

# Experiential Observations: An Ontology Pattern-Based Study on Capturing the Potential Content within Evidences of Experiences

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Modelling the knowledge behind human experiences is a complex process: it should take into account, among others, the activities performed, human observations and the documentation of the evidence. To represent this knowledge in a declarative way means to support data interoperability in the context of cultural heritage artefacts, as linked datasets on experience documentation have started to appear. With this objective in mind, we describe a study based on an ontology design pattern for modelling experiences through observations, which are considered indirect evidence of a mental process (i.e., the experience). This pattern highlights the structural differences between types of experiential documentation, such as diaries and social media, providing a guideline for the comparability between different domains and for supporting the construction of heterogeneous datasets based on an epistemic compatibility. We have performed not only a formal evaluation over the pattern but also an assessment through a series of case studies. This approach includes (a) the analysis of interoperability among two case studies (reading through social media and historical sources); (b) the development of an ontology for collecting evidences of reading, which reuses the proposed pattern; and (c) the inspection of experience in humanities datasets.

CCS Concepts: • **Applied computing** → **Arts and humanities**; • **Computing methodologies** → **Ontology engineering**; • **Information systems** → Digital libraries and archives;

Additional Key Words and Phrases: ICT technologies in support of creating new cultural experiences or digital artefacts; metadata, classification schema, ontologies and semantic processing for CH multimedia repositories; knowledge patterns; digital humanities; intangible cultural heritage; human experience studies

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## 1 INTRODUCTION

Knowledge engineering for the digital humanities has come a long way in the production of formal models for the representation of tangible elements of cultural heritage. Recent research is now attempting a systematic cataloguing, modelling and usage in content annotation of phenomenological entities that originate from the interaction with material content yet are per se immaterial. Examples include the experience of reading a book or of listening to someone read it aloud. To capture evidence of an experience through Linked Data, research projects such as the UK **Reading Experience Database (RED)** [1] and **Listening Experience Database (LED)** [2] adopted arguably simplistic approaches at modelling an experience as a single entity—with LED representing it, for instance, as an “internalised event”. These simplifications are justified by looking into their use cases, which required addressing only factual elements, such as what book was being read, who was playing the music heard, where and when.

The reality, however, is much more complex. The experiences associated with reading or listening are decoupled from the activity itself and the events it triggers, as well as from its trace that can be found in sources like diaries, letters or interviews. Instead of its *effects*, the relation between experience and activity should be modelled through epistemological lenses [3]—for example, which aspects of the experience can be found in sources?

It is difficult to reach a consensus on how to model all kinds of experiences. We shall argue, however, that one can identify recurring elements that serve as ontological members of the anatomy of an experience, which calls for an **Ontology Design Pattern (ODP)**.

In this article, we present a **Content Pattern (CP)** called **Experience & Observation (E&O)**<sup>1</sup> and discuss its application to real Humanities data. E&O models the observation of experience as (a) the direct engagement in an activity and (b) the observation prompted from the person engaged in the activity. E&O represents an experience through its factual, cognitive, phenomenological and critical coordinates. Its concepts all lend themselves to further specialisation in the ontologies where the CP will be instantiated, as well as to use cases like fine-grained text annotation.

### 1.1 Motivation and Aim

This pattern is motivated by the need to express the relations between documents where testimonies of experience, such as reading or listening, are recorded. Specifically, the types of relations we model concern the potential informational content of sources: the (experiential) observation reflecting the activity in object (trigger of the *experience*) and the prompting (the activity that triggers the *observation* about an experience). This intent can be summarised as an attempt to address the following **Research Questions (RQs)**:

*RQ1:* Given multiple heterogeneous informative datasets on the effects of interacting with cultural objects, can we perform an abstraction over the cultural domain to render these data interoperable through a reusable ontological framework?

*RQ2:* If such an abstraction is possible, what will its key concepts be, so that the phenomenological coordinates of the experience can be extracted from the informational content, while still preserving their diversity?

