

# Bridging Citizen Science and Open Educational Resource

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## ABSTRACT

The ongoing digitization of humanities' archival information has contributed to make highly valuable and highly distributed corpora available for research. Connecting this distributed knowledge and enriching it with more data following a specific research question is a big challenge in digital humanities. The project Interlinking Pictura (IP) addresses this challenge by bridging Citizen Science with Open Educational Resources (OER). In order to achieve this objective, citizens are involved in a broad range of participatory levels of research. Besides the involvement of lay researchers (retired teachers, citizen associations etc.), IP adjusts the tasks to open educational resources for distributing and for an easy integration into learning environments. The IP project is built on semantic wiki platform and involves open linked data to enrich the corpus. This offers the possibility to realize the interoperability at multiple levels using standardized vocabularies. In IP the object of interest is the multilingual "Bilderbuch für Kinder" (illustrated book for children) by F. J. Bertuch (1790-1830), which is one of the earliest encyclopedias for children and a milestone in the development of educational resources. An open edition has been created using Semantic MediaWiki as a collaborative platform to facilitate citizens' contribution. The main goal of IP is the creation of an interlinked corpus about Bertuch's illustrated book through connecting the distributed knowledge about its creation, reception, and usage in pedagogical practices.

## CCS CONCEPTS

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OpenSym '18, August 22-24 2018, Paris, France  
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978-1-4503-5936-8/18/08...\$15.00  
<https://doi.org/10.1145/3233391.3233539>

• Information systems~Wikis • Human-centered computing~Interaction design process and methods • Social and professional topics~Information systems education

## KEYWORDS

Semantic MediaWiki, Open Collaborative Research, Semantic Web, Citizen Science, Crowdsourcing; eHumanities, Open Educational Resources

## ACM Reference format:

Cornelia Veja, Julian Hocker, Christoph Schindler and Stefanie Kollmann. 2018. Bridging Citizen Science and Open Educational Resources. In *Proceedings of The 14th International Symposium on Open Collaboration (OpenSym '18)*. ACM, New York, NY, USA, 12 pages. <https://doi.org/10.1145/3233391.3233539>

## 1 INTRODUCTION

In the last years, Humanities archives are more and more digitized and contain relevant knowledge for various fields of research. The large amount of knowledge is distributed in silos and not connected making the research process unnecessarily difficult. The recent movement to open and collaborative science aims to improve the quality of, and widen access to, online collections. The shift to Citizen Science (CS) aims to the 'inclusion of members of the public in some aspect of scientific research' [11] offering the possibility for collaboration and quality improvement. The field is very diverse and includes all scientific discipline along with multiple forms, depths and aims of collaboration [12].

While interest in CS is booming around the Science's world, the adoption in Humanities projects remains uneven [7 - 8].

Despite the growing number of crowd science projects in a wide range of fields, most of CS projects, regardless of the domain of discourse, consider the educational aspect as a secondary goal or via tacit learning by intrinsic participation on the project [4, 14]. Research projects in Humanities with the explicit goal of education are largely absent also [24].

In this paper we argue for a brief consideration of the educational aspects of CS projects. Thereby we stress the

potential for creating Open Educational Resources (OER) in CS by bridging the different worlds through semantic technologies to foster interoperability and different usages.

The UNESCO forum of OpenCourseWare defined OER as 'teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions' [1]. Through a research oriented didactical concept (e.g. research-based learning) the tasks and outcome of citizens' contribution in CS projects becomes potentially OER, which enables the possibility to be integrated into digital learning environments. This approach demands interoperability, which is only slowly becoming a topic of concern in the CS community. A recent study about sharing of data and interoperability issues reveals that even perceived as valuable, interoperability is very poorly addressed in CS projects [16]. Many co-created project stated that interoperability was not a concern, while collaborative and contributory projects address sometimes interoperability at least by adopting of standard vocabularies. The interoperability that goes beyond data, disciplines and information technologies and embraces a plurality of usages (e.g. research, OER, CS) and multiple-layered schemas is still lacking.

Semantic technologies enhance interoperability between different information systems. In CS, Semantic technologies could address major challenges in turning 'the potential of cognitive surplus into a key asset' [19].

Blending wiki-style versatility and collaboration with lightweight semantic technologies, semantic wikis can offer entirely new opportunities for communication, collaboration, participation and open discourse in science.

We address this lack of research in several ways. First, we consider the experiences from collaborative projects that can provide helpful pointers for designing citizen science activities [8, 17]. Second, to build this bridge between CS and OER we argue further for the use of semantic and open technologies. Third, we discuss the challenges of linking CS and OER against the 5R's framework of OER [26]. In this respect, we consider a concrete project in Humanities, Interlinking Pictura (IP) as use case for bridging CS and OER.

The aim of the Interlinking Pictura<sup>2</sup> project is to create a scholarly online edition of Bertuch's illustrated book for children (Bilderbuch für Kinder). Around 200 years ago, Bertuch's book (1790-1830) was a milestone of state of the art publishing scientific findings in various domains for children, as educational resources. Over time, many researchers and educators used this book and published scientific studies about Bertuch's world [6]. Metadata along with scans and digitized texts of Bertuch's books were collected from 3 different libraries and gathered to create a digital edition using a Semantic MediaWiki based platform.

The use of this edition targets researchers in history of education interested to study the perceptions and evolvement of pedagogical practice of Bertuch's book over time with the aim of

building a collective digital knowledge base of the children's' book by F. J. Bertuch.

In order to achieve these objectives, the complete work of Bertuch needs to be collected, transcribed, systemized, and analyzed in detail. While this endeavor exceeds the resources for a research project, we advocate citizens to address the scientific challenges of the Interlinking Pictura project. Furthermore, we employ the wiki infrastructure as collaborative tool to gradually involve citizens in scientific research and defined 6 different tasks, each of which requires different levels of citizen's involvement and expertise. These tasks could be used as OER in educational settings.

