

Maristella Agosti · Nicola Orio · Chiara Ponchia

# Promoting user engagement with digital cultural heritage collections

Submitted: ... 2016 / Received: date / Revised version: date

**Abstract** In the context of cooperating in a project whose central aim has been the production of a corpus agnostic research environment supporting access to and exploitation of digital cultural heritage collections, we have worked towards promoting user engagement with the collections. The aim of this paper is to present the methods and the solutions that have been envisaged and implemented to engage a diversified range of users with digital collections. Innovative solutions to stimulate and enhance user engagement have been achieved through a sustained and broad-based involvement of different cohorts of users. In particular, we propose the use of narratives to support and guide users within the collection and present them the main available tools. In moving beyond the specialized, search-based, and stereotyped norm, the environment that we have contributed to developing offers a new approach for accessing and interacting with cultural heritage collections. It shows the value of an adaptive interface that dynamically responds to support the user, whatever his or her level of experience with digital environments or familiarity with the content may be.

---

## 1 Introduction and motivations

Throughout their history, cultural heritage institutions have had two central purposes. They have been charged

---

M. Agosti  
Department of Information Engineering – University of Padua  
Via Gradenigo 6/a – 35131 Padova (PD) – Italy  
E-mail: maristella.agosti@unipd.it

N. Orio  
Department of Cultural Heritage – University of Padua  
Piazza Capitaniato 7 – 35139 Padova (PD) – Italy  
E-mail: nicola.orio@unipd.it

C. Ponchia  
Department of Cultural Heritage – University of Padua  
Piazza Capitaniato 7 – 35139 Padova (PD) – Italy  
E-mail: chiara.ponchia@unipd.it

firstly with preserving artefacts of cultural significance, and secondly with describing and cataloguing these artefacts in a way that makes them accessible to a variety of audiences, from experienced researchers to members of the general public [1]. While the discharge of these roles is not without its challenges, and while the requirements of preservation and access often stand diametrically opposed to each other, the stable and long-established role of traditional cultural institutions means that there is general agreement on the responsibilities of institutions, the processes and procedures by which their work is carried out, and an established statutory and legislative basis for their work.

The advent of the widespread digitization of cultural heritage collections has significant implications for the institutions that hold them. The twin purposes of such institutions have continued to be important – the drive to digitize material of historical and cultural significance has largely been underpinned by the twin concerns of conservation and access. The imperative to preserve unique and delicate resources by producing digital surrogates has been, and continues to be, a major motivation for digitization projects. Important though preservation undoubtedly is, access is more important still. Indeed, the act of conservation implies a need for access – we may access material that we do not bother to preserve, but we do not, in a world of limited and diminishing resources, preserve what we do not wish to access.

Both digital preservation and access present challenges for owners of cultural heritage collections. Typically, the problems associated with preservation are related to technology, in particular to the ageing of hardware equipment and to the evolution of file formats. By contrast, the issues that surround access are more complex and far-reaching because they involve users and their engagement. Many of these issues are not unique to digital humanities, or to digital cultural heritage. Questions of *findability* [2] and *retrievability* [3] have relevance to and importance for the field of cultural heritage, just as they have to the wider fields of information retrieval and management.

Cultural heritage, however, raises specific questions about supporting access to cultural heritage collections and individual artefacts. In particular, Koolen et al. [1] highlight some of the key questions: “Can a modern information retrieval system provide effective access to a heterogeneous set of cultural heritage descriptions? Since traditional descriptions cater for professional searchers, is this equally effective for expert searchers and non-expert searchers? Are there ways to preserve the structure of the original descriptions, and can this help to answer complex search requests?”

In addition to these conceptual questions, Borgman outlines a serious infrastructure deficit, which she argues is a major risk factor for the development – and even survival – of digital humanities as a discipline, because most existing digital collections “don’t offer a platform for traditional note taking, much less for larger scale analysis, either quantitative or qualitative . . . [and] which often lack basic capabilities for retrieval or analysis” [4].

To date, the need for access tends to have been mostly handled at the institutional or collection level. This access is most often facilitated through online web interfaces and web applications which allow the collection to be searched and records and resources to be viewed. These interfaces have some limitations, because they tend to be *specialized*, *search-based*, *superficial*, and *stereotyped*. They are specialized because they most commonly handle material from only one collection, or from only one kind of collection. They typically require the user to rely on some – more or less complicated – variety of Boolean search to find the results they need. They are superficial in their presentation of the results – typically as a list of items, without any opportunity for more thorough exploration or discovery. Lastly, they are stereotyped in terms of the sort of user they expect and assist. In essence, they are designed to address the needs of a monolithic user, whose expectations, experience, and interests are rigidly and unalterably defined. By contrast in real-life experience such interfaces are employed by a wide variety of users that need to be properly characterized to foster their engagement.

Providing access to digital cultural heritage collections is essential if cultural institutions are to retain their relevance and usefulness. Moreover, as Borgman has pointed out [4], the ability to access these collections, to work with the data they contain and to use them as the basis for *cultural analytics* [5] are key factors in assisting the development of digital humanities methodologies.

Motivated by these concepts, we have worked towards promoting user engagement with digital cultural heritage collections for the benefit of a wide and diversified spectrum of users. The research work has been carried out in the context of cooperating in the CULTURA project<sup>1</sup>, whose central aim has been the production of a corpus

agnostic research environment supporting access to and exploitation of digital cultural heritage collections.

The aim of this paper is to share and discuss the methods and solutions that have been envisaged and implemented to engage a diversified range of users with digital cultural heritage collections, focusing in particular on a collection of illuminated manuscripts called IPSA. To achieve this aim, the paper is organized as follows: Section 2 briefly describes the CULTURA project with a particular focus on the IPSA collection. Section 3 reports on pertinent related work. The participation of different types of users was facilitated by a diversified range of user studies and evaluations, which are reported in Section 4. The use of narratives as novel tools that we have introduced in the environment to engage the different types of users are illustrated in Section 5. Lastly, Section 6 gives some final conclusions.

---

## 2 The CULTURA project and the IPSA collection

The main goal of CULTURA, a European project cofunded under the 7th Framework Programme which ran from 2011 to 2014, was to increase user engagement with digital cultural heritage collections through the development of a new adaptive and dynamic environment and specifically developed tools. The CULTURA consortium had a strong emphasis on meeting real end-user needs, maximizing societal impact and laying a foundation for successful commercialization. To this end, the environment went beyond the traditional search-based exploration by providing natural language processing technologies, entity-oriented search and a comprehensive set of logging, bookmarking, and annotating tools that make it a powerful aid to both extensive and intensive work on content collections [6, 7].

For the validation of the project, two pre-existing cultural heritage collections were used: the *1641 Depositions* and *IPSA*. The *1641 Depositions* is a collection of accounts by victims of the Irish Rebellion of 1641 studied by a research group from the Trinity College Dublin. It is a textual corpus that has been augmented by manually generated metadata<sup>2</sup>. *IPSA* is a collection of illuminated scientific manuscripts (including herbals and astronomical-astrological codices), mainly developed by a team of researchers at the University of Padua, which is a purely visual collection with extensive metadata<sup>3</sup>. The two collections, with their different and complementary natures, textual and visual, appeared to be perfect to gather a wide range of user needs, thus effectively supporting the implementation of a corpus agnostic research environment.

