Beneficial Learning Observation of a Virtual Museum for Ancient History

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Abstract. For a long time, cultural heritage has been preserved in archiving institutions such as museums, libraries, galleries, and restoration laboratories, resulting in access and review limitations. Digital technologies are introducing new solutions for documentation, maintenance and distribution of this valuable treasure. Among these new technologies are virtual museums, which have already proven their worth as a contemporary solution for attractive presentation of cultural archives. This article aims to present an innovative virtual museum, managing diverse collections of digital objects, organized in various ways by a complex specialized functionality. We focus on tools for improved content observation and enhanced learning experience, giving new solutions for effective use of virtual museum content for learning purposes.

Keywords: Ancient History; Learning Experience; Personalization; Virtual Museum.

1 Introduction

The new technologies provide advanced services to contemporary virtual museums (VM), transforming their static multicomponent structures into an environment with a dynamic federation of functional units. These changes emanate from the needs of the market, the emergence of new technologies, and especially from the requests for wider use of the museum resources and adapting these systems to the needs of different user groups.

Some key research questions, raised during the design and the development of VM systems mainly in the context of their use in education, are:

- How to present the resources in a given learning context, determining proper use cases, cognitive or clear educational goals, creative use, *etc.*?
- How to help the user not only to explore the content, but also to gain valuable knowledge?

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- How to adapt the information content for each individual user or group in order to achieve their learning goals, tasks and interests?
- How to provide knowledge in the most suitable way and form?

How to choose suitable resources for a specific situation and the method of introduction to the domain, which is a subject to research, *etc.*?

The difficulties in solving these research issues are related to the lack of working solutions regarding the basic and the extended functionality, and synchronizing the solutions with the existing standards and regulations in the e-learning field; the provision of tools for learning analysis, understanding and better interpretation of digital cultural content; the context-dependent use of digital cultural resources; contextual techniques for personalizing visitor experience, the increase and generalisation of visitor experience, of digital cultural content; the context-dependent use of digital cultural resources; contextual techniques for personalizing visitor experience, the increase and generalisation of visitor experience*, etc.* (Paneva-Marinova & Pavlov, 2018).

This paper aims to demonstrate some solutions for effective use of virtual museum content for learning purposes through services for improved content observation and enhanced learning experience. The main factors related to the VMs user experience and content usability issues are considered. The users' cognitive needs, goals, preferences, and interests have been carefully studied and become the starting point for the new functionality. The paper explores services for improved content observation and enhanced learning experience, which could be applied in a virtual museum. Special attention is paid on the personalized content usage in the VM environment.

2 Virtual Museum

The virtual museum mainly contains service panels for *Museum content management, Museum content presentation, Administrative services* (see Fig. 1.), integrated with a *Media repository* and a *User data repository* (Paneva-Marinova, Stoikov, Goynov, Luchev, Pavlov & Pavlova, 2019).

The *Museum content management* module refers to basic content creation tasks: add (annotation and semantic indexing), store, edit, preview, delete, group, and manage multimedia digital objects; manage metadata; search, access, select (filter) and browse digital objects.

The *Museum content presentation* module supports objects and collections display. It also provides collection creation (incl. search, select/browse and group digital objects according to different criteria and/or context of usage), collection metadata/semantic descriptions, status of collection display, and attractive visualization.

The content presentation module provides access to all virtual museum services through a wide range of contemporary technologies and devices – not only desktop PCs, but mobile phones, tablets, TVs, VR devices, *etc.* Interactive media technologies are used to provide the best user experience within the content of the virtual museum.

The *Administrative services* panel mainly provides user data management, data export, tracking and analysis services.

For every object the media files and objects' metadata (semantic and technical) are saved in the *Media repository*. These metadata are represented in catalogue records that point to the original media file(s) associated with every object.

The *User profile repository* manages all user data and their changes. It also records all user requests for new content tracking individual search and preview.

