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# Methodology for Design of Online Exhibitions

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**ABSTRACT**

The process of designing systems or products largely depends on a number of decisions, like "who do I design for?", "what should my product do?", "what are the user requirements?" etc. The developing teams usually base their decisions on experience and/or heuristics and this is particularly the case, in the development of online products and especially online exhibitions. The different solutions are frequently case studies of specific museums or institutions that wish to provide online content to actual or possible visitors. In addition, the interdisciplinary nature of the endeavor, involving museology, technology but also education, poses important design problems. In the following sections, we present a generic methodology for the design of online exhibitions, using top-down processes and transferable findings across museum types that wish to assist the designers during the early decision stages.

This paper provides an introduction to the field, emphasising its interdisciplinary nature and reviews related work in the area of online exhibition design. It also presents an overview of the methodology, elaborating on the individual methodology steps; in particular, the processes for determining the visitors' perception of the museum (degree of museumness); the museum needs that require to be supported; the educational approach to be adopted; the relevance to life-long learning activities; the approach to adaptivity; and user involvement have been reviewed.

**Keywords:** Online exhibitions, museums, design methodology

## 1. INTRODUCTION

A designer of online exhibitions usually goes through a series of decisions, some more difficult than others, from the very beginning of the endeavor. These decisions include a number of quite diverse aspects, such as whether the application will have a purely educational character or an edutaining element, whether it will be collaborative or intended for individual use, which is the most prominent way to present exhibits, etc. These important aspects of design are often based on heuristics and experience. Although such an ad-hoc approach may be workable for some simple situations, in the general case an explicit and established procedure is needed, such as which are the decisions to be made and who and how decides on design issues. In this light, a methodology has been developed that assists the designer of online exhibitions in the early design stages and especially during concept generation. The series of decisions are supported by a number of questions the designer is required to answer, as well as a set of tools or techniques for each question.

The design of online exhibitions is a work of interdisciplinary nature. Insulander[1] defines the museum as an area of knowledge in which different disciplines meet. The interdisciplinary character of museum learning technologies imposes another problem in the study of the field, since different methods, theories, practices and findings gather from the different disciplines. Clearly, the disciplines of museology and technology should be considered, since the former provides invaluable knowledge on the artefacts to be presented and how the museum message[2] to be conveyed should be shaped, while the latter dictates the means that are available for artefact presentation. One has to take into account that during the past years, museums have moved from preserving and displaying artefacts to institutions focused on the education and entertainment of visitors[3,4]. At the same time visitors also report that one of the main reasons they visit physical or online museums is learning, together with entertainment and socialisation[5]. To this end, museum curators strive to design and implement exhibitions that offer an educational and at the same time enjoyable experience. These principles apply to both physical and online environments; according to the above, the education discipline is rendered directly relevant to the design of online exhibitions. Thus, three

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main disciplines are involved in the design of online exhibitions, namely museology, technology and education (Fig. 1).

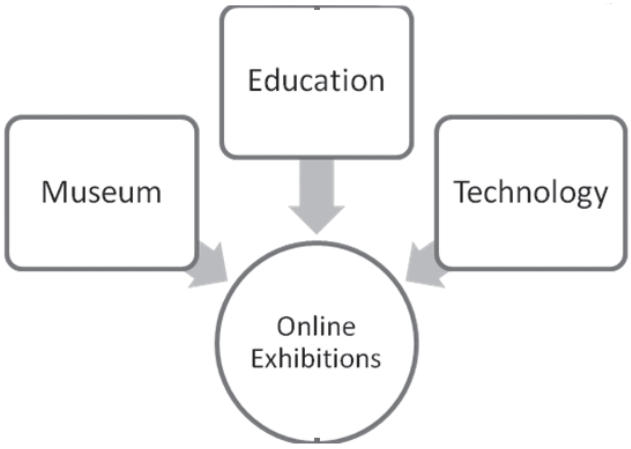


**Figure 1. Interdisciplinary nature of the design of online exhibitions.**

According to the above, online exhibition design is a complex task because:

(a) The decisions that should be taken spread across different disciplines and it should be ascertained that each decision is taken by appropriately skilled personnel and all pertinent criteria are examined.

(b) The number of decisions is considerable, and it should be guaranteed that no important design factor is overlooked.

(c) The coherence of design decisions should be guaranteed; decisions should also be taken in proper sequence, to avoid (or minimise) the need for reviewing previously taken decisions.

