manipulating independent variables (that is the 'process of interpretation') under controlled condition.

The Sompur Mahavihara in Bangladesh (a Buddhist monastery); a world heritage site was



Figure 4. The skeletal framework of the experiment platform.

selected as the case (Figure 6), while different treatment models (experiment platforms) were prepared and offered to the two pre-selected groups. The ‘Sompur Mahavihara’, also known locally as Paharpur Vihara, was built in the 3rd century A.D. (Dikshit 1938). Apart from ‘Nalanda’, it is probably the single largest (85000m² or 21 acres) vihara in Southern Asia, consisting of 177 cells and a traditional Buddhist Stupa at the centre. Considering its cultural significance and the present scholarly debates on the authenticity and appropriateness of its past (Rahaman, Rashid, and Rahman 2010), this site was preferred over others to be used as a case for the experiment platform.

Four groups of participants were selected to participate in this experiment. However, a large number of online participants (anonymous) also took part in the ‘online public participation’ phase. Undergraduate students from Khulna University, Bangladesh, were selected as respondents. Purposive or judgement sampling

was used to select the participants (Tan 2004, 33; Homles, Mohammad, and Habibah 2005, 38). Participants were selected on the basis of having (i) an interest in cultural heritage; (ii) access to the internet; and (iii) willingness to participate in the survey on a voluntary basis. Before the initiation of each experiment, an orientation clarified the significance and rationale of the study. Furthermore, the use of the experiment platform was explained and demonstrated to the participants. Table 2 describes the procedure, group formation and tasks of each group during the experiment.

A total number of 160 respondents were selected and divided into two groups (A and B). Group A was offered an experiment platform with a linear interpretive framework. On the other side, the treatment, i.e., the experiment platform which had been developed based on the conceptual framework (PrEDiC) was offered to group B. Following each experiment, end-users’ responses were collected

bdheritage.info
share your knowledge

"Please participate in forum/blog on discussing some of your experience and knowledge related to Sompur Mahavihara."
Admin

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Home > Others Hello, Guest! Join Login

bringing back the lost monument

[Join](#) [Login](#)

Welcome_home

Welcome to this site. As a part of a research project this site has been developed to collect and share public experiences and memories about 'Sompur Mahavihara' (paharpur bihar).

Membership is free. Please be a member to share your knowledge and experience with others and get the access to explore the archive.

Thank you.
Hafizur Rahaman [admin@bdheritage.info or hrahaman@gmail.com]

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Figure 5. Screenshot (partial) of the main page.

through a semi-structured questionnaire. However, at the time of writing this paper, I could not find any established or standard method for data collection (such as a standard set of a questionnaire) to evaluate end-users' interpretation of digital heritage. End-users' interpretation were measured by converting those

objectives into indicators and variables, and later into questions (by adopting Kumar 2005, 57). For example, satisfaction as one of the four objectives that affect end-users' interpretation of heritage was converted into three indicators, i.e., (i) expectation fulfilled, (ii) appreciation of visit and (iii) pleasure achieved,



Figure 6. Present view of the central temple of the Sompur Mahavihara.

and later, into ten variables and associated questions (Table 3).

However, only 149 responses were found to be valid (77 in group A and 72 in group B). Collected data, from the survey responses, were then entered in the Statistical Package for Social Sciences (SPSS) for analysis. Descriptive statistics such as Cross tabulations and Mean values together with simple inferential statistic techniques such as Chi-square and One-way Analysis of Variance (ANOVA) were used. On the other hand, self-reported descriptive written responses were examined through thematic ‘content analysis’ (Holsti 1969; Jenner and Titscher 2000; Kumar 2005). For example, the end-users’ fulfilment of expectation as an indicator of satisfaction (reference to Table 3) was measured by using four variables; i.e., (i) found uniqueness in content, (ii) got new/advanced information, (iii) easy to navigate and use and (iv) received support/feedback from others. Table 4 shows the findings by

using one-way ANOVA tests, which was conducted to verify possible significant mean differences between group A and group B regarding their expectation fulfilment.

Part of the questionnaire only investigated group B, looking for their frequency of communication with others (i.e., dialogue) (Table 5) and frequency of contribution, manipulation and exploration (i.e., interaction) during the experiment week (Table 6).

Based on the user study, it became evident that irrespective of some common experiences, significant differences in attaining new perspectives persist between the groups. The empirical evidence from the survey responses, a higher ‘interpretation’ of digital heritage (i.e., Sompur Mahavihara) became apparent among group B. The quantitative evidence received from the semi-structured questionnaire also supports the qualitative written responses by the respondents. Group B had found diversified information from the contributions of others and

Table 2. Different groups and their task during the experiment.