In [8] we have already reported the evaluation of the environment as a whole, while in this paper we report

---

<sup>1</sup> <http://www.cultura-strep.eu/>

<sup>2</sup> <http://1641.tcd.ie/>

<sup>3</sup> <http://ipsa.dei.unipd.it/>

on and discuss how the tools developed within the CULTURA project have been applied to the access of illuminated manuscripts of the IPSA collection, the one we used to contribute to the project.

An illuminated manuscript can be a book or document written by hand rather than typed or printed. Each page of a manuscript can be constituted by different types of information, including: pure handwritten text, one or more images without text, or by a combination of one or more images with handwritten text, as in Figure 1 where sample images of the IPSA digital archive are shown.

The IPSA digital archive is constituted by illuminated images taken from manuscripts, which were produced mainly in Padua and the Veneto region during the XIV and XV centuries. IPSA includes 56 manuscripts that now belong to some of the most important libraries in Europe and the world, including: the British Library<sup>4</sup>, the Bodleian Library<sup>5</sup>, the Pierpont Morgan Library<sup>6</sup>, the Biblioteca Marciana<sup>7</sup>, the Biblioteca Apostolica Vaticana<sup>8</sup>, and the Biblioteca Medicea Laurenziana<sup>9</sup>. Only one manuscript is currently preserved in Padua: the lavishly illuminated Pseudo-Apuleio of the Botanical Garden Library<sup>10</sup>.

All manuscripts included in IPSA are scientific books, of which 46 are astrological and 10 botanical codices. The digital archive includes about 3400 images. The aim of the entire collection is to testify to the shaping of a new scientific outlook in the University of Padua during the XIV century [9]. The collection has been digitized and marked up with key metadata information through the efforts of several research groups. The metadata include information on the content and the provenance of each digital image.

IPSA is not only a digital archive, but also a web-application that enables users to work with images in different ways. It was originally created for professional researchers of History of Art and History of Illumination to allow them to compare the images held in the collection and verify the development and the spread across Europe of a new scientific outlook in the 14th century at the University of Padua and a new realistic way of painting strictly related with the new scientific studies [10]. In order to attract users' attention to such a highly-specialized collection, serious reflection and in-depth research on different types of potential users were required. As a consequence, interaction with final users lasted for the entire project life-cycle in a sort of *closed-loop* evaluation [11], the main outcomes of which are reported in Section 4, and this interaction constitutes the

basis of user engagement with the collection and the environment.

---

### 3 Related work

The term *Digital Cultural Heritage Collections* covers a broad and heterogeneous range of different collections that can vary according to many factors, particularly the typology of the digitized items. This is strictly related to the term *Cultural Heritage* itself, which encompasses several main categories of heritage, such as tangible (e.g. painting, sculptures, coins, manuscripts) and intangible (e.g. traditions, performing arts). Therefore, Digital Cultural Heritage Collections can refer to many different kinds of collections, each of them with its own unique features. The type of content is also related to the available tools that allow users to retrieve, access, study, and annotate the collection. Nonetheless, we restrict our discussion to collections of tangible heritage, with a particular focus on visual content contained in manuscripts and documents, and to tools related to a *storytelling* approach as can be obtained through *narratives*.

#### 3.1 Collections of illuminated manuscripts

The study and analysis of the bibliography on environments where digitized manuscripts and documents and their metadata are made accessible show that they can range between two poles: from environments presenting the collection of a single library or cultural institution to environments of increasing complexity presenting the collection of a network of libraries and/or other cultural institutions. Clearly the complexity of these environments varies according to the amount of digitized material and the number of libraries and cultural institutions contributing to the project: Europeana<sup>11</sup>, which is better introduced later in this section, is the most complex of these environments.

The environments presenting the collection of a single cultural institution are mostly search-based systems which scarcely engage users in interactions more complex than browsing. If we consider on-line catalogues of highly important libraries, for example the catalogue of the illuminated manuscripts of the British Library<sup>12</sup> or the catalogue of the illuminated manuscripts of the Bibliothèque nationale de France<sup>13</sup>, we find that these web-applications allow users to see manuscript reproductions as if they were leafing through the facsimiles, to get some basic information, to download images, but nothing more.

A notable exception is the online open catalogue of an important Italian library, the Biblioteca Malatestiana

---

<sup>4</sup> <http://www.bl.uk/>

<sup>5</sup> <http://www.bodleian.ox.ac.uk/>

<sup>6</sup> <http://www.themorgan.org/>

<sup>7</sup> <http://marciana.venezia.sbn.it/>

<sup>8</sup> <https://www.vatlib.it/>

<sup>9</sup> <http://www.bmlonline.it/en/>

<sup>10</sup> <http://www.bibliorto.cab.unipd.it/>

---

<sup>11</sup> <http://www.europeana.eu/portal/>

<sup>12</sup> <http://www.bl.uk/catalogues/illuminatedmanuscripts/>

<sup>13</sup> <http://mandragore.bnf.fr/html/accueil.html>



Fig. 1 Sample images of the IPSA digital archive

in Cesena<sup>14</sup>. Indeed, the Malatestiana on-line open catalogue<sup>15</sup> presents a number sections [12,13] that, together with the typical ones providing information about the library and access to its search facilities (searches can be done by call number, illuminator, subject, date, and so on), also include the “Contributed bibliography” and the “Building site”. The former enables all registered users to add new bibliography to the manuscript descriptions, thus creating a new record with the related references; the record will become visible to other users after validation by the website administrator. The latter is a virtual space where registered users can contribute to the study of a single manuscript. Up to now two building sites have been created, the first on a IX century manuscript with Isidore of Seville’s *Etymologiae* (ms. S.XXI.5) and the second on a *Gospel Book* dated 1104. The website is available in Italian, English and German.

Environments presenting the collection of a network of different cultural institutions are becoming increasingly relevant, therefore in the following we present three representative examples related to access of digitized illuminated manuscripts.

Firstly we can mention *Enluminures*<sup>16</sup>, the main on-line database of illuminated manuscripts and incunabula held in French municipal libraries [14]. The website offers two kinds of search, the “Guided search” and the “Expert search”. The former presents users with the list of cities that joined the project; if the user clicks on the name of a city, they will be shown the call numbers of all the digitized manuscripts belonging to the libraries of that city. Furthermore, users can conduct a search by manuscript author, manuscript title, illumination typology, illumination title and illumination context. The “Expert search” offers the possibility to perform a key-

word search or a combined search with different criteria: call number, author, manuscripts title, illumination title, earliest chronology, latest chronology; the user can also select additional criteria from a drop-down menu. The web application is enriched by virtual presentations of some of the most beautiful manuscripts from the collection and a selection of illuminations with the same subject, e.g. *war*. The website is available only in French.

Another important project is *Digital Scriptorium*<sup>17</sup>, an image and cataloguing database that brings together the Medieval and Renaissance manuscript holdings of a growing number of international libraries and institutions, mainly North-American [15]. In *Digital Scriptorium* users can perform a basic search, a call number search, or an advanced search. In the advanced search, users can combine different search criteria: call number, author, title, docket, language, provenance, binding, caption, range of dates or single date. In addition, users can tick a *yes/no* radio button answering the following questions: “Dated ms?”, “Document?”, “Figurative decoration?”, and can add the desired country of origin and the current location of the item they are looking for. In addition, users can choose to limit the results to illuminated manuscripts. The website is available only in English.