The work described in this paper provides researchers a framework, tools and methods used in the IP project to easy involve citizens in research process. This process follows a design approach driven by researcher's requirements and aiming at understanding demands and expectations of citizens. The focus is on the interconnection of semantic web technology, citizen science and the collaborative creation of OER. The paper discusses the challenges of collaborative creation of OER and their level of openness using the 5R's framework [26].

The following section will elaborate the research context, in which this work is set, briefly introducing relevant related works, while Section 3 introduces the architecture and the various functionalities offered by the framework on which this approach is based. Section 4 presents the project setup while Section 5 presents our research methodology and design and describes the outcome of the project from educational perspective. The remaining sections discuss the project outcome, grasp the future work, while the last concludes our research, and end the paper.

## 2 RESEARCH CONTEXT

Before discussing the research areas that affect our research approach, we want to clarify the different terms that are used for its description.

### 2.1 Crowd science: Peer Production, Crowdsourcing and Citizen Science

The literature review stats that Peer Production, Crowdsourcing and Citizen Science are forms of broader term: Crowd Science [9, 21].

*Peer production* (or mass-collaboration) is a form of IT-mediated production that decentralizes both goal setting and execution to networks of individuals or more structured communities. Resources and goods are jointly developed and maintained by a community and shared according to community-defined rules. It relies on self-organizing communities of individuals where the labor of a large number of people is coordinated towards a shared outcome [3]. One of the well-known peer-production instances is Wikipedia.

*Crowdsourcing*. Simply defined, crowdsourcing represents the act of an organization taking a function and outsourcing it to a generally large network of people in the form of an open call [3, 24].

<sup>2</sup> <https://interlinking.bbf.dipf.de/index.php/Hauptseite>

Crowdsourcing is a deliberate combination of top-down goals set and initiated by an organization and bottom-up crowd-derived processes and inputs [21]. Certain authors pointed out that when crowdsourcing is collaboratively performed, it takes the form of peer-production [9].

In contrast to the peer-production, in crowdsourcing the tasks it involves are pre-specified by the task designer, usually an organization [21].

*Citizen Science* (CS) refers to the “inclusion of members of the public in some aspect of scientific research” [10]. The field is very diverse in includes virtually all scientific disciplines along with multiple forms, depths and aims of collaboration [7]. As a computer-mediated problem solving, idea-generation, tool and production model for organizations, Citizen Science leverages the distributed knowledge found in crowds, through different kind of project types and means such as crowdsourcing (by micro-tasking, open collaboration or tournament-based competitions [17]), collaborative or co-created [5, 24].

Sometimes confused with crowdsourcing, citizen science productions do not represent peer production in the same sense as crowdsourcing and CS projects are not self-organizing [24]. The most notable difference is that crowdsourcing does not necessarily aim to engage citizens in research projects and a research body does not normally lead that such initiatives, thus it is one of the major techniques employed in citizen science initiatives.

When considered as a tool, method, or form of research collaboration, citizen science is associated with the potential for significant benefits for volunteers, for example, for improving literacy [10] or even writing scientific papers.

## 2.2 Semantic Web technologies in research

A social platform solution, like a semantic wiki, is a promising environment, providing the users with a low level of technological expertise, and easy way to manage machine-processable knowledge. Semantic wikis yield the creation of added-value services based on the semantics of web pages.

Semantic wikis provide the collaborative environment for users to contribute semantic markup (annotations) and easy-link relations between wiki pages. Annotations are required to refer to an ontological model defining concepts and properties that can be associated to pieces of wiki contents. Generally, those annotations are designed to create instances of domain ontologies and their related properties, whereas several wikis use semantic annotations to provide advanced metadata regarding wiki pages.

A semantic wiki has an underlying model of the knowledge described in its pages, allowing capturing or identifying further information about the pages and their relations. The formalization of the knowledge model should be available as RDFS or OWL, so that machines can process and reason on it.

MediaWiki<sup>3</sup> is a form of Social Software web based platform, which enables collaboratively digital content creation, maintenance and information retrieval.

Semantic MediaWiki<sup>4</sup>(SMW) is a semantically enhanced Wiki engine that enables users to annotate wiki's content with explicit, machine-readable information. It supports adding structured and semantically annotated information into wikis using a specific syntax. SMW is based on a simple and unobtrusive mechanism for semantic annotation.

From the functional point of view, SMW may use and extend the MediaWiki template mechanism by offering to process semantic properties as parameters of the template. On this basis, semantic forms facilitate user input by hiding the complex syntax of the semantic templates.

A SMW based platform gives the opportunity to use a mature already existing framework, extensible and under an open license. SMW offers a modular semantical platform with various extensions, which offers a fundamental affordance of qualitative research for small/medium research projects.

In order to provide the community of practice with the whole array of commodities needed to accomplish the community's goal, SMW, together with bespoke tools make the research process transparent (Open Science). Web platforms based on SMW offer services for semantic annotations, eases formalization of research questions and hypotheses, connectivity and collaborative space, along with the possibility of retracing back the data [22].

## 2.3 Open Data and Open Educational Resources

Open Knowledge International defines Open Data as “data that can be freely used, re-used and redistributed by anyone – subject only, at most, to the requirement to attribute and sharealike” [18] is not traditionally considered as Open Educational Resources (OER). In educational and academic contexts, Open Data can be used as an OER to help support the engagement of students and researchers in analyzing and collaborating towards finding solutions for contemporary real-world problems. Nevertheless, Open Data lack of a clear educational embeddedness.

OER include learning content, software tools to develop, use and distribute, and implementation resources such as open licenses. The learning content is educational material of a wide variety, from full courses to smaller units such as diagrams or test questions [1]. It may include text, images, audio, video, simulations, games, portals and the like. OER can be an important building block for anchoring open science practices in teaching. Additionally, in the context of citizen science, OER materials could be specifically targeted at civil society and furthermore, could be created by citizens for citizens. Wiley described in [13, 26] the characteristics of OER through the so-called 5R's (Retain, Reuse, Revise, Remix, Redistribute), which

<sup>3</sup> <http://www.mediawiki.org/>

<sup>4</sup> <https://www.semantic-mediawiki.org/wiki/>

specifies a licensing and technical framework for assessing the relative openness of an OER.