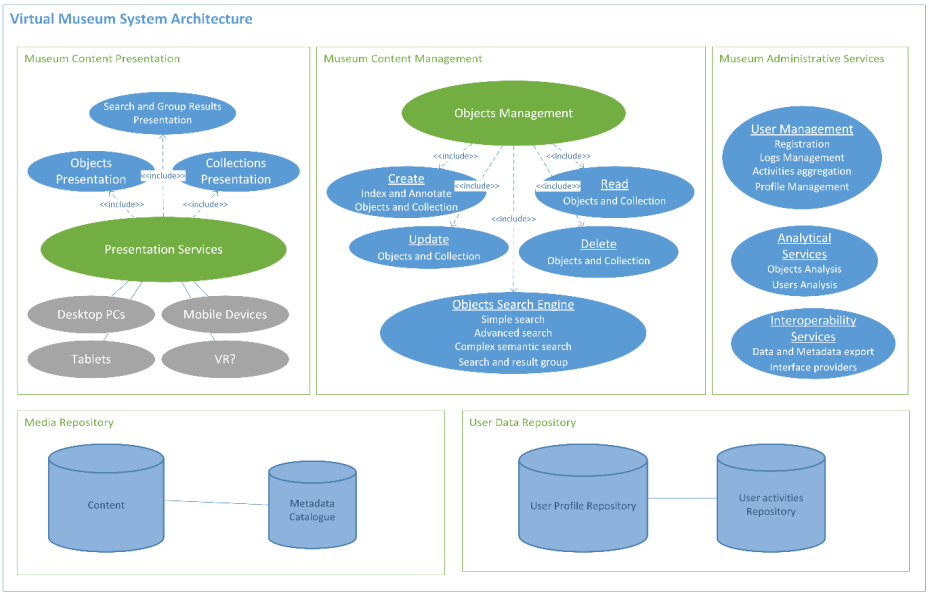

Fig. 1. VM architecture

3 User Experience and Content Usability Issues

When the virtual museum is "visited" by a user who has learning purposes in the environment (*viz*. learner, student, *etc.*), "one size fits all" solutions are not enough to satisfy his/her needs. Different learners have different learning needs and preferences that (should) affect the learning function outcome. They expect from the system a "personal facilitator" and not a "classroom" behaviour, where their personality and needs are known and taken into account. Based on L. Cronbach, and R. Snow (Cronbach, & Snow, 1997), in learning context, personalization is most generally defined as an adaptation of the learning process and its content to the personal characteristics and preferences of the learner, as much as possible.

There are several benefits of thinking about and trying to understand learning preferences (n.d., Centre-Student-Development):

- Students learn most effectively when the strategies used are closely matched with their preferred learning style.
- Students can potentially improve their learning by knowing what their strengths are and then doing more of what they are good at.

- Consequently, students can improve their learning by knowing what their weakness are and trying to enhance their skills in these areas.
- Different situations and learning environments require different learning strategies, so it's best to have a large repertoire from which to draw.

P. Arapi, et al. (Arapi, Moumoutzis, Mylonakis, Stylianakis, Theodorakis, & Christodoulakis, 2008) explore which are these educational needs and preferences that essentially should be considered as input parameters in personalization processes and what is their role in the construction of a learning plan and the selection of appropriate learning resources. Consequently, they identify and analyse a number of factors that can influence the extent and outcome of learning such as the learning style, learner goals/objectives, previous knowledge, educational level and difficulty, technical and other preferences (*e.g.* language*, etc.*).

The paper's authors research practices point to different factors that should affect even more the learning activities and selection and usage of the VM content for learning, such as:

- The space in which learning takes place, its aesthetics and mood, user interfaces, visual elements, input devices, interaction with other learners or mentors, possibility of dynamic changing of the learning place, even its realism.
- Interactivity and the learner immersion in the learning place.
- The "interplay" between the learner and the learning narrative or the learning place as a whole.
- The learnativity content model - the concept of assembling content into higher-level objects, as it is defined by E. Wagner (Wagner, 2002).
- The set of challenges the learner will face within the learning space and synchronization of the challenges with the ability of the learner.
- Maintaining the learning interest by implementation of multiple difficulty settings for the different learners, and the use of non-trivial learning objects – applied games, puzzles, stories, conundrums, *etc.*
- Transforming the learning activities traditionally thought as "boring" into more attractive and "fun" tasks, thus improving the quality of the learner experience – whether the learner enjoys working with the e-system, or whether they find it frustrating.
- Setting awards for the efforts – reward the learners for skill, imagination, intelligence and dedication.
- Enhancing the motivation by encouragement, diversity, and extended curiosity.
- Eventually, conscious awareness of the learning as a key engine for future success.