The *Virtual Manuscript Library of Switzerland*, or simply *e-codices*<sup>18</sup>, also deserves a mention. The aim of *e-codices* is to provide access to all medieval and selected early modern manuscripts of Switzerland via a virtual library [16]. Users can perform a keyword search within the manuscript descriptions, or they can search in the list of the libraries involved in the project, if they already know the call number of the manuscript they are interested in. Once they have clicked on the library name, they will be shown the list of all the digitized manuscripts of that institution. The list of manuscripts presents the

<sup>14</sup> <http://www.malatestiana.it/>

<sup>15</sup> <http://catalogoaperto.malatestiana.it/>

<sup>16</sup> <http://www.enluminures.culture.fr/>

<sup>17</sup> <http://bancroft.berkeley.edu/digitalscriptorium/>

<sup>18</sup> <http://www.e-codices.unifr.ch/>

thumbnail of the first page of each manuscript with a short description; by clicking on the chosen item, the user can access the complete catalogue file of the manuscript and its complete reproduction. What is most remarkable is that *e-codices* provides an annotation tool, available for registered members. Through the annotation tool, users can add annotations or bibliographical references on a particular item, and then comment upon that reference or comment upon another user's comment. The website is available in four languages: German, English, French and Italian.

As mentioned above, Europeana is *par excellence* the most complex example of an environment that provides access to the collections of a network of cultural institutions: Europeana is an online library, museum and archive from across Europe and it provides access to millions of books, paintings, films, museum objects and archive records that have been digitized by more than 3,500 contributing institutions including world-famous national libraries, galleries and museums. At the end of 2014, the Europeana database held more than 36 million metadata records, making available to the public an astounding amount of metadata and digital resources that allow users to explore Europe's cultural and scientific heritage from prehistory onwards [17]; now it is no longer necessary to wait for one Europeana report to know the number of records held in the database, because the number is made available online on the Europeana portal homepage<sup>19</sup> where, for example, on May 2018 the online digital resources – i.e. artworks, artefacts, books, videos and sounds – amounted to 52,133,822.

There are a number of projects that have contributed or are contributing technology solutions to Europeana. This constitutes an added value, as Europeana is fostering different kinds of research to address some of the issues raised by creating and managing such a huge collection, like the need for a single common standard for item cataloguing and metadata interoperability [18]. Other projects aim at increasing Europeana content and increasing user involvement, e.g. the still ongoing Europeana 1914-1918, which aims to collect material related to the Great War, also asks users to add their personal stories<sup>20</sup>.

Clearly, in order to reach the widest possible public, user studies were needed and these used to be commissioned by Europeana to external bodies (such as University College London, England, or the University of Strathclyde, Scotland). One of these studies, presented in [19], is particularly relevant to the present work, because the assessment of the system was carried out by asking the participants to collate a PowerPoint presentation from materials retrieved on Europeana to produce a virtual tour of their city. Such a *storytelling* approach, which envisages the use of short paths or stories to foster

and increase user engagement, could be compared to the one we propose through the use of narratives.

### 3.2 Narratives

The concept of narratives is gaining increasing importance in studies concerning digital libraries and the digital humanities. In general, over the years digital libraries have evolved from monolithic and domain specific systems towards service-oriented architectures to support users of different categories [20] and in this respect narratives can be a useful tool. The term narrative can acquire different meanings according to the various purposes that narratives address or the different ways that narratives can be implemented. In this context, narratives are a means of communicating and sharing interpretations and ideas relating to the content it contains, and may also be contextualized with related and background information to further aid exploration away from the path, or off the beaten track. In this subsection we present some selected examples of narratives employed in environments with cultural heritage collections, highlighting their particular features.

First of all, narratives can be used to present historical events – quite a logical choice deriving from the structure of history as a succession of events. A valuable example can be found in [21] where the authors present a model which allows representation of multiple narratives related to World War I. The narratives present historical events, but they do not present different opinions about the causality of those events, even though the related history is controversial and different authors may wish to express different opinions about it. So end-users are presented with a succession of facts on a specific historical event, but they are not provided with a critical interpretation by domain professional users.

In “The First World War Poetry Digital Archive” project [22] paths have been incorporated as a primary aid for learning and navigation. In particular, users are offered written tutorials on the main subjects of the collections, e.g. *An Introduction to WWI Poetry*, but the most relevant aspect is that users are invited to create their own path using a *path creation tool*. So while users are helped in the learning process by tutorials created by expert users, they are also prompted to interact creatively with the collection.

The *PATHS* project has been devoted to the problem of supporting end-user access to large digital libraries of cultural heritage collections [23]. The *PATHS* project developed a novel interface for cultural heritage collections aiming at supporting information exploration, discovery and use through a variety of visualization modes, especially the interaction system called *path*. In [24] paths are defined as “a device for ordering, connecting and annotating a series of items of interest that have been collected in a cultural heritage digital library collection”.

<sup>19</sup> <https://www.europeana.eu/portal/en/>

<sup>20</sup> <http://www.europeana1914-1918.eu/>

Alternative approaches have been reported in the literature to help users create and access narratives for cultural heritage applications: these include combining temporal and spatial information [25] narratives or promoting the interaction of museum visitors among each other [26] or with the artefacts [27].

The temporal and economic effort of narrative creation has been addressed as well. The *Instant Multimedia* [28] is an easy tool for the non technologically minded, aimed at the fast prototyping of multimedia applications for cultural institutions, while the reuse of existing narratives has been addressed in [29] within the *meSch* project.

Another interesting approach is the one presented in [30]. The authors suggest the use of narratives as a new first-class search functionality of digital libraries exploiting the potential of the Semantic Web and of the Linked Open Data. The long-term aim of this study is to provide digital libraries with a new search tool which should not only return a list of objects but also present one or more narratives composed of events related to the objects and endowed with a set of semantic relations linking these events into a semantic network.

Besides subjects of scientific research, narratives are already in use in a number of real contexts. For instance, they are the core system employed for teaching in the Khan Academy, an online academy whose mission is to provide free education in all knowledge fields. Contents are explained through narratives structured on different stages. At some stages users are given textual explanations on the matter or presented with short videos containing lessons; other stages envisage practical exercises to verify what the users have learned. Although the effectiveness of the approach has been disputed [31] the popularity of the Khan Academy confirms the interest towards this approach by the public.

---

## 4 User studies and evaluation

Comprehensive user studies conducted within long-term investigations of digital library services – and in environments that manage cultural heritage collections – can support a deeper understanding of user needs, preferences and behaviour in different usage conditions, and can give directions to better design web interfaces and applications, as shown and reported in [32]. Also in our work, for users of all types, focus groups and interviews were fundamental. This was true at the beginning of the design process, when potential users were asked to reflect on their needs, wishes and preferences for a research environment, as well as in the following steps of the user requirement elicitation process.