## 2.4 Related work

Many heritage organizations embrace wiki-style platforms as a means to collect contextual knowledge from their user base, as wikis are a way both to facilitate collaborative contributions and to track the history of successive contributions from multiple users [19]. Certain subsets of the humanities disciplines have developed their own typologies for involving citizens. Most notable among these are the cultural heritage and Galleries, Libraries, Archives and Museums (hereafter GLAM) sectors [9] and the form of involvement is crowdsourcing, under various flavors.

To the best of the authors' knowledge, a similar semantic wiki based platform to facilitate the research in Humanities and Education and using citizens as scientists to create open educational resources are very seldom. There are several similar projects dealing with citizen science and educational goal that we will discuss in this section.

CAISE project [5] is one of the first projects highlighting public participation in scientific research (PPSR) that discusses aspects of informal science education in relation with Citizen Science. It surveys the citizen science landscape and establishes models for PPSR and also processes, steps, or activities in which the public can be involved.

The last survey shows that in Germany and Austria the CS practice includes several projects in the humanities, particularly historical disciplines [20]. The main platform for CS research in Germany is the platform 'Bürger schaffen Wissen'<sup>5</sup> which features several projects in the Humanities. One is the digital reconstruction of the city of Leipzig<sup>6</sup> and another is the 'Verein für Computergenealogie e.V.'<sup>7</sup> that uses digital methods for genealogy and transcribe gravestones.

Several projects in eHumanities sought to harness the power of crowdsourcing to facilitate the transcription of the manuscript papers. Examples of this kind of projects are: Shakespeare's world project<sup>8</sup>, the Bentham Project at University College London (UCL)<sup>9</sup> which embraces wiki-style user interface and Mutual Muses<sup>10</sup>.

Other projects use members of the public for curation, like Trove<sup>11</sup>. This project uses members of the public adding information to records as a method for Libraries to enhance the details of their collections. Trove is tracking also the behavior of the users making these corrections. The British Museum curators worked together with Wikipedians in the "Wikipedian in

residence" program for sharing knowledge between amateurs and professionals.

Several projects are using citizens in much more complex actions. An example is exploreAT!<sup>12</sup>, a collaborative transdisciplinary Digital Humanities project created to explore Austria's culture through the language glass. The project intended outcome is to publish linked open data that connects complex features with the global and European knowledge web. The citizens will perform a large range of tasks, from crowdsourcing to co-design. Another example is LitLong<sup>13</sup> project which uses natural language processing technology informed by literary scholars' input in order to text mine literary works set in Edinburgh and to visualize the results in accessible ways.

Over the time, several web platforms were created to support CS projects and activities. Most of these platforms support only micro-tasking like Amazon Mechanical Turk (AMT)<sup>14</sup>, crowdsourcing or collaborative works (Crowdcrafting<sup>15</sup>, Zooniverse<sup>16</sup>[23]). They are multi-projects platforms.

It is worth to recall here two platforms that enable researchers in the sciences and humanities to create, monitor and control complex crowdsourcing projects with minimal effort. The first is MicroPasts<sup>17</sup> - funded by the UK Arts & Humanities Research Council and the second is Curio [15]. These two platforms serve each a specific project.

Several citizen science projects have the explicit goal education. There projects are mostly in the area of biodiversity (Dragonfly Detectives<sup>18</sup>) or environment, as in the summer program hosted by the Acadia Institute of Oceanography in Maine. There are no explicit outcomes in the form of open educational resources available.

Our work differs from each of these methods in research subject, objectives and methodology. We combine stakeholder's goals with Semantic MediaWiki technology in order to open and connect various levels of expertise to create an augmented knowledge base by using open educational resources.

## 3 PROJECT SETUP

Friedrich Justin Bertuch (1747 - 1822) was a publisher who lived in Weimar, Germany. He published a wide range of works, from magazines to books. His most important work is probably the 'Bilderbuch für Kinder' - illustrated storybook for children. Over the time, he published in several fascicles, as can be seen in **Figure 2**, left. The layout was on all topics the same: a page containing a picture on the first side and then on the following pages the explanations of these drawings. The drawings and the texts together were called "Tafeln" (tables). The book contains 12 volumes; each of the volumes aggregates around 100 'Tafeln'.

<sup>5</sup> <http://www.buergerschaffewissen.de/>

<sup>6</sup> <http://www.buergerschaffewissen.de/projekt/alt-leipzig>

<sup>7</sup> <http://compngen.de/>

<sup>8</sup> <https://www.shakespearesworld.org>

<sup>9</sup> <http://www.ucl.ac.uk/bentham-project>

<sup>10</sup> <https://www.zooniverse.org/projects/melissaagill/mutual-muses>

<sup>11</sup> <https://trove.nla.gov.au/>

<sup>12</sup> <https://www.citizen-science.at/projekte/exploreat>

<sup>13</sup> <https://litlong.org>

<sup>14</sup> <https://www.mturk.com/>

<sup>15</sup> <https://crowdcrafting.org/>

<sup>16</sup> <https://www.zooniverse.org/>

<sup>17</sup> <https://crowdsourced.micropasts.org/>

<sup>18</sup> <https://dragonflydetectives.wordpress.com/about/>

Since most of ‘Tafeln’ consist of more than one picture, we cropped them in order to facilitate the picture analysis.

We brought metadata together with scans and digitized texts from different libraries and created a digital edition using SMW. The platform contains around 19.000 images and 45.000 pages. This digital edition offers to researchers in history of education the possibility to study the perceptions and evolvement of pedagogical practice over the time. In order to enhance the knowledge accumulated into wiki, we enable the possibility to involve citizens to collect and validate metadata.

