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INTERACTION LEVELS OF DIGITAL INTERFACE METAPHORS IN MUSEUMS – LEARNING OUTCOME AND DISTRIBUTION OF ATTENTION.

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DOI: 10.63442/VHEF2687

KEYWORDS | DIGITAL INSTALLATION, MUSEUM INFORMAL LEARNING, HUMAN-COMPUTER INTERACTION, INTERFACE METAPHOR, INTERACTION LEVEL

ABSTRACT | The striking difference between digital interpretative tools compared to earlier analog modes is their dynamism, which takes visitor interaction to a more complex level – from passive recipient to active interpretive participant. Digital installations in cultural heritage sites are a kaleidoscopic phenomenon: they can be structured along several largely independent dimensions and used for several functions, not to mention the richness of technological combinations in its implementation.

This research focuses exclusively on digital installations mounted in the physical space of the exhibition as 'standalone' kiosks. As additional classification criteria, levels of interaction and interface metaphors are both particularly important for this research. The focus will be on teenagers and young adults, as the deployment of museum technology is driven by the demand to engage them as future visitors. There is little empirical research on digital installations of cultural heritage, and the results so far tend to focus on usage or visitors' attitudes toward technology, but only in the general overview of informal learning.

Therefore, we wish to measure the learning outcomes of digital installations and their impact on the attention paid to artefacts and other modalities presented in the exhibition environment. We aim to investigate the use of digital installations through 3 case studies in cultural heritage institutions in Budapest (Petőfi Literary Museum, House of Music, Skanzen).

This short paper introduces a pilot study that was carried out last autumn at the Petőfi Literary Museum; we draw methodological lessons and some observations concerning our research questions.

1. Introduction

1.1 Characteristics of Digital Installations

The digital installations in cultural heritage sites are a kaleidoscopic phenomenon: they can be structured along several largely independent dimensions and used for several functions, not to mention the richness of technological combinations in its implementation. In exhibitions – here explicitly in museums and exhibition centers – primary usage conditions of digital installations are positioning in location and duration of visit, number of users, intellectual/physical challenge, visitor content production, and creative contribution by visitors (Ruttkay & Bényei, 2018).

While intended function may be one (or several) of the following:

- arousing interest to motivate visitors,
- multimodality to integrate visual and other (audio, tactile, motor) channels in the transfer of knowledge,
- playful learning and participation to address visitors in active involvement,
- personalisation of visit,
- outreaching beyond the museum walls in time and space (Ruttkay, 2020).
- Narrative positioning,
- contextual representation of space and time of the exhibition's theme,
- express an emotional charge (Studio Louter, 2024).

In the discipline of Human-Computer Interaction, digital installations in museums are categorized in two ways. Firstly, according to realisation in space: as standalone (kiosk), mobile (portable), and assemblies (comprehensively installed). Secondly, based on the degree of augmentation, contextually embedded and embodied (related to space in an objectified form), extended reality content (AR/VR/XR) and multisensorial (affecting different modalities) can be distinguished (Hornecker & Ciolfi, 2019).

As additional classification criteria, **levels of interaction** and **interface metaphors** are both particularly important for this research.

1.2 Complexity of Interactions and Interface Metaphors

The striking difference of digital interpretive tools compared to earlier analog modes is their dynamism, which takes visitor interaction to a more complex level – from passive recipient to active interpretive participant.

In our definition, **complex-level interaction** of digital installation combines three, but at least two, of the cognitive, affective, and psychomotor learning domains of Bloom's taxonomy (Bloom, 1956). Whereas, at a **low-level interaction**, the handling condition of the installation relies predominantly on one type of these learning domains to convey its messages.

For example, watching a video projection has neither psychomotor (imitation, manipulation, etc.) nor cognitive (analysis, synthesis, application, etc.) requirements for use, relying solely on affective domain of reception. In the 'Letterpress' installation, psychomotor manipulation (sorting letters) and affective value selection (giving headlines) are combined (Figure 1).