Concerning IPSA, professional researchers both expert in History of Illumination and in History of Medieval Art were involved at different stages of the project. At the beginning of the project, professional users of the

collections were surveyed to provide their input for the initial collection of user requirements, while during the life-cycle of the project professional researchers were interviewed regularly on both an individual and group basis. These interactions resulted in a number of publications in journals of humanities studies [33], and were an invaluable means of validating the real life usefulness of the environment.

### 4.1 Task-oriented Evaluation

In the case of non-professional users, it was possible to take advantage of the opportunity to work closely with groups of undergraduate and postgraduate students who were involved in the sustained use of the system. This type of work was carried out over three years, and a report on some of this activity is presented in [11].

#### 4.1.1 First year

In the first year of the project, the original website of the IPSA collection was presented to two different cohorts of students: 40 undergraduate students (age range 19-25 years) attending courses on history of arts, and 25 postgraduate students (age range 23-30 years) attending courses on information science. On this occasion two tasks were developed to be carried out by students in order to have them interacting with the system with a specific goal, and not just browsing the collection. The task could be completed in about 1 hour, although some of the participants took advantage of having access to the IPSA collection and interacted with the system for all the allotted time, which was about 2 hours.

The first task was related to the botanical codices in the IPSA collection and proposed a guided comparison between the *Liber Agregà de Serapion* (London, British Library, ms. Egerton 2020) and the *Erbario Roccabonella* (Venice, Biblioteca Marciana, ms. Lat.VI.59), two remarkably important manuscripts made in the region of Veneto, the first in the late Middle Ages, the latter during the Renaissance copying from the *Liber Agregà*. The students were required to verify this relation as well as find out which plants in the *Roccabonella* manuscript are copied from the *Liber Agregà* and which are not copied from this model but from other sources.

The second task made use of astrological manuscripts in the IPSA collection. The objective of this task was to have the students read the catalogue files and mine information from the database. Each student was given an astrological subject, namely representations of constellations or astrological signs and they were required to do a search by the subject assigned and analyze the first or the last five images in the results list. Then they were required to put them in chronological order.

Thanks to these tasks, students were led to use all the main IPSA features, and get a clear and exhaustive

idea of the application. The trials turned out to be a successful way of creating a dynamic relation with users and obtaining useful feedback, as reported in [34]. Moreover, to obtain further feedback, after each trial students were asked to answer an evaluation questionnaire developed specifically by a team of psychologists from the University of Graz.

#### 4.1.2 Second and third year

In the second year of the project other interactions were carried out following a schema of loop-interaction structured as follows:

1. Elicit user requirements: a re-engineered version of IPSA, improved according to the results of the first year evaluations, was presented to a new cohort of students, which were required to do some simple tasks very similar to those of the first year evaluations.
2. Modify the interface: IPSA was modified according to the feedback received from the new evaluation, using the results in the questionnaires and the outcomes of personal interviews and collective discussions.
3. Evaluate the modifications made: the modified IPSA interface was presented to the student cohort to verify if the changes made affected user perception of the IPSA environment, and to a small group of professional researchers to validate the results.

Similarly to the first year evaluations, participants included 110 undergraduate students, age range 19 – 24 years, attending courses in history of arts. They were asked to interact with the system for a reasonable amount of time (at least 30 minutes and no more than 2 hours) through some specifically-developed tasks, which were a variation on those proposed during the first year. The same students were asked to participate in the new evaluation (a re-evaluation) of the system, after the modifications were inserted, which was organized two weeks later.

Moreover, in the final months of the second year of the project, part of the IPSA metadata was integrated in the CULTURA environment and was evaluated by a new group of students. In this case, participants included 80 undergraduate students (age range 20 – 25 years) attending courses in cultural tourism. At the beginning of the third year of the project, IPSA in the CULTURA environment was evaluated to a greater extent with professional researchers in History of Illumination.

## 4.2 Results of task-oriented evaluation

On the basis of the interactions which were performed throughout the life-cycle of the project use cases were developed and user requirements elicited and refined. One of the key results of this process was a catalogue of user requirements which, in addition to outlining the features

required, also recorded the user groups for which each feature was important, and how important each feature was in the case of each group. One of the findings to emerge very clearly from this exercise was the fact that less experienced users ranked more highly those tools that allowed them to explore the content collections in a relatively undirected way. By contrast, professional researchers were far more likely to require tools that took them directly to specific artefacts, or sets of artefacts that were relevant to their interest.

Thus user input guided the development of the environment as a whole, as well as the individual tools that it comprises. In this way the development of the environment was truly user-driven. The focus of evaluation was on usability and usefulness, and for this reason our starting model was the *Interaction Triptych Model* [35], which analyzes and describes the interaction process with a digital library or research environment as a basis for deriving requirements and parameters for evaluation. Three main components of interaction are identified and captured by the model: the user, the content and the system. The analysis of the relationships between these components results in the following three evaluation aspects:

- **Usability:** efficiency and effectiveness of user interaction with the system; that is a user-system relationship;
- **Usefulness:** content utility and relevance to user tasks and needs; that is a user-content relationship;
- **Performance:** precision, recall, response time; that is a content-system relationship.

The evaluation aspects of the Triptych model were extended to address the quality axes specific to the research environment and its services, and to form a common ground for evaluation studies. In addition to the consideration of pairwise relations between the interaction components of the triptych model, our evaluation approach also considered the ternary interrelation between all three components. In substance, this relation was addressed in terms of adaptation quality, visualization quality and collaboration support in the formative evaluation studies that were conducted. The evaluation outcomes on the different qualities of the evaluation model provided targeted information on aspects and potential for further refinement or extension of specific features of the environment. The results obtained from all user studies on the same system release were consolidated to derive implications for further development. A range of changes was implemented in a new system release and a circular process was carried out for several iterations to reach the environment corresponding to the findings of the user studies. In this way, the developed evaluation model provided a sound theoretical basis for a systematic and comprehensive examination and validation of the novel functionalities integrated in the environment, in addition to traditional evaluation topics on the overall system and of general interest; this new evaluation model has been presented in detail in [8].

Being based on a number of tasks assigned to fixed groups of users, the evaluation procedure allowed us to measure **user engagement** through specific questions rather than using direct information such as number of visits and time spent during a session [36]. Thus, a number of items in the questionnaires investigated the quality of the user experience and the desire to use IPSA again in the future. Participants were asked to assess their level of agreement in a five-level Likert scale with sentences addressing their intention of using IPSA on a regular basis (“I would like to use the system frequently”), the quality of interaction (“I feel confident using the system” and “I think the system was easy to use”) and the overall perception of the interface (“I find the various functions in this system very well integrated” and “I would imagine that most people would learn to use the system very quickly”).

### 4.3 Indications to improve user support

The evaluations done in the first two years and at the beginning of the third year of the project highlighted the great variety of user approaches to the system, even when working with small and apparently homogeneous groups. In particular, users from all categories consistently stressed the need to be able not just to locate and annotate the material, but to organize it within the interface – in the case of professional researchers – or access it in an organized way – in the case of students. These users also provided a comprehensive list of suggestions for achieving this customizability. Most commonly, they requested the ability to create different sorts of *workspaces* for individual projects, and a folder functionality to allow bookmarks and annotations to be categorized and ordered. They also required the ability to copy and move bookmarks and annotations, also outside the environment. This feature means that the environment can be more than a self-contained reservoir – it can become part of a pipeline, a link in a longer chain of analysis, and a cog in a larger research machine.