## 2. RELATED WORK

The issue of online exhibition design has attracted the interest of researchers in the past one decade, following the widespread of interactive multimedia, broadband Internet and virtual reality technologies. Tinkler[6], *et al.* and Charitos[2], *et al.* provide an approach on how virtual museums can be designed and implemented, while in Lepouras[7], *et al.*, and Charitos[8], *et al.* the issue of creating and employing online exhibitions in the premises of the museum for enhancing the visitors' experience is examined. Bannon[9], *et al.*, suggest the introduction of hybrid artefacts, i.e., installations that allow visitors to manipulate physical and digital material in a visible and interesting manner for many museum visitors, providing additional tools for the designer to capture the interest of the visitors. Yet, these approaches mainly focus on technological aspects, not considering the educational requirements for the designed exhibitions. Bonis[10,11], *et al.* examine the issue of providing digital museum installations that adapt to the users' preferences, while Hong[12], *et al.* present an approach where XSL technology is employed to deliver different presentation styles to different user groups, focusing on the implementation aspects of adaptivity and adaptation. Sparacino[13], *et al.* examined how new technologies, such as wireless object and body tracking and wearable computers, should be incorporated in the design of online exhibits.

Marty[14] refer to the Spurlock Museum, which is characterised as a "holistic approach to museum informatics", focusing on the study on the social impact of information technology on the collaborative activities of the curators and exhibit designers planning on the new Spurlock facility. Hein[15] and Alen[16] focus on how learning aspects should be incorporated into the museum design, but technological factors that are of particular importance for online exhibits are not considered at the same level of importance as museological and educational aspects. Finally, Falk[17] and Hsi[18] discuss post-implementation assessment of visitor's experience in digital and digitally-enhanced exhibitions.

To summarise, it seems that a large number of previous studies have aimed at different design aspects for the development of online exhibitions from technology requirements of the users[19] to specific case studies[20]. Different generic approaches for the design of online exhibitions have been published, also attempting to assist the designers with different strategic issues[21,22]. Regarding the very early stages of the design cycle, our methodology aims at assisting the designer primarily at the conceptual level.

## 3. METHODOLOGY

The proposed methodology is based on a series of questions posed to the potential designer of online exhibitions. The six main questions useful for the designers are shown in Table 1.

For each question, we have developed different tools and techniques in order to facilitate the answering process. In the following section the questions, the relevant techniques and tools will be presented.

**Table 1. Main questions related to methodology**

| | |
|---|---|
| 1. | What is the degree of museumness for the specific exhibition? |
| 2. | Which museum needs will I support? |
| 3. | What is the optimal educational approach for my purposes? |
| 4. | Is life-long learning relevant? |
| 5. | Will it be adaptive? |
| 6. | How can I involve the user? |

### 3.1 Degree of Museumness for the Specific Exhibition

Recent studies have shown that the way people define a physical or virtual space seems to have clear implications on learning[23]. This work explored how visitors view the different museum types, and their expectations with regards to learning or other activities they might want to be offered in an online museum. Therefore, the different museum types are classified based on the visitors' perceptions, and the term museumness is introduced in order to describe visitors' perceptions on a certain physical or virtual space and whether this space forms a typical museum or not[24]. Museumness does not form a 'yes' or 'no' category; rather it suggests a continuum that different museum types can have higher or lower scores. For example, visitors might consider both an archaeological museum and an art gallery as museums, but of different degree of museumness, since the former collects all the stereotypical characteristics that form the notions of museums and the latter contains fewer of those characteristics. A scale of the 'perceived degree of museumness' was produced and it was further correlated to specific activities visitors want to be offered by the museum (i.e., learning, socialisation, entertainment).

The Hooper-Greenhill & Moussouri[25,26] classification of museum types was used in order to produce the museumness scale. Since each museum type seems to have unique activity demands and is approached differently by its users, the authors of this presents work opted to examine each museum type individually, rather than the grouping suggested in Hooper-Greenhill & Moussouri[25] (e.g. archaeological museums are placed in the same category with history museums). The museum types used are: Zoos, archaeological museums, art galleries, industrial museums, history museums, science museums, children museums, botanical gardens, aquariums, and technological museums. This need to consider each type's characteristics separately is also reflected in a study by Dierking & Falk[27].