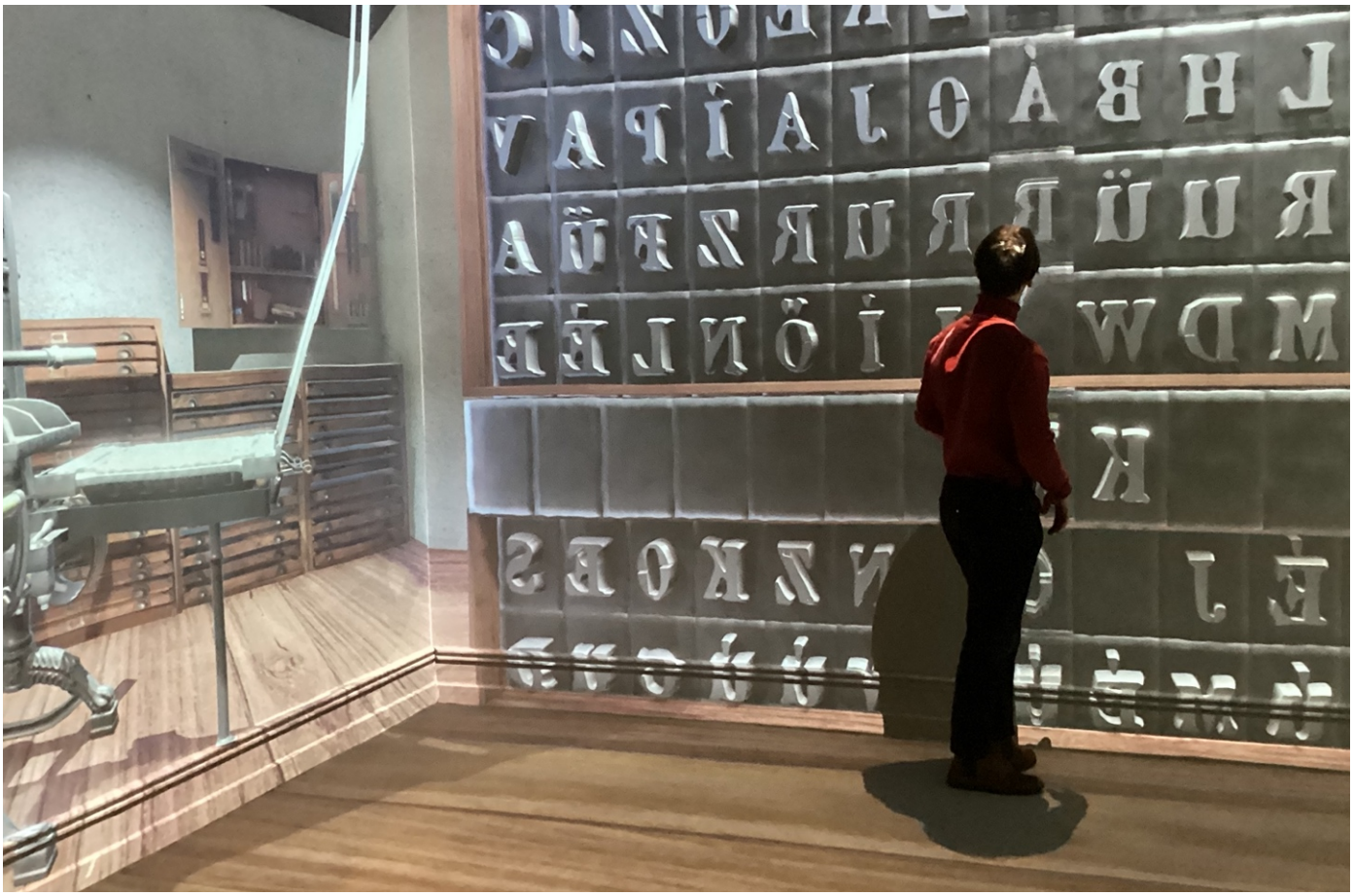

Figure 1 Example of complex-level interaction from the pilot study: "Printing press" implements a media metaphor to challenge participants by sorting the letters to create newspaper headlines.