The involvement of CS is stepwise: first, increasing the metadata quality, for instance by linking to external sources or transcribing texts. Second, sharing resources that can be interesting for other researches, and make it discoverable, connected and complete digitalized. The third step is to allow researchers to have an overview of literature about Bertuch and his time. Researchers may use our platform as a starting point of planning their future research. The semantic templates and forms offer an optional affordance via semantic queries to include the topic-related knowledge graph in the current researcher’s wiki page. Optional, worker may enable or ignore the platform suggestions.

Due to the flexibility of SMW, customized functions and tools can easily be added pertinent to specific research project goals. Also, SMW empowers users in terms of fast knowledge accumulation and enables to participate in lightweight collaborative ontology design without explicitly stated as such. Therefore, the work within the digital edition could be published directly as open data. In Humanities, researchers usually expect lower technical barriers in using a tool and the SMW based platform helps them to collaborative create a common digital corpus of data and common ontologies.

#### 4 PROJECT ARCHITECTURE: EDUCATIONAL PERSPECTIVE

The following section describes the architecture of our web platform (see Figure 1). The web platform development process is stepwise, we explain first how the data was collected via the semantic forms and how specific templates and forms are integrated into the SMW. Secondly, we describe how each entity is processed and how each entity is represented on a wiki page. Thirdly, we tailored templates and tools to enable researchers – professionals and volunteers – to jointly participate to research on Bertuch’s illustrated book for children. Finally, we explain how tasks are integrated into the platform, the dependencies and possibility to chain the research workflow.

The main actions involved are: pre-processing of the input, data collection and integration and post-processing.

The input consisted of an XML-export from the library of our partners at the German library for the history of education (BBF), which is part of The German Institute for International Educational Research (DIPF) also.

##### 4.1 Pre-processing

Firstly, after discussions with stakeholders, we designed the ontology for the platform: entities and properties, and establish templates for import. As part of input data filtering step, we extracted entities and properties from an XML export file from the BBF library. We developed a Semantic MediaWiki special tool to import the data automatically to complete this action. In addition, several entities and metadata were extracted and considered.

Part of this step is the planning of tasks for citizens. The purpose of these tasks is creating concepts and relations related

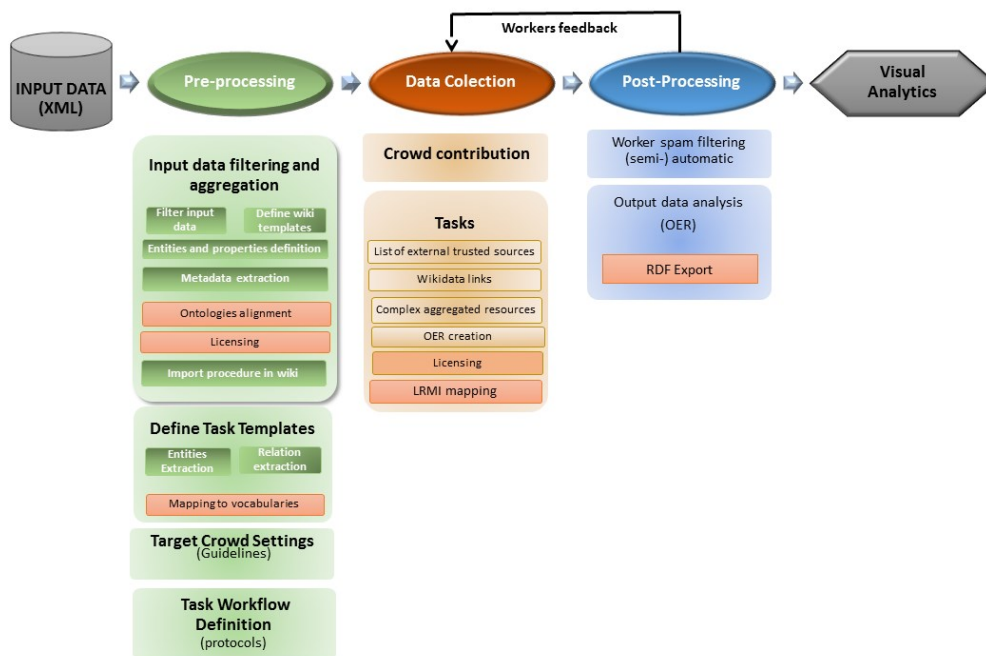


Figure 1. Overall architecture.

with their research. We defined these tasks according with 5 task templates. The full description of these tasks is in [Section 5](#).

The workers consist of both expert crowd, and a general crowd. Each of these crowds interacts with initial set of entities and properties. Nevertheless, a different level of expertise is required. The target crowd settings step entails picking the difficulty of the task according to the guidelines and protocols that platform provided.

Given the collaborative space of wikis, we didn't constraint somehow the access to tasks. We rely on wiki facilities: 'to share the little I know'.

The SMW uses the content templating mechanisms inherited from MediaWiki, under the name of seeding wiki pages.

Using templates is useful for structured input, allowing non-technical users to add annotations to the wiki without too much effort. SMW use aggregation of properties results into templates, and then an aggregation of templates results into a semantic form.

Semantic forms give an intuitive interface to templates:

- Allow the creation of templates using forms for adding and editing pages,
- Are defined using a mini-scripting language,
- Are created on-the-fly, based on existing data, form definition and the templates that the form outputs.

## 4.2 Data collection and integration

Researchers with low level of technical expertise can easily edit and create new data on the wiki using semantic forms. For this purpose, SMW also provides an "Edit with Form" option, which allows users to edit each page via user-friendly forms. Each of the form is build up automatically on a semantic template, as the previous step stated.

In order to collect data from citizens, it is imperative to find the necessary motivations for engaging them into contributing. After discussions and qualitative interviews with stakeholders, students and professionals, we established incentives for crowd labor, such as learning and competition with peers. A key requirement was the time flexibility, while target groups of professionals have difficult schedules.

In order to attract and retain crowd on the platform, we plan to enlist top ten contributors on the main project page. Also, we enabled wiki semantic statistics per user, so each of workers knows at some point in time how many contributions they have. The platform states the difficulty of task for each of them and gives guidelines and advices how to complete.