Moreover, users with less knowledge about the content asked for a greater integration with external resources, eventually the ones they were more familiar with, which can provide a context for interpreting the material. This user group had also a noticeable interest towards the research work carried out by scholars, which in some cases was stronger than the interest towards the subject of the research (i.e. the cultural heritage content). The resource becomes more appealing when it can be used to share scholarly experience with other user groups.

A common denominator of these requirements was that the IPSA collection would be more engaging if it could more clearly show the structure of relations within its content, either because this expresses the scientific results of research or because this can be a path along which students access the content. This finding corre-

lated with the results of questions related to user engagement, which showed room for improvement in users’ confidence and easiness while using the system. This latter consideration suggested that user engagement could be improved by providing additional tools to guide users across the complex structure of the IPSA collection. Our approach was to use narratives, as described in the next section.

## 5 Discussion

As reported in [36]: “User engagement refers to the quality of the user experience that emphasizes the positive aspects of interacting with an online application and, in particular, the desire to use that application longer and repeatedly. User engagement is a key concept in the design of online applications (whether for desktop, tablet or mobile), motivated by the observation that successful applications are not just used, but are engaged with.”

### 5.1 User engagement

From the systematic analysis approach proposed and reported in [37], engagement emerged as a process with distinguishable attributes inherent at each stage in that process. In order to address the requirements of the different user types of interest, to support their workflows, and to enable them to view culturally significant collections in new and rewarding ways, the environment that has been made available<sup>21</sup> adopts an adaptive architecture that presents the user with both the content and the tools that are relevant to their investigation at any given time.

The process of engagement of the user with CULTURA has different steps that can be considered “points of engagement” [37]. The one we consider most notable is the point where the user can be engaged through *narratives*. Narratives have been designed and developed using intensive interaction with users to engage them so that users benefit from the use of the available digital cultural heritage collections.

### 5.2 User engagement through narratives

The term narrative is used “to represent the adaptive flow of concepts that are woven together to make a coherent offering to a user. Individual concepts may be grounded with either content or services, or may be further refined with the execution of a sub-strategy” [38]. It is generally assumed that narratives play a central role in engaging users inside gamified environments [39], but their effectiveness has been explored in other fields. Rowe

<sup>21</sup> <http://cultura-project.eu/>



and collaborators [40] found that narratives helped students improve their engagement with the learning material, with a positive effect in their learning gains and problem solving abilities. The results presented in [41], which measured the effect of narratives in promoting data exploration, showed that the effect depends on the kind of content.

Narratives are a central part of the way in which adaptivity is implemented within the CULTURA/IPSA environment. These narratives are threads through the collection, linking artefacts and tools related to a particular topic. Expert researchers, guided by the use cases and user requirements outlined during user consultations, designed narratives. They used their specialist knowledge of the collections to create a series of paths through the content that can engage users from all the groups in the exploration and use of specific content.

### 5.3 Structure of the proposed narratives

To address the different level of expertise of each category of users, each narrative has a number of levels. Less expert users are offered a relatively high level narrative, but as users interact with the resources that are presented to them, the system dynamically discloses additional material, resulting in a more complex and more captivating user experience. These narratives allow for an open-ended and developing engagement with the resource collections.

An example of a high level narrative are the ones designed for less expert users. These describe the different steps of a short course on a specific topic that is encompassed within the collection. Typically, the relevant material will be spread across the diverse parts of the different components of a collection. Adaptive narratives provide structured routes through the collection, exposing the user to artefacts that are relevant to their topic of interest. Furthermore, at certain steps of the narrative, users are given the possibility to access some extra steps which will provide them with additional information on that particular topic, also using external resources such as Wikipedia<sup>22</sup>. Once they have gone through all the additional steps, users will come back to the point they left the narrative and will be able to proceed.

These narratives were implemented for both collections in the environment, and the user experience of these narratives validated their usefulness for both types of content collection. In the case of the historical textual corpus, a series of narratives were developed for use with secondary school students who were encountering the collection for the first time. These users were presented with a sidebar containing a brief explanation of the context of the individual part of the text being viewed, along with prompts for further research. In the case of the collection of illuminated scientific manuscripts, Figure 2

represents, from top to bottom, the flow of a narrative; the most relevant resources are presented in order and, at any step, the user can choose to access additional information or alternative visualizations. Users can move backwards or forwards within the narrative, or branch off into further narratives, covering particular areas that especially pique their interest. At any point, the user can leave the pathway to carry out their own detailed investigations. Users are able to resume the narrative when desired.

In addition to tying together chains of documents, these narratives can include the other tools that contribute to the environment. For instance, a user of the IPSA collection who is following a narrative based on herbals of a given historical period can be presented with the results of a faceted search based on chronology and title; an example is depicted in Figure 3.