Interface metaphors are technologies embedded in everyday objects to accelerate the initial familiarity in visitors (Carrol et al., 1988) – just as frames, lenses, vehicles, media, or maps in museums. This proposed list (Table 1) does not aim to be exhaustive, but it provides an overview of the main characteristics. Yet, without playfulness or implemented as a low-level interaction (e.g., launching videos), interface metaphors could be reduced to mere scenery if visitors are left as passive recipients.

Table 1. Interface metaphors of digital installations in exhibitions.

Metaphor	Connotation	Object Extenstion
Frames	border, in and out, casing, framework	window, gate, painting, mirror
Lenses	scaling, reduce, expand speed up, slow down	glasses, telescope, microscope, scanner, door viewer
Vehicles	motion, shifting, navigation, progress	carriage, boat, bicycle, car, aeroplane, spaceship
Media	communication, information knowledge, verification	printing press, book, journal telegraph, radio, television
Maps	coordinates of place and time, background, context	diorama, interactive map, datavisualization

1.3 Earlier Empirical Research on Usage and Effect

The diversity of media technologies and heterogeneous content create unique challenges for evaluation (Diamond et al., 2016). There is little empirical research on digital installations of cultural heritage, and the results so far tend to focus on usage (Hinrichs & Carpendale, 2011) or visitor attitudes toward technology (Hanko et al., 2014) but only in general overview on learning outcomes (Pallud, 2016) or evaluation of it (Kontiza et al., 2020).

Comparisons between graphical and manipulative (tangible) interfaces showed that the latter are more frequently tried, especially by children. In both cases, involving multiple participants leads to significantly longer interaction (Horn et al., 2009). The absolute and relative location of visitor paths influences the attention paid to digital installations proved by installation usage's time spent compared to visitor paths in Chopin Museum (Knast, 2017).
While in vitro design research rooted in HCI (Höök et al., 2003) has turned to in situ evaluation (Galani & Kidd, 2019) to adapt its criteria to the museum's informal learning environment (Bekele & Champion, 2019).

In the Mesch project, researchers evaluated how visitors use digital and non-digital exhibition elements (museum objects, digital replicas, labels, multimedia) by integrating personal meaning maps to measure visitors' informal learning (Damala et al., 2016). Pre- and post-visit mapping helps to assess visitors' knowledge of a broad range of exhibition topics (Falk et al., 2010).
Engagement and learning were examined in two natural history museums, where interactive *tree of life* with 70,000 species was presented on a touch table. A bigger proportion of visitors who used the digital installation understood evolution concepts compared to those who watched overlapping video content in the same time frame (Horn et al., 2016).

2. Own Research Agenda

Our research focuses exclusively on digital installations mounted in the physical space of the exhibition as 'standalone' kiosks. The scope will be on teenagers and young adults (10–19- and 20–25-year-olds) as the deployment of museum technology is driven by the demand to engage them as future visitors. We wish to measure learning outcomes of digital installations and their impact on the attention paid to artefacts and other modalities presented in the exhibition environment. We aim to investigate the use of digital installations through 3 case studies in cultural heritage institutions in Budapest (Petőfi Literary Museum, House of Music, Skanzen).

2.1 Research Questions

1. How does digital installation usage effects visitors' attention distribution in the same exhibition space compared to non-users?

    a) Do digital installation users pay less attention to the collection's objects?
    b) Do digital installation users pay less attention to other presentation modalities?

2. Do users grasp the message conveyed by the digital installations?

    a) How is the recall of digital installations' content right after the visit related to the extensiveness of the usage of the installation?
    b) How is the recall of digital installations' content 4-6 weeks later after the visit related to the extensiveness of the usage of the installation?

3. Comparing complex to low-level interaction usage, which induces a higher proportion of

    a) the involvement of fellow visitors in interaction?
    b) more positive emotional state?
    c) telling about their experience with digital installation to others in 4-6 weeks after the visit?

2.2 Hypotheses

1. Digital installations' users are not paying less attention to the objects or the presentation modes in proximity compared to non-users.