After the task is complete, the rendering phase is responsible of how each user contribution is represented in a wiki page. The rendering phase is accomplished by the corroborative actions of MediaWiki template engine, which translates template calls into wiki text and SMW engine which translate template calls parameters into semantic properties and typed entities.

## 4.3 Post-processing

We rely on MediaWiki facilities to prevent spams. Also, we plan to employ a semi-automatic check like in Wikipedia to address Spam-filtering.

The platform enables XML import and export of metadata, as genuine facilities of MediaWiki software. Using the SMW facilities, collected data may be exported in RDF format to other external application or other semantic wikis.

An important phase of post-processing step is the users' feedback. This phase allows collecting observations, mal-functionalities and we can 'tune' the templates and guidelines as we collect new requirements.

## 5 DESIGN APPROACH

Citizen science is often seen as an informal way to achieve both educational and scientific objectives, and can be seen as a secondary activity to the efforts of museums and science centers in informal education [4]. In our design approach, both activities have the main importance, since one of the most important goals is to create open educational resources.

We use a mixed methods approach to understand the different demands and expectations of citizens and stakeholders<sup>19</sup>, as follows:

- a. The top-down approach is based on goal driven management of project and resources combined with coordination analysis in a collaborative environment.
- b. The bottom-up approach is driven by citizen motivation to participate to the project: expert consultation and group focus interested in the subject. We used this approach in tasks' design and it is supported by technological tools.

One of the challenges is to harmonize the scientific goal of the stakeholders and educational goal of the citizens.

In order to address this, the strategy considered to attract target groups by reusing the social network of participants evolving around the Library for the history of education (BBF): retired teachers, students and 'Friends of BBF' group. Students interested in the Digital Humanities are invited also to participate to the platform and learn how to carry out research in and create reusable pieces of educational resources.

### 5.1 Tasks Design

The tasks design is a result of bottom-up approach driven by researchers' requirements and citizens' expectations. Their actions encompass the tasks categorization in conformity with level of actions performed by citizens and expected outcome (see [Table 1](#)). A comprehensive analysis of the tasks action and level of participation in the inquiry shows that T5 may reuse the outcome of previous tasks and require a higher degree of expertise. Following the methodology exposed by Bonney et al. in [5] and Wiggins and Crowston in [25] we analyzed the workers performed actions. This analysis helps us to categorize the project at the level of co-created projects; even not all the actions enlisted are always required. Par example, action 'Design data collection methodology' is only sometimes explicitly addressed.

<sup>19</sup> [https://en.wikipedia.org/wiki/Top-down\\_and\\_bottom-up\\_design](https://en.wikipedia.org/wiki/Top-down_and_bottom-up_design)

In the following paragraphs, we present the full description of tasks and expected outcomes.

**Table 1. Tasks categorization and their dependencies.**

Performed actions	T1	T2	T3	T4	T5
Choose or define question(s) for study					X
Gather information /resources	X	X	X	X	X
Develop explanations					X
Design data collection					S
Analyze data		X		X	X
Interpret data				X	X
Disseminate conclusions					X
Discuss results and ask new questions					X
Task dependencies	I	I	I	I	D, T2, T3, T4

**T1: Transcription of translations.**

The first citizen science task is the transcription of translations of the actual texts that are part of the book apart from the pictures. The texts were in French, Italian und English. These texts were OCR-scanned, but not corrected. This task brings back the original intention of Bertuch to have his works translated into multiple languages.

**T2: Specifying the connection to Wikidata.**

*Wikidata harvesting.*

Wikidata<sup>20</sup> is a crowd-sourced knowledge base that maintains information about entities of human knowledge, called items in Wikidata parlance, which can be topics of Wikipedia articles (people, cities, movies, biological entities, etc.) or anything else deemed of interest. Information about an entity is structured as a collection of *statements*, which are pairs consisting of a key, called, *property*, and a *value*, which can be an atomic data value, an item, a property, or some possibly complex structure. Currently, Wikidata contains roughly 25 mio. entities, and 2719 properties. Many properties are quite specific, and apply only to few entities, there are not always structural commonalities among entities. Another challenge is language ambiguity, over the time, the names of many biological entities (animals and flowers) changed. Workers are invited to search first Wikipedia for the appropriate entity that match Bertuch’s intended term for a specific entity and link to Wikidata item.

Following guidelines, they collect information and explicit which biological entities were described in Bertuch’s work and give an overview of the 18th century knowledge’s level as reflected in the book. The outcome of this task is at least a link to a Wikidata entry. An automatic process using Wikidata API could harvest information about that entity and write it in wiki, using a semantic template.

**T3: Literature about Bertuch and his work.**

At the advent of 18th century, there were many other authors publishing encyclopedias. Bertuch was a famous publisher of his time; along with "Bilderbuch für Kinder", his publications consist of magazines and various kinds of literature. The goal of this task is to have an overview of all these works, since this work was not addressed yet.

The task outcome is an index of prior works which Bertuch used in his encyclopedia, along with other works influenced by Bertuch. Citizens are invited to collect literature of that time and in the best case link to digitized versions of work. This task will help other researchers who want to do the other complex tasks.

**T4: Literature review: predecessors and successors.**

Earlier research showed that many pictures of the book were copied or at least inspired from other sources [6].

In the 18th century it was not easy to get pictures of exotic places and animals, so the editors re-used other sources for their paintings. At that time, were also many other encyclopedias published. Citizens are invited to make these connections visible, while provide also a link to each picture of the predecessors’ work. A variation of this task is regarding successors’ work. Other authors re-used the illustrations of Bertuch’s book for their own projects.

**T5: Custom Research**

Traditional library services lack in users –sources interactions. This holds still true for professional researchers that want to work with these sources. A partners’ requirement is regarding the affordance to use the platform for their customizable research. This request is addressed by providing sematic templates with minimal design constraints and gives the possibility to everyone interested in further research about Bertuch and his works.