Additionally, the provision of creative experiences, learning-by-doing and role-playing scenarios are also worth mentioning.

Moreover, a key factor is the proper learner model definition: the "who", or the degree of specialization in defining who is modelled and what the learner history is; the "what", or the cognitive goals, plans, attitudes, capabilities, knowledge, and beliefs of the learner; the "how", or the model to be acquired and maintained; and the "why", or considering whether to elicit information from the learner, give assistance, provide feedback, or interpret the learner's behaviour (Paneva, 2006). J. Callan et al. (Callan, J., Smeaton, A., Beaulieu, M., Borlund, P., Brusilovsky, P., Chalmers,. . . Toms, 2003)

comment that the user models should take into account also the overall information space – the context – including:

- Cognitive abilities, e.g. learning styles, perception.
- Individual differences, e.g. experience, education, age, gender.
- Individual and group behaviour patterns and history.
- Subject domains.
- Work tasks, e.g. writing an essay, choosing a movie, planning a holiday.
- Work environments, and
- How all of the above change over time.

Callan et al. emphasize on investigating methods for building more robust, flexible and portable models of the complexity of users, tasks and contexts to inform the diverse possibilities for personalization (Callan, J., Smeaton, A., Beaulieu, M., Borlund, P., Brusilovsky, P., Chalmers,. . . Toms, 2003). Targets for this work include the ability to develop implicit rather than explicit methods for learning user preferences, which form the user models, and the development of user models that are portable across applications, devices and systems. Perhaps the biggest challenge in this area will involve the development of user models that will drive personalisation and recommender systems, that are rich enough to capture as much of the user's task environment (context, task, situation), history, contribution to communities and individual preferences, as possible while conforming to personal privacy choices.

Major problems appear during the design of the software solutions (services, components, *etc.*), closely capturing the factors discussed above. Some of them concern the communication between the user and the software environment, which is in many cases ambiguous and even unsuited. Other are related to the formal presentation of the subjective issues such as learner's skill, imagination, motivation, intelligence, dedication, *etc.* Furthermore, in order to provide effective forms of personalized learner experiences, the focus must be on the design of the interaction *per se* as an integral part of the whole system. There is a need to develop multi-modal mixed initiative interfaces that draw on a range of user information seeking models. The requirement is, thus, for research to develop theories of interaction which underpin the design of applications and vice versa, and which go beyond issues of simple elicitation, presentation and feedback (Paneva-Marinova, D., Stoikov, J., Pavlova, L., & Luchev, 2019; Bogdanova, Todorov, Noev, 2019).

4 Services for Improved VM Content Observation and Enhanced Learning Experience

A very important future trend is that any learning content from any source (virtual museum, digital libraries and repositories with digital objects, knowledge grids, *etc.*) will be available anywhere at any time – via natural interaction – on any interactive learning platform, in any format desired by the user, which implies that a specific attention should be paid to services for learning content delivery, creation (production), adaptation, personalization, storage, *etc.* In a society where content on demand is available everywhere from any provider, finding appropriate learning content for the user needs

(discovery) becomes crucial. Discovery can be both of specific pieces of content and of packages of related content. The discovery engine should have at least some level of intelligence, remembering previous choices made and evoking that information to refine new searches. The standard, current use of discovery is for a search to be conducted, followed by the subsequent download of the information required. This is the way most people expect discovery to be used, neglecting sometimes that this leads to an unnecessary overestimation of the users' ability to choose the ultimate search terms. An alternative view is that the VM search service could be based on examples or it can rely on searches user(s) made previously (possibly based on a profile that could be stored in the network or in the learning platform, or aggregating the search behaviour of multiple users.