2. Long-term knowledge transfer is only can be conveyed through exhaustive usage.

3. Usage of complex-level interaction-based digital installations compared to low-level based, induce

    a) larger proportion failed to try
    b) more exhaustive exploration of content
    c) higher proportion of fellow visitor involvement
    d) emotional intensity (less neutral state).

4. Experience with complex-level interaction-based digital installations are more often told to others in 4-6 weeks after the visit.

3. Empirical Research Methodology

3.1 Entry Questionnaire – Visitor Profile, Knowledge Brought

To evaluate digital installations' learning outcomes, we apply combined quality and quantity research (Malik et al., 2023). In order to profile the visitors, we use a demographic questionnaire before the exhibition. It is also surveys visiting habits and pre-knowledge of digital installations and exhibition themes, adapting the aforementioned personal meaning mapping method (Falk et al., 2010). Participants are asked to pin up a badge (Figure 2), which links the measurement phases with an anonymous code (Y02=yellow badge+second measurement).

3.2 'In the Wild' Observation – Mode and Circumstances of Use

The guided and covert observations could be 'shadowing' or 'point tracking' depending on the floorplan. To ensure consistency of logging, intercoder agreement should established on the relative values observed, and each observer is expected to record trials before substantive sampling.

The following aspects of usage are observed and coded.

- interaction's duration
- whether it is used alone or with a partner
- degree of usage (try but give up/ask for help/use successfully, etc.)
- extent of usage (amount of discovered content offered)
- attention paid to artifacts or presentation modes(object-descriptions/wall-signs/ QR-codes)
- displayed emotions
- general attitude (experience-seeker/in-hurry/wandering).