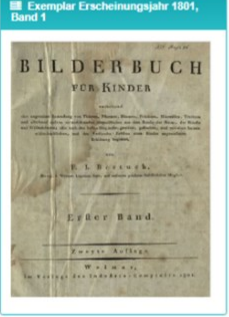
**5.2 Creation of open educational resources**

Using the open structure of a wiki, the researchers are able to create their own research questions and answer them using wiki resources. One of the challenges in CS projects is the strategy to attract users and retain them into project.

One of the target groups is formed by lectures in the (digital) humanities who teach information literacy or methods of the humanities research. By providing clear documentation we allow lecturers that lack the technical expertise to set up a similar system to also use digital methods in their courses.


<sup>20</sup> <https://www.wikidata.org/>

### Exemplar Erscheinungsjahr 1801, Band 1




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Band:	1
Umfang:	100 Bl., ungez. Bl.
Sprache:	ger. fle
Besitzende:	Bibliothek für Bildungsgeschichtliche Forschung Berlin
Einrichtung:	Bertuch-Bilderbuch für Kinder enthaltend eine angenehme Sammlung von Thieren, Pflanzen, Blumen, Früchten, Mineralien, Trachten
Gehörtzu Bertuch:	


Enthaltene Tafeln



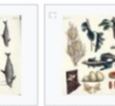
Verflüssigte Thiere in heißen Ländern




Verflüssigte Thiere aus heißen Ländern



Vögel die nicht fliegen



Drey Walffisch-Arten



Der Seidenurmum mit seinen Verwandlungen

### Der Elefant

Der Elefant wird auf der **ersten Tafel im ersten Band** zusammen mit dem Kamel vorgestellt. Er wird im strengen Profil nach rechts blickend gezeigt. Sein Rüssel ist leicht geschwungen, die Stoßzähne sind groß und gebogen, die Stirn fällt leicht zurück. Der Rücken ist zum Gesäß abfällig, die Vorderbeine enden in handähnlichen Füßen mit ausgeprägten Zehen, bei den Hinterbeinen ist die Fußform nicht so stark ausgeprägt. Auffällig sind die massiven Vorderbeine mit sehr hoch angesetztem Kniegelenk und die beiden senkrechten Falten oberhalb der Beine.

Die Kolorierung zeigt bei allen Exemplaren ein graues Hautbild - mit leichten Schattierungen; der Scan aus Weimar ist eher dezent koloriert, das Berliner Exemplar ist kräftiger, das Heidelberger hat einen Einschlag ins bräunliche.

Auf allen Exemplaren steht der Elefant auf einem grünlichen Untergrund mit deutlicher Schattierung.

Kopfform und die kleinen Ohren lassen auf einen asiatischen Elefanten schließen.


#### Beschreibender Text

Größe: 10 bis 14 Fuss hoch (3 bis 4,2m) und 16 1/2 Fuss lang (5m)  
 Lebensdauer: fast 200 Jahre  
 Wikipedia: ältester Elefant im Zoo 86 Jahre alt, (Elefant ⓘ)  
 Besonders treu und sehr gelehrig und geschickt.  
 Habitat: Afrika und Asien, in Herden von mehr als 100 bis 1000 Stück  
 Wikipedia: Herden umfassen 6 bis 30 Tiere, im 19. Jh. soll es Herden von bis zu 100 Tieren gegeben haben (Asiatischer Elefant ⓘ)


#### Vorläufer

Die Abbildung entspricht spiegelverkehrt der ersten Tafel aus *Cochens* Portefeuille. Auch diese Tafel enthält zusätzlich die Darstellung eines Kamels, allerdings werden noch drei weitere kleine Tiere vorgestellt.


Eine ähnliche Bildung des Vorderbeins sieht man bei einer Raffaelzeichnung von Hanno, einem Elefanten im Besitz von Papst Leo.



Tafel I, Bd I, 1790, (Exemplar Weimar)



Tafel I, Bd I, 1801, (Exemplar Berlin)



Tafel I, Bd I, 1801, (Exemplar Heidelberg)

Figure 2. To the left, an Exemplar (part of Volume) wiki page, to the right the outcome of task T5.

An important aspect is the level of openness of OER and how this is supported by the SMW based platform. The 5Rs framework allows a formalization of the level of openness, and it was considered at the design level.

One of the primary benefits of an OER is that it can be adapted to the needs of specific learning settings. In order to facilitate this, the 'R's of 'revise' and 'remix' are necessary. And for revisions and remixing to be legal, a license that permits derivatives is necessary. At the design level, it was established the degree to which the OER to be open, and we used 'CC BY NC SA' to license the OER accordingly. This states that OER can be revised and remixed for non-commercial purposes and the derivative works will be shared under the same license. Users can redistribute and disseminate data and reuse these in different learning contexts. Also, they can remix and combine information about Bertuch's books, remix the tasks descriptions, combine the outcome of tasks with external sources (linked open data).

The SMW based platform enables several technical aspects that make OERs easier to revise and remix, and consequently affect the level of openness of an OER.

Retain specifies the possibility to own a copy of the OER. Technically, this aspect is covered by XML and pdf export from the platform. For semantic web reuse, RDF export is provided also. OERs will be easy to revise or remix technically as they are easily editable via semantic forms. There is no need of special technical skills to use semantic forms. For any registered user, the access to the source file is also provided.

### 5.3 Ontology description

Ontologies are designed to define concepts and relationships related to the knowledge base. In SMW based platforms, semantics are formally defined using the OWL DL based upper level ontology: Semantic Wiki Vocabulary and Terminology (SwiVT)<sup>21</sup>. This ontology gives the possibility to reuse and aggregate knowledge among different semantic wikis. This ontology includes the most basic terms involved in the markup metadata model used by SMW. SMW reuses the MW "Category" namespace to define classes. A wiki page may be declared as an instance of a class. The semantic properties are declared via annotation mechanism directly in wiki page. The semantic wiki based platform allows citizens to formulate their custom research questions and answers them based on already collected data or other means. The outcome of this task is a resource that could be used as an open educational resource. See Figure 2, right, the research outcome about elephant.