To validate our assumptions, we conducted statistical confidence tests on the results of the questionnaires. Assumptions were accepted when the statistical confidence that the assumption holds (formally termed as confidence interval) was greater than 95 %, equivalently denoted as $p < 0.05$ (the probability that we have a statistical error is less than 5 %). The 95 % confidence interval is a limit widely used in applied practice[28]. The Chi-Square test[29] was primarily used for validating our assumptions. For more information on statistical confidence tests and confidence intervals, the interested reader is referred to Snedecor & Cochran[30].

It has been found that the different degrees of museumness highly correlate with the preferred and the expected activities of their users. More specifically, by conducting statistical confidence tests on the results of questionnaires collected from potential museum visitors, we found that the hypothesis that "There would not be any differences between peoples preferred activities for different types of museums" is rejected with very high confidence[31]. The primary activity that visitors expect and want to perform in institutions they consider typical museums, is learning. When an institution is not seen as a museum (i.e., has a low degree of museumness), the visitors expect and wish to be primarily entertained. Figure 2 summarises the results, partitioning the museums into three categories according to their museumness (yes/high, maybe/medium, no/low).

These findings imply that the design of a 'fun' activity in a historical or archaeological museum will at least surprise the visitor, or some visitors might see it as inappropriate. In the same way, institutions with low degrees of museumness require the implementation of entertaining and/or edutaining applications in their premises (physical or online). More specifically, the focus of technology in a zoo and an aquarium should be primarily on entertainment, secondly on learning, and thirdly on socialisation. In children's museums, people expect primarily entertainment, secondly socialisation and lastly learning. Art galleries and historical museums

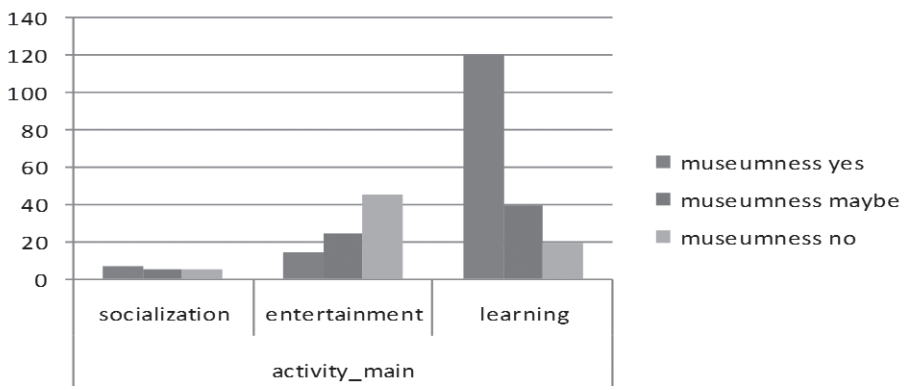


**Figure 2. Degree of museumness and expected main activity[23].**

demonstrate similar characteristics when it comes to activity expectations. In both these museum types, people expect to learn first, socialise next, while entertainment is not considered necessary. Due to their high scores on the museumness scale, museums like archaeological, industrial, science and technology require applications that enhance learning mainly and then entertainment and socialisation. The museumness scale is particularly helpful in showing the desired focus of technology for museum use, according to user expectations, thus assisting the designer to decide whether her application will be strictly educational, edutaining, collaborative and/ or allowing communication of users.

### 3.2 Support for Museum Needs

Literature reviews[32-35] reveal that museums around the world employ technology in order to address needs of the users. Online exhibitions should consider those needs and attempt to support them. Some of the recurring themes in the technologies used by many museums are the need to support:

(a) *A specific population (children)* - For example, 'Rhodes Hall' was an online hypermedia system that used pedagogical principles of 'Constructionism and Problem-Based Learning' to assist the learning process of school students before and after their visit in a historic home. The system was designed for the special needs of a specific population[36].

(b) *Navigation and mobility of users both physically and online (i.e., museum web-pages showing different routes)* - To support both visitor navigation and mobility, 'City' was developed, that combined hypermedia technology and virtual environments. The application was designed for on site as well as off site visitors. On site visitors were equipped with a hand held, PDA device that supported their physical movement, whereas off site visitors could either use a web-only environment or a virtual environment[37].

(c) *Interactivity (need to define the degree of interactivity with the online exhibits)* - An example of an interactive system is 'ARCO' (Augmented Representation of Cultural Objects) that provided a set of tools for the creation of Virtual Reality and Mixed Reality exhibitions. The system's virtual reality components supported distant visitors, since it was also web-based. The system's mixed reality components supported visitor interaction with the virtual and the real world simultaneously[38].