The mission of VM developers should be to facilitate *the production of new audio-visual content* that take maximum advantage of the new technological capabilities. Thus, we view interactive learning content as the most important element of content production. Learning content will request contributions from individuals, and individuals will wish to personalize and adapt content to their needs. The main requirement is the implementation of more economical and more intuitive user-friendly tools for content production. It is therefore essential that content developers have better access to technology that enable content creation and implicitly opens the way to distribution channels.

Content adaptation is the ability to tailor content to the current learning state of the user. Content adaptation is related to content personalization, which is aimed at accommodating content semantically to the user's requirement. Currently, very little content adaptation is offered by the digital environments. Some features are supplied in the field of media adaptation, but this adaptation is often basic. Several international research efforts are focused on the design and implementation of middleware infrastructures for content adaptation. While most of those proposals tend to adopt an adaptation approach based on static content selection, some research activities have already addressed real-time content production, and only a few research efforts consider dynamic binding of resources and service components. Still, there is huge potential to achieve autonomous on-the-fly adaptation, with little or no human intervention. Adapters should be capable of self-description, and a pervasive support infrastructure should take the appropriate context-based adaptation decisions, without affecting the design and implementation of multimedia servers and client applications.

Content personalization is the ability to adjust the content to the user's preferences as well as the usage context. Personalization is a means of meeting the user's demands more effectively and efficiently by making interactions faster and easier. Furthermore, content personalization is closely related to knowledge management, data mining, and learning objects annotation and indexing.

User experience personalization will be effective when the users receive highly relevant content available exactly when they want – any type of media available at any time and in the most efficient way.

This 'context awareness' is much more than location awareness alone, or merely the immediate situation. We suggest a middleware infrastructure capable of collecting all

context metadata from clients, servers, involved resources and the environment in general, and transparently deciding the most appropriate content customization operations, with no impact at all on the design and implementation of multimedia clients/servers.

A very important objective in the field of personalization is the development of a system that is aware of the user's situation. Such a system will interpret the contextual information considering preferences previously declared by the user or choices previously made to supply appropriate 'tagged and targeted content'.

A support service infrastructure should be able to properly aggregate data about the context, in order to distil a context view at the proper level of abstraction depending on who/what is in charge of taking decisions on the basis of that view. Sometimes, those context data should be migrated, possibly proactively, with the learner they apply to, depending on user movements during the service session (Pavlov, R., Paneva, D., Moumoutzis, N., Arapi, P., Ovcin, E., Morrone, G., & Markus, 2007).

5 Conclusions

Further investigations in the above-discussed domain point to a wide variety of directions:

- Creation of workable methods and tools, aiming to increase and generalize the visitor experience in the virtual museum. Moreover, creative user experiences will support the effective on-line learning through VMs.
- Contextual techniques for personalizing the experience in these platforms.
- Development of new digital and transmedia storytelling solutions for learning purposes, creation of interactive virtual exhibitions, gaming and gamification, virtual worlds, live simulations, animations, interactive media previews.
- Multimodal interfaces and intelligent visualization of complex information relying on enhanced user experience and usability (incl. user-centric visualization and analytics, real-time adaptable and interactive visualization, real-time and collaborative 3D visualization, dynamic clustering of information, *etc.*), *etc.*

Furthermore, the design and improvement of the learner experience would not be restricted by the available technologies, platforms and tools. The field has great potential for innovations especially in the current situation of active imposition of e-devices, e-literacy, and e-content. The focus will be in the research and exploitation of new or emerging technologies (e.g. 3D, augmented and virtual reality, visual computing, smart world, environments and devices, media convergence, social media, *etc.*) for the development of innovative products, tools, applications, and services for creative digital content production, usage and management. The aims are to transform and customize the valuable parts of mankind's cultural and historical ancestry into digital assets, whose integration and reuse through research-lead methods has high commercial and non-commercial potential for learning and cultural institutions, tourism, creative and media industries.

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