<sup>21</sup> <http://semantic-mediawiki.org/swiwt/>



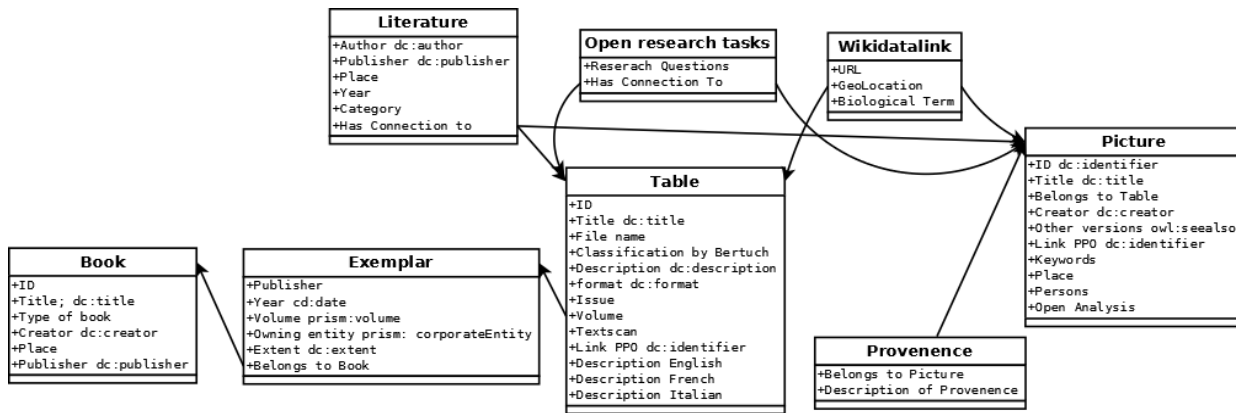


Figure 3. Overall ontology.

The IP wiki core ontology is the result of the metadata import into wiki, enriched with new entities and properties. Citizens’ work helps designing and structuring IP’s extended ontology. In fact, interacting with SMW based platform, citizens can enrich the ontology by creating new attributes and entities. This ontology is the conceptual model specific IP topic, used to model the wiki pages about project knowledge. **Fehler! Verweisquelle konnte nicht gefunden werden.** presents IP overall ontology. Entities like *Literature*, *Open Research Tasks*, *Wikidata link* belong to the extended ontology created via citizens’ work. This ontology is dynamically developed, following the incremental way of research in Humanities and the research steadily refinement.

We mapped semantic properties to standard vocabularies and ontologies, where this is appropriate: dcmitemrs<sup>22</sup>, foaf<sup>23</sup>, bibo<sup>24</sup>, owl<sup>25</sup>.

### 5.4 Addressing interoperability issues: Mapping to LRMI Vocabulary

The Learning Resource Metadata Initiative (LRMI)<sup>26</sup> [2] has been adopted by <http://schema.org> and aims to establish an open standard for adding semantic mark-up to online learning resources. Using the LRMI vocabulary enables easier discovery of content by search engines and other organizations. Thus, mapping concepts from the project underlying ontology to the LRMI vocabulary contributes towards a model of consistent organization and discovery of content.

LRMI provides a generic framework for describing learning resources, which is independent from certain educational frameworks. To this end, LRMI introduces the concept *AlignmentObject* and the *educationalAlignment* property [2]. The

*AlignmentObject* is an abstract concept mapped to educational levels, subjects and topics. The *educationalAlignment* links a learning resource with an educational concept. The *AlignmentObject* class provides an *alignmentType* property that describes the type of alignment being specified.

In order to feed search engines with metadata about learning resources and the open educational resources, semantic markup is added to the wiki pages of a content item, i.e. an image. The next example demonstrates how to embed markup using *alignmentType*, *educationalFramework* and *educationalAlignment*. A wiki page categorized as open educational resource is associated to an instance of OER class instance. The content of the *alignmentType* property indicates that ‘wiki page title’ is an educational level.

#### Example of wiki page content

```
<div>
<h1>Recherche Elefant</h1>
<p>Resource type: lesson, learning activity</p>
<p>Target audience: teachers</p>
<p>Educational level: 7</p>
<p>Location: <a href="https://interlinking-pictura.semantic-cora.org/index.php/Recherche_-_Elefant">Recherche_-_Elefant</a></p>
</div>
```

#### With added microdata that becomes:

```
<div itemscope itemtype="http://schema.org/CreativeWork">
<h1 itemprop="name"> Recherche Elefant </h1>
<p>Resource type:
<span itemprop="learningResourceType">lesson</span>,
<span itemprop="learningResourceType">learning
activity</span></p>
<p>Target audience:
<span itemprop="audience" itemscope
itemtype="http://schema.org/EducationalAudience">
<span itemprop="educationalRole">teacher</span></span>s.
</p>
```

<sup>22</sup> <http://www.dublincore.org/documents/dcmi-terms/>  
<sup>23</sup> <http://www.foaf-project.org/>  
<sup>24</sup> <http://www.bibliontology.com/>  
<sup>25</sup> <https://www.w3.org/OWL/>  
<sup>26</sup> <http://www.lrmi.net/the-specification>

```

<p itemprop="educationalAlignment" itemscope
itemtype="http://schema.org/AlignmentObject">
  <span itemprop="alignmentType">Educational
level</span>:
  <span itemprop="educationalFramework"> tertiary
education/Hochschule</span>
  <span itemprop="targetName">7</span>
  <link itemprop="targetUrl" href="
https://www.bildungsserver.de/Hochschulsystem-1158-de.html"
/> </p>
<p>Location: <a itemprop="url" href=" https://interlinking-
pictura.semantic-cora.org/index.php/Recherche_-_Elefant ">
Recherche_-_Elefant </a>
</p>
</div>

```

Any information encoded in webpages using LRMI metadata will be available through some of their generic tools and services, e.g. Google custom search engines.