(d) *Adaptivity (need for personalised content though adaptive or adaptable applications)* - 'AHA' (Adaptive Hypermedia Architecture) was a web-based adaptive hypermedia system that identified different visitor needs and adapted the presented content accordingly[39].

(e) *Communication (socialisation and communication are some of the most important expected activities)* - The above mentioned 'City' project also allowed the communication and social interaction of visitors, since co-visiting between on site and off site visitors was possible. The communication between the participants was mainly verbal[37].

| Museum needs | Issues to consider | Who is involved |
|---|---|---|
| **Audience** | Who are my users or target groups? | Museologists |
| | What are the characteristics of my audience? | Educators |
| **Navigation - Mobility** | Apart from the online usability demands for navigation, will I support onsite navigation though my online application? | Museologists; educators; technology experts |
| | Can I support the mobility in the physical space with the help of the online environment? | Technology experts |
| **Interactivity** | What is the degree of interactivity I will provide to the user? (i.e. Can she enlarge, rotate, etc. the exhibits?) | Museologists; technology experts; educators |
| **Adaptivity** | Will my online application adapt to the unique learning characteristics of user? | Museologists; educators |
| | Will this adaptation process be continued to the premises of the museum? | Museologists; educators |
| **Communication** | Shall I allow communication of the users? | Museologists; educators |
| | What will be the form of this communication? (synchronous, asynchronous, between whom, etc.) | Museologists; technology experts; educators |
| **Collaboration** | Should I provide collaborative tasks for the users? | Museologists; educators |
| | Should I incorporate other needs, like collaborative tasks for specific populations, or adaptive collaborative tasks, etc.? | Museologists; educators |
| | What will be the form of the collaborative tasks? | Museologists; technology experts; educators |

(f) *Collaboration (Recognising two important issues)*: (i) technology could be isolating, and (ii)people rarely prefer to visit museums alone, which led to the development of museum applications that enhance cooperation/collaboration of visitors.

The 'Rhodes Hall' application, described above, supported the collaboration between the students in order to facilitate learning and problem solving[36].

The identification of these needs will hopefully lead to the explicit recognition of the issues by the designer and enable the dialogue between the design team and the museum. Table 2 summarises the museum needs relevant to the design of online exhibitions, and the issues to be considered for each need. For each need, the table also lists the expertise of people who should be involved in the decision-making process.

team can view 'NICE' a system that employed several principles of collaborative learning and on the same time it also supported several museum needs, like audience, interactivity, communication, etc.[41].

Similarly, 'Mystery in the Museum' also used the theory of Collaborative Learning, but it supported different museum needs, like mobility[42]. Employing a classification scheme of educational theories and educational technologies in museums, offers the design team a concise view of current tendencies, common practices and possible research gaps.

Furthermore, understanding issues of educational theory and learning practice is directly relevant to the design process for two main reasons:

(i) There are cases that the museum knows what will be presented but has not decided on how it will be presented, and

**Table 2. Museum needs and issues to consider**

| Nature of truth | Schools of thought | Learning theories-models | Educational goal |
|---|---|---|---|
| **Empiricism, Realism** (single truth) | Behaviourism | Classical conditioning | Effective transmission of knowledge (i.e. mathematical axioms) |
| | | Operant conditioning | |
| | Cognitivism | Cognitive schemas and models | |
| | | Enaction theory | |
| | Developmentalism | Stage theories | |
| | | Mediation model | |
| | | Sociocultural theory | |
| | | Activity theory | |
| | Computationalism | Artificial intelligence | |
| **Relativism** (multiple truths) | Constructivism | Problem-based learning | Providing tools for the discovery of own truth and the creation of meaning (i.e. interpretation of history) |
| | Constructionism | Situated learning | |
| | | Cooperative learning | |
| | | Conversation learning | |

### 3.3 Optimal Educational Approach for Purposes

The team designing an online exhibition should also take into account the different learning theories and their outcomes. For this reason, one employ a classification of different educational theories, showing their basic principles, outcomes, relation to technology and examples of educational technologies that use them; such classifications are described by Antoniou & Lepouras[40,32]. For example, wishing to develop an application that supports communication and collaboration of visitors, the design team can easily refer to the classification to determine:

(a) What are the main principles and the scientific background of collaborative learning,

(b) Which previous applications have been used for collaborative learning in museums, and

(c) How it was utilised. For example, the design

(ii) There are cases that the museum has made clear choice on both the what and the how of learning, and the designers need to quickly and effectively understand the concepts involved, in order to specify in detail the relevant solutions.