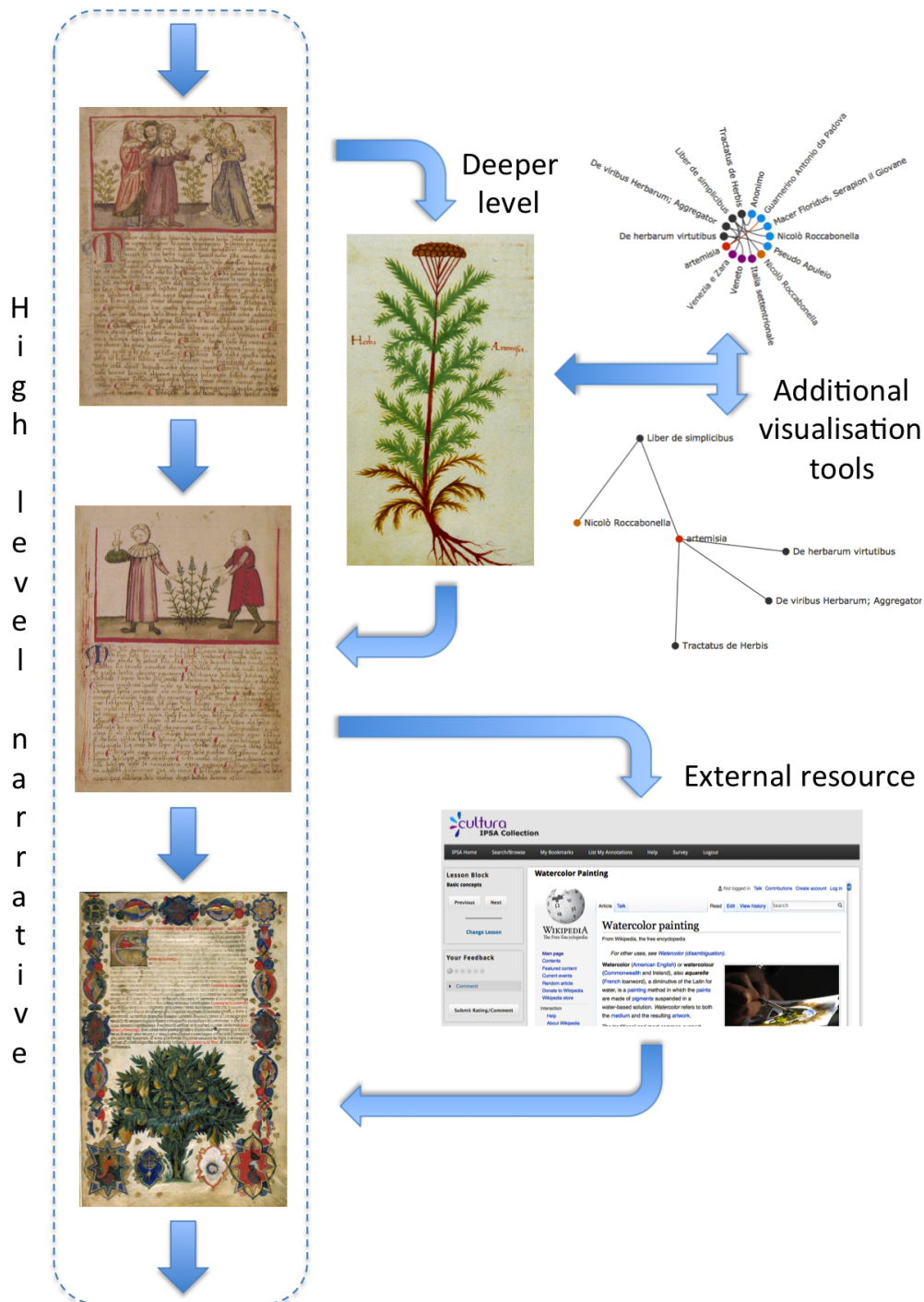
For users of the collection of illuminated medieval manuscripts, narratives are structured on different levels. For example, one of the narratives examines the development of botanical illustrations in Italy and allows the user to learn about the specific features of the software, while allowing them to access some extra material. By showing the development of botanical illustrations over the centuries, it is possible to present users with all the most significant features of the environment and teach them how to use it in an informal and efficient way. Thus the user, proceeding with the narrative, is shown useful tools, for example the visualization tool which associates works, authors, scribes, locations and illustrations to dots of different colours connected in order to show all the relevant data referring to an illumination. The visualization tool has been specifically designed to prevent the user from being disoriented while looking at the different illustrations of the same plant that are present in different manuscripts on the same screen [42].

Afterwards, the user can continue to follow the sequence of the narrative, otherwise they can use the visualization tool to follow new routes. For example, the user can ask to see the illustrations of the same plant they have been shown that are present in other manuscripts. If the user clicks on one of the authors shown in the visualization tool, the system displays a callout specifying the type of entity and allows the user to see the entity network of the author.

The entity network of an author is prepared by the system *on the fly* to answer the specific request of the user. In this way the user is adapting the interaction of the system to their interests, because they can leave the structure of the narrative and use the environment to adapt it to their specific interests.

By clicking on each of the works (a red dot for each work), the user is presented with a contextual square containing the essential information on the work together with an illustration if the dot refers to an illustration of a plant. From that square the user can navigate in the visualization tool of that specific plant and can continue to

<sup>22</sup> <https://www.wikipedia.org/>



**Fig. 2** Graphical representation of the structure of a narrative

explore the digital cultural heritage collection. At certain steps users are given the possibility to access some extra steps, where they will be given more information on the topic of the narrative: for example, more manuscripts of the same type as those the narrative deals with or explanations of the main painting techniques employed to illuminate the manuscripts of the collection.

As these examples show, these narratives provide a number of useful tools. They allow the diverse features of the environment to be brought together in a way that enhances the way users interact with the collection. For instance, they guide users without limiting them, by providing relevant suggestions when necessary, and allowing the user to follow additional sub-paths in order to delve

## Search Results

Results: 132

### Selected facets

earliestChronology - 1200

manuscriptTitle - Herbarius

<p><b>vettonica</b>  <b>Call Number:</b> Wien, Osterreichische Nationalbibliothek, Codex Vindobonensis 93  <b>Manuscript Title:</b> Herbarius  <b>Author:</b> Pseudo Apuleio  <b>Scribe:</b>  <b>Illuminator:</b>  <b>Sheet:</b> 13v  <b>Dimensions (mm):</b> 275x186  <b>Century:</b> 1200</p>	
<p><b>vettonica</b>  <b>Call Number:</b> Wien, Osterreichische Nationalbibliothek, Codex Vindobonensis 93  <b>Manuscript Title:</b> Herbarius  <b>Author:</b> Pseudo Apuleio  <b>Scribe:</b>  <b>Illuminator:</b>  <b>Sheet:</b> 14r  <b>Dimensions (mm):</b> 275x186  <b>Century:</b> 1200</p>	

Fig. 3 Faceted search

deeper into a particular topic, or to leave the narrative path entirely in order to undertake independent exploration, secure in the knowledge that a single click will return them to the narrative. The content is notable for its complexity, and the tools that the environment provides add further layers of richness.

Such a wealth of material is challenging for users, and adaptive narratives provide important support, guidance and direction, without the need to conceal or stifle any of the complexity and the opportunities for discovery that this complexity brings. Furthermore, in the case of collections of *static* items like illuminations or handwritten documents, narratives prove to be a valuable way to promote user engagement because they add to the experience of the items the diachronic dimension they lack. In fact, collections of films or music pieces by their nature provide users with extended experience, while for art-historical or historical collections it is more difficult to offer something similar.

Thus narratives help in fostering a more involving experience of the collections, which is more complete and extended over time. Therefore, other kinds of static collections can benefit from narratives too, e.g. archaeological collections.

### 5.4 Evaluation of narratives

The effectiveness of narratives as a tool to enhance user engagement was evaluated during the final part of the third year of the project. Again, participants were undergraduate students (age range 19–25 years) attending courses in cultural tourism. In addition to these 70 participants, 10 secondary school students (age range 17–18 years) attending an art college were included, and the results were used for comparison. Results are presented in detail in [43]. In each trial, participants were divided into two halves:

- **Test group:** these participants were required to follow the narrative lesson described in Section 5.3 and, afterwards, to complete a task.
- **Control group:** these participants were required to freely interact with the IPSA interface for an amount of time comparable to the one required for following a narrative and, afterwards, to complete a task.

In the case of the undergraduate students 35 participants constituted the test group and 35 participants constituted the control group, while in the case of secondary school students 5 participants constituted the test group while 5 participants constituted the control group. Each participant had a similar task to complete,

with the same structure of the first task described in Section 4.1.1. They had to verify a proposed comparison between the Liber Agregà de Serapion (London, British Library, ms. Egerton 2020) and the Erbario Roccabonella (Venice, Biblioteca Marciana, ms. Lat.VI.59), to search the related images and to take note of their experience and considerations using the annotation tool. The task involved exclusively the botanical codices because only the metadata related to them were imported in the CULTURA environment. In fact botanical codices were identified as the most significant subset of metadata to be imported and represented in CULTURA for use as a case study to test the new environment and its functions. The task described above, also on the basis of our previous evaluation experience, was considered suitable both for undergraduate students and for secondary school students, because it effectively leads users to an accurate interaction with the environment. As in previous evaluations, at the end of the test, which lasted about 90 minutes for both groups, participants had to fill in a questionnaire developed by a team of psychologists from the University of Graz [8]. In addition, further feedback was collected through an open discussion carried out by the tester. The two groups did not show any difference in the ability of completing the proposed tasks. This may be due to the fact that the tasks were conceived in order to be easily fulfilled, thus as an instrument to facilitate the exploration of the system functions rather than as a variable to be measured.