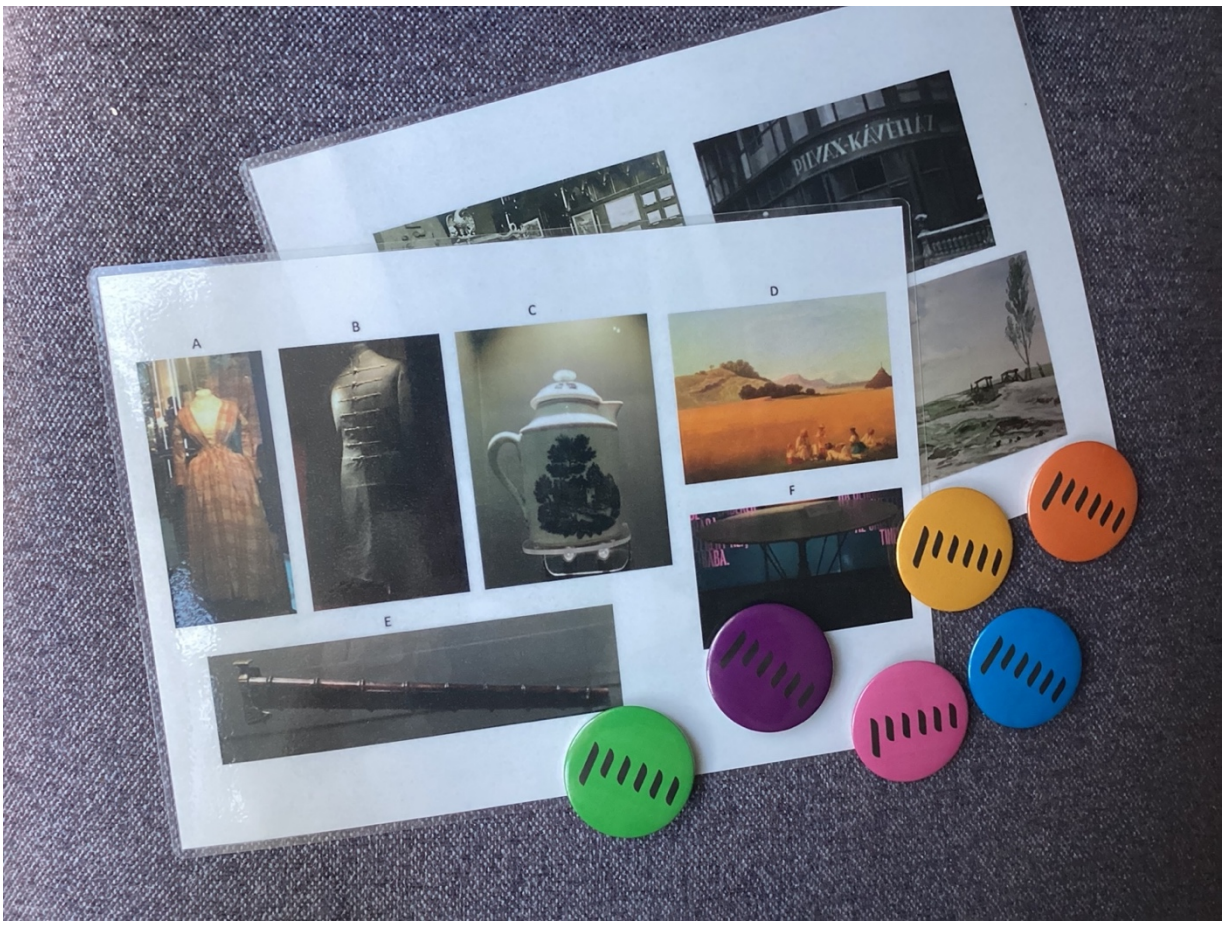

Figure 2. Research supplies: badges, artifact photos, and personal meaning maps.

3.3 Exit Interview – Paid Attention to Installations, Artworks, and Texts

At the exit interview, laminated photographs could be handed out (Figure 2) to help identify artworks and evaluate digital installations based on user experiences and the distribution of attention. We ask them to formulate the main message of the digital installations they have engaged. We also ask them to identify which object they recognize and whether they can name the person associated with it from its description.

3.4 Online Questionnaire – Long-Term Knowledge

The follow-up online questionnaire is designed to shed light on the long-term knowledge gain therefore, we ask respondents about their recollection of the installations 4-6 weeks after the visit with questions like: Have they talked about digital installations since? Do they remember digital installations' specific content? How well can they recall displayed objects in the proximity of a digital installation?

4. A Pilot Study

In Petőfi Literary Museum *Petőfi 200 To be or not to be a poet?* permanent exhibition, a pilot study was carried out in the fall of 2023. In design and purpose, [three] significantly different digital installations were chosen, the remaining 13 were not the subject of the research due to their repetitive format or lack of learning function.