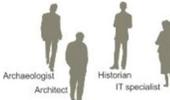
Phases	Participants	Group Task	Result / Outcome		
Development and Testing Phase	Primary construction [01 person]	Researcher 	<ul style="list-style-type: none"> • Content development • Experiment Platform construction • Questionnaire development • Work as moderator 	<ul style="list-style-type: none"> • Basic construction of Experiment Platform • Preliminary Questionnaire prepared 	
	Cognitive walkthrough [04 Professionals]	Group – E 	<ul style="list-style-type: none"> • Content proofing and comments • Cognitive walkthrough of the online platform • Work as moderator • Experience the site for 3 days • Response in questionnaire survey • Comments in group discussion 	<ul style="list-style-type: none"> • Professional construction [Platform updated] 	
	Pilot survey [3 days]	Group – C [10 participants]		<ul style="list-style-type: none"> • Attend the orientation seminar • Experience the site for 7 days • Response in post-experience questionnaire survey 	<ul style="list-style-type: none"> • Updated experiment platform • Updated questionnaire
Evaluation Phase	Experiment 01 : Evaluating group A [7 days] [linear interpretive method applied]	Group - A [80 respondents] + [moderators]		<ul style="list-style-type: none"> • Take part in dialogic interaction [i.e., Contribute (image, text, video, links, news), Discuss, Form groups, Explore, Debate, Ask question, Comments, Invite others, Blog and Chat] 	<ul style="list-style-type: none"> • End-users experience data [filled questionnaire]
	Experiment 02 : (1) Online public participation [3 months] [proposed interpretive method applied]	Anonymous Participants [approx. 200 users] [moderators]		<ul style="list-style-type: none"> • Attend the orientation seminar • Experience the site for 7 days • Response in post-experience questionnaire survey 	<ul style="list-style-type: none"> • Explicit online knowledge base [generated by common disposition of cultural experience and memory by general people]
	(2) Evaluating group B [7 days] [proposed interpretive method applied]	Group – B [80 respondents] + [moderators]		<ul style="list-style-type: none"> • Attend the orientation seminar • Experience the site for 7 days • Response in post-experience questionnaire survey 	<ul style="list-style-type: none"> • End-users experience data [filled questionnaire]

Table 3. Selection of questions to measure satisfaction of the end-users.

Indicators and Variables	Questions	Measuring Scale
Expectation fulfilled	<i>Q.9. I am satisfied with this web-portal because:</i>	5 point Likert scale
i. Uniqueness of content	a. Found unique contents	
ii. New/advanced information	b. Got new information	
iii. Easy to navigate and use	c. Easy to navigate and use for me	
iv. Received supports / feedback	d. Received responses from members and moderators	
Appreciation of Visit	<i>Q.10. I appreciate this experience because:</i>	5 point Likert scale
i. Self-appreciation of online visit	a. It is worth to visit this web-portal before going to Sompur Vihara	M.C.Q.
ii. Appreciation of involvement / membership	b. I am glad to be a member	
iii. Willingness to inform others	c. I like to inform my friends	
iv. Suggest further improvement	<i>Q.12. Is there anything about this 'portal' that you think need improvement ?</i>	
Pleasure	<i>Q.9. I am satisfied with this web-portal because:</i>	5 point Likert scale
i. Fun achieved (self-rating)	e. I had fun	
ii. Overall Experience (self-rating)	<i>Q.11. How do you rate your overall experience of visiting this web-portal?</i>	

Table 4. Expectation fulfilment among groups.

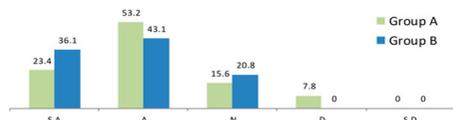
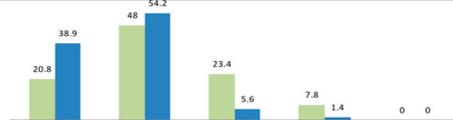
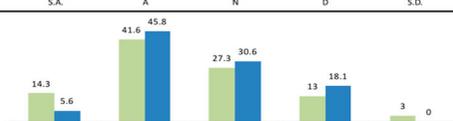
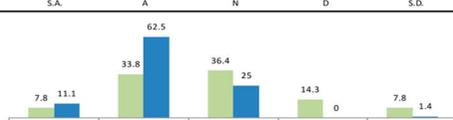
Indicators	Variables	Response	Mean	ANOVA	H ₀
Expectation Fulfill	Found unique contents		0.78 (A) 1.15 (B)	F(1,147)=8.245, p<0.005	Rejected
	Got new information		0.82 (A) 1.31 (B)	F(1,147)=15.333, p<0.000	Rejected
	Easy to navigate and use		0.49 (A) 0.39 (B)	F(1,147)=0.459, p>0.499	Accepted
	Received feedback		0.19 (A) 0.82 (B)	F(1,147)=18.601, p<0.000	Rejected

Table 5. Use of forum, chat room and blog by the participants.

Frequency of use	Interaction and Activities		
	Forum (%)	Chat Room (%)	Blog (%)
Almost never	9.7	13.7	6.9
Occasionally	45.8	27.8	45.8
Once/day	15.3	12.6	26.4
More than once/day	19.4	2.8	11.1
Total usage (%)	90.2	56.9	90.3

Table 6. Contribution by the respondents.