Results from the questionnaires were largely positive. Users in the test group showed consistently higher scores in their evaluation of system *usability*. This result may be due to the fact that the proposed narratives also included the use of visualization and annotation tools, which were then present in a real context. More importantly, the test group gave a higher rank also to system *usefulness*, showing that an introductory lesson based on the collection content can improve the way users consider the content as relevant.

Results on usability and usefulness were similar between the two user typologies (undergraduate students and secondary school students). The participants were also asked to assess their experiences with digital environments and their familiarity with the content of the collection. The variations in usability and usefulness did not change depending on user knowledge.

Considering both the feedback provided by the questionnaires and the opinions gathered through the discussions which followed the trials, the employment of narratives actually improved user engagement with the digital content. In respect to the control group, users in the test group reported higher interest towards accessing again the collection and, on average, they spent more time interacting with the system. Moreover, users in the test group described higher confidence using the system, which was perceived easier to use. Another important result was that users in the test group reported higher sat-

isfaction while interacting with the system. For example, it emerged that some of the available tools were difficult to grasp without a proper explanation, particularly the ones developed for professional users: through narratives general users can better understand their function and usefulness and achieve a more satisfactory interaction with the system.

---

## 6 Conclusions

The environment that we have contributed to developing offers a new way of accessing, interacting with and promoting user engagement with cultural heritage collections. It demonstrates the value of an adaptive interface that responds dynamically to support the user, whatever his or her level of experience with the environment or familiarity with the content may be. This flexibility has been both required and facilitated by the attempt to address the needs not of a single stereotype of user, but of a broad spectrum of user constituencies. In this context, the development of narratives to support the user's experience while interacting with the system has proved to be the right answer to the problem of raising, sustaining and promoting user engagement.

The design of the adaptive environment and of the narratives is based on input from users: in fact considerable effort has been invested in developing contacts and working closely with users from a broad range of user communities. This user engagement has been both sustained and broad-based. This level of engagement is demanding, but essential in helping to underwrite the real-world usefulness and thus the long-term sustainability of the resulting environment. Currently, the measurement of successful engagement with users is a field where we do not have well-developed models, although a number of metrics are applied to observe what is happening (as for example described in [44]): we hope that this paper could trigger a useful discussion on how to improve, quantify and evaluate user engagement.

---

## Acknowledgments

The authors are most grateful to Alexander Cormack for the thorough linguistic revision. The work reported has been partially supported by the CULTURA project, as part of the Seventh Framework Programme of the European Commission, Area "Digital Libraries and Digital Preservation" (ICT-2009.4.1), grant agreement no. 269973. The authors would like to thank the CULTURA partners for the useful discussions on many aspects related to user engagement with cultural heritage collections.

## References

1. Koolen, M., Kamps, J., de Keijzer, V.: Information Retrieval in Cultural Heritage. *Interdisciplinary Science Reviews* **34** (2009) 268–284
2. Morville, P.: *Ambient Findability*. O'Reilly, Sebastopol, CA, USA (2005)
3. Azzopardi, L., Vinay, V.: Retrievability: an evaluation measure for higher order information access tasks. In Shanahan, J.G., Amer-Yahia, S., Manolescu, I., Zhang, Y., Evans, D.A., Kolcz, A., Choi, K., Chowdhury, A., eds.: *Proceedings of the 17th ACM Conference on Information and Knowledge Management, CIKM 2008*, Napa Valley, California, USA, ACM (2008) 561–570
4. Borgman, C.L.: *Scholarship in the Digital Age. Information, Infrastructure, and the Internet*. The MIT Press, Cambridge, MA, USA (2009)
5. Manovich, L., Douglass, J., Magdalin, S., Kuester, F., Yamaoko, S.: Cultural Analytics Research Environment. In: *Proc. of SIGGRAPH 2009 Art Gallery*, New York, NY, USA, ACM (2009) 20:1–20:1
6. Munnely, G., Hampson, C., Lawless, S., Conlan, O.: The CULTURA Portal. In Bolikowski, L., Casarosa, V., Goodale, P., Houssos, N., Manghi, P., Schirrwagen, J., eds.: *Theory and Practice of Digital Libraries – TPDL 2013 Selected Workshops*, Cham, Springer International Publishing (2014) 155–158
7. Agosti, M., Conlan, O., Ferro, N., Hampson, C., Munnely, G.: Interacting with Digital Cultural Heritage Collections via Annotations: the CULTURA Approach. In Marinai, S., Marriott, K., eds.: *ACM Symposium on Document Engineering, ACM (2013)* 13–22
8. Steiner, C.M., Agosti, M., Sweetnam, M.S., Hillemann, E.C., Orio, N., Ponchia, C., Hampson, C., Munnely, G., Nussbaumer, A., Albert, D., Conlan, O.: Evaluating a Digital Humanities Research Environment: the CULTURA Approach. *International Journal on Digital Libraries* **15** (2014) 53–70
9. Agosti, M., Benfante, L., Orio, N.: IPSA: A digital archive of herbals to support scientific research. In Sembok, T.M.T., Zaman, H.B., Chen, H., Urs, S.R., Myaeng, S., eds.: *Digital Libraries: Technology and Management of Indigenous Knowledge for Global Access, 6th International Conference on Asian Digital Libraries, ICADL 2003*, Kuala Lumpur, Malaysia. Volume 2911 of *Lecture Notes in Computer Science*, Springer (2003) 253–264
10. Agosti, M., Ferro, N., Orio, N.: Graph-based automatic suggestion of relationships among images of illuminated manuscripts. In Haddad, H., ed.: *Proceedings of the 2006 ACM Symposium on Applied Computing (SAC)*, Dijon, France, ACM (2006) 1063–1067
11. Agosti, M., Benfante, L., Manioletti, M., Orio, N., Ponchia, C.: Issues to Be Addressed for Transforming a Digital Library Application for Experts into One for Final Users. *International Journal of Heritage in the Digital Era* **1** (2012) 89–94. 10.1260/2047-4970.1.0.89.
12. Cartelli, A., Palma, M.: Towards the project of an open catalogue of manuscripts. In: *Proc. of the Informing Science + Education Conference*, Santa Rosa, California, USA, Informing Science Institute (2002) 217–214
13. Cartelli, A., Daltri, A., Errani, P., Palma, M., Zanfini, P.: Il catalogo aperto dei manoscritti Malatestiani: esperienze e prospettive. In: *Le Reti in Rete. Per l'Inventario e l'Edizione dell'Archivio Vallisneri*. Volume 5 of *Biblioteca dell'Edizione Nazionale delle Opere di Antonio Vallisneri*. L.S. Olschki, Firenze, Italy (2011) 123–132. 10.1400/221375.
14. Lepinay, O.: Sites français sur les manuscrits enluminés. *Enluminures et Liber floridus*. *Rivista di Storia della Miniatura* **13** (2009) 215–217
15. Dutschke, C.: Digital Scriptorium. Now and tomorrow. *Rivista di Storia della Miniatura* **14** (2010) 203–205
16. Bernasconi, M.: E-codices: la biblioteca virtuale dei manoscritti conservati in Svizzera. *Rivista di Storia della Miniatura* **15** (2011) 196–197
17. Europeana: *New Frontiers. Europeana Annual Report 2014*. Europeana Pro Publications (April 2015)
18. Casarosa, V., Meghini, C., Gardasevic, S.: Improving Online Access to Archival Data. In Agosti, M., Esposito, F., Ferilli, S., Ferro, N., eds.: *Digital Libraries and Archives. 8th Italian Research Conference, IRCDL 2012*. Volume 354 of *Communication in Computer and Information Science*, Berlin / Heidelberg, Springer Verlag (2012) 153–162
19. Birrell, D., Dobрева, M., Ünal, Y., Feliciati, P.: Constituencies of use: Representative usage scenarios in international digital library user studies, a case study on Europeana. In Hedlund, T., Tonta, Y., eds.: *Transforming the Nature of Communication, 14th International Conference on Electronic Publishing, ELPUB 2010* (2010) 245–257
20. Agosti, M., Ferro, N., Silvello, G.: Digital Libraries: From Digital Resources to Challenges in Scientific Data Sharing and Re-Use. In Flesca, S., Greco, S., Masciari, E., Saccà, D., eds.: *A Comprehensive Guide Through the Italian Database Research Over the Last 25 Years*. Springer International Publishing, Cham (2018) 27–41
21. Hyvönen, E., Lindquist, T., Törnroos, J., Mäkelä, E.: History on the semantic web as linked data – an event gazetteer and timeline for the World War I. In: *Proceedings of CIDOC 2012 - Enriching Cultural Heritage*. (2012) 12
22. Brown, S.: The First World War Poetry Digital Archive. *Reference Reviews* **24** (2010) 32–33
23. Agirre, E., Aletras, N., Clough, P., Fernando, S., Goodale, P., Hall, M., Soroa, A., Stevenson, M.: PATHS: A system for accessing cultural heritage collections. In: *Proceedings of the 51st Annual Meeting of the Association for Computational Linguistics: System Demonstrations*. (2013) 151–156
24. Goodale, P., Clough, P., Hall, M., Stevenson, M., Fernie, K., Griffiths, J., Agirre, E.: Pathways to discovery: Supporting exploration and information use in cultural heritage collections. In: *Proceedings of Museums and the Web Asia 2013*. (2013)
25. Landon, G.V., Landon, W.J., Snodgrass, C.L.: A Geospatial Narrative Framework: Breathing New Data into Historical Manuscripts. In: *Proceedings of the Second Workshop on eHeritage and Digital Art Preservation*. (2010) 43–48
26. Callaway, C., Stock, O., Dekoven, E., Noy, K., Citron, Y., Dobrin, Y.: Mobile drama in an instrumented museum: Inducing group conversation via coordinated narratives. In: *Proceedings of the 16th International Conference on Intelligent User Interfaces*. (2011) 73–82
27. Chu, J.H., Harley, D., Kwan, J., McBride, M., Mazalek, A.: Sensing history: Contextualizing artifacts with sensory interactions and narrative design. In: *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*. (2016) 1294–1302
28. Rubegni, E., Di Blas, N., Paolini, P., Sabiescu, A.: A Format to Design Narrative Multimedia Applications for Cultural Heritage Communication. In: *Proceedings of the 2010 ACM Symposium on Applied Computing*. (2010) 1238–1239
29. Risseuw, M., Cavada, D., Not, E., Zancanaro, M., Marshall, M.T., Petrelli, D., Kubitzka, T.: Authoring augmented digital experiences in museums. In: *Proceedings of the International Working Conference on Advanced Visual Interfaces*. (2016) 340–341