## 6 DISCUSSION AND FUTURE WORK

Manuscript and early prints held in heritage institutions (libraries and archival collections) are of special interest for humanities research. In order to achieve a harmonized, standardized and meaningful description of resources, librarians, archivists and humanities researchers, on one side, need to collaborate in low technological barrier frameworks. On the other side, Semantic Technologies give the opportunity to address the recent move in eHumanities towards multi-method approaches offering multi-layered research environments. In this respect, our approach employs Semantic MediaWiki (SMW) technology in order to fulfill requirements (functional, structural and as user interface) of a web-based platform that serve as an infrastructure for IP project. Moreover, the project stakeholders invite citizens to participate and convert their knowledge to contribute to the project and learn about Bertuch and his world and also create pieces of new knowledge in the form of open educational resources. As we have discussed in the [Section 2](#), not many projects state education as a primary goal.

CS projects are built up on two pillars: technology and citizens motivations. The IP project uses a researcher's and citizen's design driven approach to address the technological challenges. We employ the light semantic web technologies and tools, collaborative spaces and elaborate methodology to create appropriate tasks. Web platforms based on SMW are a way to ease the research process.

Our main contributions in this work address several levels:

- A new collection of semantic templates and forms to Semantic MediaWiki to capture the metadata of the digitized version of Bertuch's book.
- Methodologic and infrastructural support for collaborative creation of OER.
- A dynamic ontology of Bertuch's world.
- A set of bespoke tools and templates to support citizens' contribution to the project.

- Usage of controlled vocabularies to address interoperability at the project and metadata level.

We use already existing social networks around the BBF library interested in the subject and create task templates which gradually imply users in the subject. Clear guidelines and early examples could help also.

Also, user feedback is an important way to collect requirements and suggestions. Their motivation and interest is kept alive by the opportunities to improve their skills and contribute to OERs creation, as there are mostly professionals in education.

### 6.1 Limitations of work

As the IP project is still under development, there are only limited quantifiable assets available. Most of the findings came on the form of lessons learned.

### 6.2 Lessons learned

- Help wiki users "Snap to grid". Users can make change to ontology that will invalidate previously verified requests and they can diverge on ontology evolution. Restrict ontology updates to administrators is not in the wiki spirit. But clear guidelines, templates, semantic forms and "good practices" examples state the best.
- Involve users in early stages of project design and development and bring semantic technologies to user not vice-versa.
- Give back enhanced corpora of data and metadata along with user experience in the form of comments, image and/or text annotation or references to external resources achieved via citizens 'contribution to digital libraries.
- The work in wiki based platforms never ends and maybe someone else with access to the same wiki knows something better about the topic. This style matches the eHumanities research style which is incremental and evolves around the research object.

### 6.3 Future work

There are certain other possibilities to use data collected by citizens in the project. Using Wikidata API is only one way to add more structured data. Another way is to use other sources that are connected to Wikidata. Once semantic linking of Bertuch' predecessors and successors are collected in to IP wiki, it is possible open the unexplored way to have quantitative analysis, i.e. how much of Bertuch's book is original content and how much is copied or inspired from other works. We can also show how Bertuch influenced other publishers at the same time.

The IP project is mostly targeting the German space, where LOM standard for educational resources is mostly used. In order to make our project interoperable with the rest of these resources, we plan to map our ontology terms to Lom standard too.

Our work can be interesting for teachers and lecturers in the (digital) humanities that often lack the technical capabilities of building digital tools. In this respect, the project will be used in

the summer term 2018 for a course about digital humanities at Hochschule Darmstadt in the master's program information science.

## 7 CONCLUSIONS

In summary, we have performed both an experimental and theoretical study of the spin eigenmodes in dipolarly coupled bi-component cobalt and permalloy elliptical nanodots. Several eigenmodes have been identified and their frequency evolution as a function of the intensity of the applied magnetic field has been measured by Brillouin light scattering technique, encompassing the ground states where the cobalt and permalloy dots magnetize. When considered as a tool, method, or form of research collaboration, citizen science is associated with the potential for significant benefits for volunteers, for example, for improving literacy [10] or even writing scientific papers.

Many scientific projects employ MW and SMW as underlying technologies to support research in different domains.

Several works employ citizen science as tool to leverage the crowd knowledge into key assets, mostly on the different typologies of crowdsourcing.

Our work is trying to better use citizens' collective knowledge by employing them into a higher level of performed actions in research: metadata curation and enrichment, external sources interlinking and co-creation of open educational resources. We invited the citizens' network evolving around BBF library, students and retired teachers to be part of the project, contribute and learn. Another target group consists of the lecturers at university. They may use the IP project platform in their courses, to teach digital methods in the humanities. It is also suitable for lecturers in information or computer science to teach students methods used in the humanities.

The approach is a layered candidate in achieving interoperability at the syntactic and semantic level with a low technological entry barrier: at the data level, we adopted standardized vocabularies, along with LRMI open initiative for describing online learning resources.

At the organizational level, to ensure interoperability with other citizen science projects, we enrolled the project into the SciStarter.org database, which uses a new proposed metadata set to describe citizen projects.

Also, we described IP platform as authorized source for open educational resources by enrolling the project to OER worldmap<sup>27</sup>.

Nevertheless, Digital Humanities is concerned with not just the use of digital technology for humanities projects, but how the use of digital technology for humanities projects changes the user's experience. This almost unexplored path opens two possible research questions which might be of interest and open new directions to continue our work in the future:

a. What can be learnt by analyzing users' behavior using the IP project platform?

<sup>27</sup> <https://oerworldmap.org/resource/urn:uuid:d6a432b3-bbca-42bf-9aeb-b29cf51acd5c>

b. How can we use this information to better tailor our services and build on the relationship we've developed with these users?

## ACKNOWLEDGMENTS

Initially, the realization of the research environment Semantic CorA was supported by the German Research Foundation (DFG); its further development for Interlinking Pictura was funded in the context of the eHumanities Center CEDIFOR by The German Federal Ministry of Education and Research (BMBF) no. 01UG1416C.

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