Frequency	Contribution and sharing					
	Blog post	Image	Links	Forum post	File	Video
1 ~ 5 nos	31.9	19.4	22.2	18.1	11.1	2.8
6 ~ 10 nos	11.1	12.5	11.1	8.3	1.4	1.4
11 ~ 15 nos	1.4	4.2	0	2.8	2.8	0
16 or more	0	2.8	0	0	0	0
Total submission (%)	44.4	38.9	33.3	29.2	15.3	4.2

had become more attached to the community. They were also found to have spent more time in interacting and exploring the experiment platform than group A. Greater interaction and dialogue with others, along with access to an explicit generic knowledge base seemed to have helped them to understand more about the cultural, spatial, historical and architectural issues of Sompur Mahavihara. Indeed, this outcome signifies the impact of the presence of the framework (PrEDiC) on end-users. The detailed description of the operationalization of the considerations, data analysis and evaluation procedure can be found in Rahaman (2012).

6. The scope of the framework

The framework presents 15 considerations to support four aspects (Figure 3). However, these considerations are mainly ‘concepts’; those reflect a mental image or perception and can be implemented (or grounded) differently according to the choice of media (2D, 3D, Augmented Reality and Mixed Reality) or tool (CAVE, MUVE, HMD etc.). For example, ‘real-time feedback and practical action’ is a consideration presented to support embodiment. In response to this consideration a 2D web platform can offer a pop-up message and trigger a beep; whereas with a virtual reality (VR) environment with a haptic/tactile controller, the response could be a combination of visual, sonic and touch. Similarly, applying considerations of ‘novelty and surprise in content

presentation’ or ‘collecting or personalising artefacts or resources’; will differ according to the used tool, media and settings. The user experience and interactivity will also vary accordingly. A VR environment made with Oculus Rift or HTC Vive and applied in an indoor environment might offer a different experience with compare to an outdoor setting, which uses an AR app on a mobile device or a Mixed Reality Headset like Microsoft HoloLens. However, this also implies that these considerations are mostly device or media independent, and exclusively depends on how the ‘user-experience designer’ deals with them.

The presented conceptual framework (Figure 3) has tried to categorize the considerations in a grouped fashion as a sub-set of four aspects (i.e., presentation, cultural learning, embodiment, and dialogic interaction). However, these methodical considerations are implicitly dynamic and conceptually interwoven with each other, and possess the possibility of belonging to more than one aspect. For example, ‘active participation’ as a consideration mentioned under ‘embodiment’, also has a secondary impact on learning and dialogic interaction. Similarly, consideration of ‘dialogue between experts, participants and others’ mentioned under dialogic interaction, may also have an impact on learning and embodiment, and could also be grouped under those aspects.

‘Organic virtual communities’ are formed organically by individuals with similar interests, and its life and contribution rely on the active participation of the members. Interested

members with some particular knowledge and a high level of enthusiasm and engagement make the group sustainable. However, the formation of such a community or interested group requires an extended period. On the other hand, for any digital heritage projects, which has limited time span but demands a large number of active members; high motivation and initial support from the administrator or organiser is required to promote the group dynamics. Besides, certain components of the framework are yet to be fully investigated, particularly grounding the concept of 'embodiment' with new tools and technologies that require bodily involvement.

Data collection methods require further research and testing to establish a set of standard questionnaires that can also evaluate participants' cognitive process, internalization and mindful state, concerning the interpretive indicators mentioned in this study. This indicates direction for future research.

7. Conclusion

It has often been argued that the domain of digital heritage is still limited by its ability to fully accumulate intangible cultural heritage, or fascinated with achieving 'photo-realism' or bound to demonstrate technical artistry or power of new technology due to the pressure of 'heritagization'. In contrast, an argument about the necessity of an interpretive method has rarely been elicited and discussed in digital heritage domain. Thus, significant literature, methods and critical discourse including supportive charters or guidelines are absent within the domain of digital heritage. In this context, this paper has first, defined four objectives for digital heritage interpretation from a perspective of an interpreter. To achieve these objectives, a detailed conceptual framework has been proposed with fifteen considerations. These considerations are flexible and applicable to varied media and tool in varied ways. A case study followed by the user evaluation has been presented

later to validate the applicability and impact of the framework on a 2D online platform.

The presented interpretive framework (i.e., PrEDiC) shows a unique potential to synthesize the concept of 're-construction' and 'popular interpretation' in a digital realm to produce a nonlinear interpretive process. From both points of theory and practice, it also presents a way to juxtapose the professional and popular content at the narrative level. Additionally, the PrEDiC framework initiates a new discourse to understand how an interpretive process can unfold a space for inter-subjectivity and create an environment where higher satisfaction, provocation, learning and understanding of the past from multiple perspectives can take place.

Although the paper highlights some methodical limitations, applying the same framework in a 3D platform (such as in CAVE) or an on-site Augmented Reality (AR) platform might have different impact to end-users, which require further research through tailoring of methods, practice and prototype development. Nevertheless, I believe this paper will help heritage professionals, scholars and user experience designers to initiate strategies and plan before developing a digital heritage project for improved interpretation.

Disclosure Statement

No potential conflict of interest was reported by the authors.

Notes on contributor

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