Educational theories often follow specific philosophical and/or epistemological schools of thought, and they set trends for the educational systems. These are distinguished from learning theories, since the latter are more specified descriptions and predictions of the learning processes within certain educational systems. It is beyond the scope of the present work to elaborate further on issues of educational and learning theory. Here the main point is that all educational theories have a core epistemology they follow, thus shaping the different educational goals. Table 3 lists some of the major educational theories and their relation to epistemology, and specific educational goals.

In addition, all theories seem to have some

**Table 3. Quick organisation of educational and learning theories[44]**

| Nature of truth | Schools of thought | Learning theories-Models | Educational goal |
|---|---|---|---|
| **Empiricism, Realism** (single truth) | Behaviourism | Classical conditioning | Effective transmission of knowledge (i.e., mathematical axioms) |
| | | Operant conditioning | |
| | Cognitivism | Cognitive schemas and ,models | |
| | | Enaction theory | |
| | Developmentalism | Stage theories | |
| | | Mediation model | |
| | | Sociocultural theory | |
| | | Activity theory | |
| | Computationalism | Artificial intelligence | |
| **Relativism** (multiple truths) | Constructivism | Problem-based learning | Providing tools for the discovery of own truth and the creation of meaning (i.e., interpretation of history) |
| | | Situated learning | |
| | Constructionism | Cooperative learning | |
| | | Conversation learning | |

advantages and disadvantages. There are certain aspects of learning that one theory could explain and predict better than another. A designer could use elements from different theories and integrate them in order to support design. According to Mergel[43] different theories could be used for different learning situations. For example, behaviourist principles could be useful in memorisation tasks, cognitive elements in tasks of schematic organisation and constructive principles in complex problem solving. Future studies could identify different stages in learning and propose the most suitable learning practices for each purpose.

Table 3 summarises the described information in a concise and comprehensible manner. By allowing the design team to easily view some important theories and associate each one with its corresponding epistemological origins and educational goals, it assists the design team in the process of selecting the most prominent one for application in the design of the online exhibition.

### 3.4 Relevance of Life-long Learning

Different social and economic factors have made life-long learning a reality. Viewing museums as educational institutions implies that museum learning could include anything from informal learning, to non-formal (i.e., seminars, school trips) and formal learning (i.e., museum-issued diplomas)[44]. The content of any technology designed for online exhibitions should consider issues of life-long learning, to cover the different possible educational situations that might emerge. Moreover, having reviewed visitor studies literature[5,26], four major types of visitors are identified:

(a) Individuals that visit alone,

(b) Groups,

(c) Families, and

(d) Schools.

All the above types have unique learning needs and their behaviour in a museum differs significantly[5]. Information selection and presentation should be adapted to their specific learning demands. In addition, considering issues of life-long learning[45,46], we propose the use of the seven categories/scenarios for the initial stages of the design of online learning technologies for museum use (Table 4). These scenarios assist in the decision for the appropriate learning content for each circumstance. Note that edutainment activities are included in learning activities, in the informal learning condition; however, this depends on the degree of museumness of the

**Table 4. Learning content and life-long lLearning in online exhibitions**

| | Individuals | Families | Schools | Groups |
|---|---|---|---|---|
| **Formal education** | Set curriculum | No existing scenario | Set curriculum-cooperative learning | No existing scenario |
| **Non-formal education** | Negotiated curriculum | No existing scenario | No existing scenario | Negotiated curriculum–cooperative learning |
| **Informal education** | Different learning tasks – edutainment | Different cooperative learning tasks – edutainment | No existing scenario | Different (cooperative) learning tasks – edutainment |

specific museum.

### 3.5 Adaptivity

Adaptivity is an important museum need that should be considered in the process of designing online exhibitions. Once it is decided to use adaptivity, individual learning characteristics, like learning styles, cognitive styles, type of intelligence, approaches to learning, motivation type, etc., have to be considered. Works that are related to different individual learning characteristics, particularly those focusing on the study of cognitive style[47] could be valuable tools at this stage. Among other possible learning factors (i.e., learning style, intelligence type, etc.) we focus on cognitive style, because previous research has shown that it is appropriate for use in the design of learning technology[48] and online learning technologies, since it is a rather constant personality characteristic. Cognitive style describes the preferred and optimal way an individual approaches to learning material. For example, some users might prefer to view more text, whereas others might prefer pictures or sound.