30. Meghini, C., Bartalesi, V., Metilli, D.: Using Formal Narratives in Digital Libraries. In Grana, C., Baraldi, L., eds.: *Digital Libraries and Archives - 13th Italian Research Conference on Digital Libraries, IRCDL 2017, Modena, Italy, Revised Selected Papers*. Volume 733 of *Communications in Computer and Information Science.*, Springer (2017) 83–94
31. Ani, K.K.: Khan Academy: The hype and the reality. *Education Digest* **78** (2013) 23–25
32. Agosti, M., Crivellari, F., Di Nunzio, G., Gabrielli, S.: Understanding User Requirements and Preferences for a Digital Library Web Portal. *International Journal on Digital Libraries* **11** (2010) 225–238
33. Sweetnam, M.: ‘Sheep in the Midst of Wolves’?: The Protestant Ministry in the 1641 Depositions. *Journal of Irish Scottish Studies* **6** (2013) 71–92
34. Ponchia, C.: Engaging the User: Elaboration and Execution of Trials with a Database of Illuminated Images. In Agosti, M., Esposito, F., Ferilli, S., Ferro, N., eds.: *Digital Libraries and Archives*. Volume 354 of *Communications in Computer and Information Science.*, Springer (2013) 207–215
35. Tsakonias, G., Papatheodorou, C.: Analysing and Evaluating Usefulness and Usability in Electronic Information Services. *Journal of Information Science* **32** (2006) 400–419
36. Lalmas, M., O’Brien, H., Yom-Tov, E.: *Measuring User Engagement*. Morgan & Claypool Publishers (2014)
37. O’Brien, H.L., Toms, E.G.: What is user engagement? A conceptual framework for defining user engagement with technology. *JASIST* **59** (2008) 938–955
38. Conlan, O., Staikopoulos, A., Hampson, C., Lawless, S., O’Keeffe, I.: The Narrative Approach to Personalisation. *New Review of Hypermedia and Multimedia* **19** (2013) 132–157
39. Werback, K., Hunter, D.: *For the Win: How Game Thinking Can Revolutionize Your Business*. Wharton Digital Press, Philadelphia, PA, USA (2012)
40. Rowe, J.P., Shores, L.R., Mott, B.W., Lester, J.C.: Integrating learning, problem solving, and engagement in narrative-centered learning environments. *International Journal of Artificial Intelligence in Education* **21** (2011) 115–133
41. Boy, J., Detienne, F., Fekete, J.D.: Storytelling in information visualizations: Does it engage users to explore data? In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. (2015) 1449–1458
42. Conklin, J.: Hypertext: An Introduction and Survey. *Computer* **20** (1987) 17–41
43. Agosti, M., Orio, N., Ponchia, C.: Guided Tours Across a Collection of Historical Digital Images. In: *Proceedings of the Third AIUCD Annual Conference on Humanities and Their Methods in the Digital Ecosystem*. AIUCD ’14, New York, NY, USA, ACM (2015) 7:1–7:6
44. Huges, L.M., Ell, P.S., Knight, G.A.G., Dobрева, M.: Assessing and measuring impact of a digital collection in the humanities: An analysis of the SPHERE (Stormont Parliamentary Hansards: Embedded in Research and Education) Project. *Digital Scholarship in the Humanities* **30** (2015) 183–198