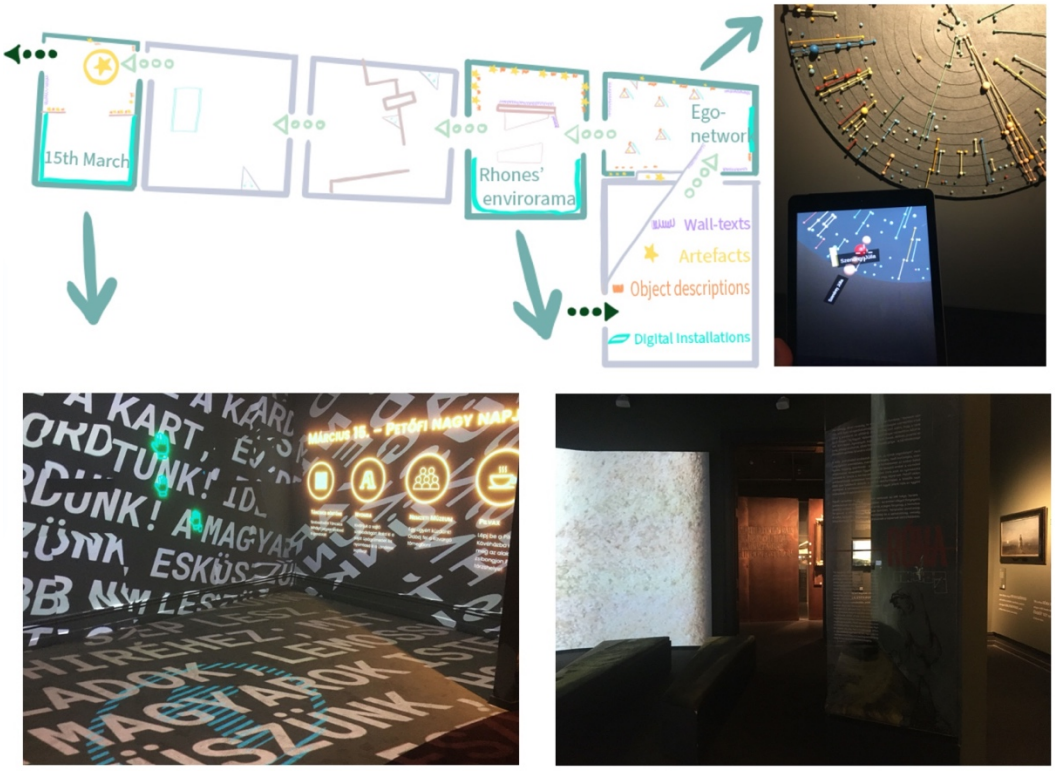

Figure 3. Digital installations on floorplan (top left), Ego-network (top right), Rhone's Envirorama (bottom right), and 15th March (bottom left).

Ego-network (Figure 3) was the kick-off installation, which promotes exploratory learning in layered content - combining data visualization and augmented reality tools (Figure 3). It is aim to reveal who was important to the poet.

Rhone's Envirorama (Figure 3) is an immersive, large-scale projection from the center for relaxation and contemplation. By definition, envirorama is a new generation of the diorama, except it shapes the environment to include visitors as part of it: "Being 'in' a walk-through reconstruction quite directly makes a visitor feel 'part of' the display" (Roppola, 2018, p.151).

15th March (Figure 3) is the final digital installation in the exhibition. Projections of the embayment do not provide narrative factual knowledge; rather, it helps to situate the participant in the milieu of the period. To address schoolchildren at the end of the content-rich exhibition requires full bodily gestures via motion sensors.

The pilot aimed to fine-tune the methodology. Therefore, we applied convenience sampling (n=52), where the gender ratio was 35-65% in favor of females. The vast majority already have used a digital installation in museums (81%), came with family or friends (68%), and were from Budapest (65%).

4.1 Improvements, Limitations, Results

Lessons learned concerning methodology

The major difference between 'shadow-' and 'point-tracking' is that the latter allows more relevant data to be collected in a shorter time; however, the risk of data loss is higher due to the number of observers. Personal meaning maps should be selected that do not appear in any other representation in the exhibition to ensure that the digital installations alone could provide access to learning about the concept.
The small sample size and limitation of the target population did not allow us to get significant answers to the research questions. Moreover, to compare the types of installations, it will be necessary to observe more applications – yet results can be considered indicative for future research.

Some observations about the research questions

1. There is no evidence that those who used the digital installation tended to pay less attention to the artworks or the descriptions.
2. The shorter the time users spent watching Rhone's Envirorama, the more time they spent looking at the artwork. While different relationship was identified for the other complex-level interaction-based installations, more attentive usage was associated with more careful observation of the artworks.
3. More than 75% of respondents mentioned digital installations; complex installations emerged as the most prominent.
4. More positive emotions were monitored during complex-level interaction.

This research makes useful steps in strengthening the evaluation practice of the Hungarian museum scene and also helps digital curators and design practitioners to fine-tune the iteration process in cultural heritage institutions since design practice and -research is built on knowledge advancement and exchange between them.

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This contribution was presented at Cumulus Budapest 2024: P/References of Design conference, hosted by the Moholy-Nagy University of Art and Design Budapest, Hungary between May 15-17, 2024.

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ISBN Volume 1: 978-952-7549-02-5 (PDF)
ISBN Volume 2: 978-952-7549-03-2 (PDF)

DOI Volume 1: https://doi.org/10.63442/IZUP8898
DOI Volume 2: https://doi.org/10.63442/TADX4016

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