In an online environment a simple and quick questionnaire can reveal the user's cognitive style, when the user first uses the application, together with other factors that affect learning like age, gender, cultural background, etc. Previous research has shown that different cognitive styles have significantly different learning interests, different needs and content preferences, as well as different degrees of desired adaptivity.

Briefly, some people prefer to control the application more than others that seem to accept recommendations more easily. For the former users are suggested adaptable solutions (i.e., solutions where the user can explicitly customise the system behaviour), while for the latter adaptive solutions are proposed (i.e., solutions where the system observes the interaction with the user and tailors itself accordingly with no explicit actions being needed on behalf of the user). Different cognitive styles highly correlate with the amount of control provided by the application; by conducting statistical confidence tests on the results of questionnaires collected from four museums, it is found that the hypothesis "There would not be any differences between the visitors style and the desired amount of control" is rejected with very high confidence[23].

It is also found that different cognitive styles have different content preferences. This finding has direct implications for the organisation and the presentation of the online museum content. For example, the flexibility provided by online exhibitions allows for the presentation of different exhibitions to the user (i.e., some users might be interested in history, aesthetics, uniqueness of objects, etc.) depending on to the individual interests[3].

In addition, interestingly enough, cognitive style correlates with different nationalities, having remarkable design implications[4]. Another rather expected result is the high correlation found between cognitive style and age[5], since it is known that although cognitive style is a relatively constant personality characteristic, it is however, affected by age. In Antoniou & Lepouras[32] a full list of guidelines is provided for the use of cognitive style in museum adaptive learning technologies. Furthermore, previous research has provided a list of guidelines for the accommodation of all cognitive styles in the design of adaptable learning technologies[49,50]. For example, cognitive styles seem to differ in regards to preferences in: bottom-up or top-down presentations, facts and examples or symbols and abstraction, individual learning or group learning, structured material or less structured and affective learning, linearity or non-linearity of presentations, etc.

### 3.6 User Involvement

Involving the user can have multiple dimensions, like concept generation, identification of user requirements and usability demands or evaluation of the end product. Although time and cost restrictions might apply, it is a good idea to involve the potential users in the design processes from the early stages of development. Previous research has shown that even quick ethnographic techniques that collect qualitative data in a short period of time can be very useful[51]. It was also found that even children can effectively participate in the design processes of museum related technologies, making participatory design techniques a valuable tool[51-53]. The potential benefits of the early involvement of users, require the development of techniques for collaborative design. An online environment can also allow for the use of online focus groups or the use of a discussion forum. In this, it is important to consider the creation of an online space that users can contribute with new ideas and evaluate the existing practices.

## 4. CONCLUSIONS AND FUTURE WORK

Users of an online exhibition have a triple role. They are technology user, with certain usability demands, but also learners and museum audience with specific learning and museum needs. All three roles have discrete characteristics and requirements. It is important to consider all three different roles both separately and in relation to each other. The proposed methodology aims at assisting the designers in considering all user roles and pertinent aspects and eases the decision processes they have to make, in regards to technology in itself, learning content, presentation style, etc. Table 5 provides the suggested methodology, the steps that one has to follow for the design of online exhibitions and

**Table 5. Methodology questions and relevant procedures**

| Questions | Procedure |
|---|---|
| 1. What is the degree of museumness for the specific exhibition? | Assess the perceived degree of museumness of the specific museum and determine the main visitor activity (i.e. learning, socialisation, entertainment) |
| 2. Which museum needs will I support? | Identify needs to be supported (audience, mobility, interactivity, adaptivity, communication, cooperation/collaboration) |
| 3. What is the optimal educational aroach for my purposes? | Use the classification of educational theories to determine which best fits the museum needs you wish to support |
| 4. Is life-long learning relevant? | Consider issues of life-long learning and the different scenarios that apply in the different learning situations and determine the appropriate learning content for each one |
| 5. Will it be adaptive? | Consider issues of individual learning characteristics and use suitable guidelines |
| 6. How can I involve the user? | Use a quick method to involve visitors in design and elicit user requirements |

suggested procedures for realising each step.

An extensive evaluation of the proposed methodology has not been conducted; however, the methodology has been applied to a limited number of cases, with very promising results. A more extensive evaluation is scheduled with diverse museum types and museum needs. Assessment of learning outcomes in each case will also be performed. For further assisting museums to proceed from exhibition design to exhibition implementation, compilation of a guide on which current technologies are prominent for each design parameter, e.g., which technologies can be employed to deliver the desired level of adaptability are being planned.

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