A hypothetical upper ontology of observation would abstract from the phenomenon by providing a middleware between phenomenological ontologies and ontologies of sources (Figure 1). On the one hand, ontologies of sources like LRMoo/FRBRoo [4] and SPAR [5] describe objective features of sources but not their information content. On the other hand, experiential ontologies describe the phenomenon in object but not the relations between the content structures and features of the sources. In other words, the need for the E&O is grounded on the need for a language to express general features of sources with a direct relation to their phenomenological content. For example, a listener may recount that hearing a particularly “groovy” riff in a rock song, or a peculiar

<sup>1</sup>Submission to the ODP portal: [http://ontologydesignpatterns.org/wiki/Submissions:Experience\\_%26\\_Observation](http://ontologydesignpatterns.org/wiki/Submissions:Experience_%26_Observation).

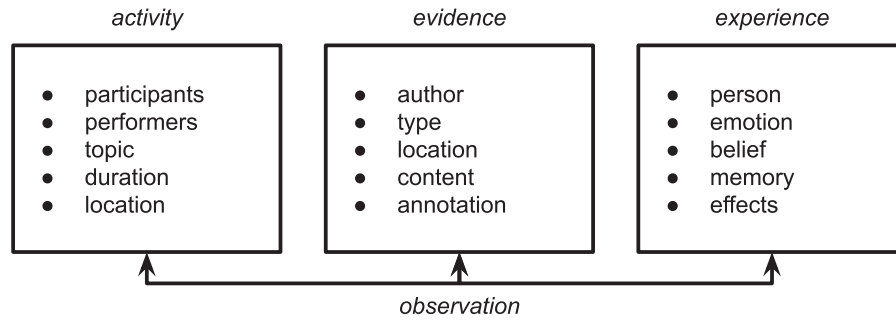


Fig. 1. Observations are the result of a combination of activity, experience and the opportunity to express the observation (evidence).

rendition of it in a live performance, inspired them to conduct research on the musicians who wrote, played or were influenced by it. This latter example demonstrates that an abstraction over this reality into a knowledge pattern should not make assumptions on what is labelled as sources—that is, those whose consumption prompts the observation. They could belong anywhere in the information layering of FRBR, such as works, expressions or manifestations (which musical performances generate),<sup>2</sup> and which ones should be treated as sources depends on the user’s ability to discern among those layers when recording their evidence.

Indeed, each different experiential study adopts different models for the description of data, grounded on the nature of the phenomenon in object and relying on a set of assumptions concerning the homogeneous nature of sources. In this scenario, the E&O pattern supports data interoperability between research use cases, clarifying the relation between activity, reflection and the evidences used in experiential studies.

## 1.2 Application Scenarios

The E&O pattern is intended to support extending schemas and ontologies to encode research data from experiential studies to express key facts concerning sources, which would otherwise be lost with the background knowledge of the experts on those sources.

Interoperable research data do introduce new issues. Indeed, data reuse enables a detachment between the analysis of sources and the use of the generated data: the in-depth understanding of sources (e.g., provenance and limitations) is therefore no longer a requirement for using the data. For instance, a scholar in Classical Studies can mix and match data from heterogeneous studies, such as online book reviews or marginalia from an author’s library, without being an expert in either type of source or method. In other words, the technical feasibility granted by having a common schema of the research subject does remove the need for information necessary to the correct framing of a study. E&O provides a way to reinstate the context of datasets, which is necessary to interpret the data correctly. For instance, is the reading experience spontaneous or guided by a questionnaire? Is it a mature recollection years after reading or an immediate response? Is reading a free choice or part of a school or work assignment?

The rest of the article is structured as follows. Section 2 provides a brief background on experiential studies and the issues concerning observing experience. Section 3 presents a summary of the state of the art, including relevant patterns and experiential ontologies. Section 4 describes the E&O pattern in detail, whereas Section 5 is devoted to its evaluation. In Section 6, we discuss the application of the pattern and of the retrospective case studies. Section 7 provides a discussion of the case studies in terms of common patterns emerging from applying E&O to the encoding of the different types of sources. Finally, Section 8 concludes the article and includes future lines of work.

<sup>2</sup><https://www.ifla.org/publications/functional-requirements-for-bibliographic-records>.

## 2 BACKGROUND

The E&O ontology pattern stems from a need to support interoperability across disciplines and projects that share a focus on human experience. Specifically, it addresses the interoperability of the sources of evidence of experience, such as private letters or diaries.

A prior work on a **Reading Experience Ontology (REO)** [3] is being implemented as a module for the CIDOC-CRM ISO standard for cultural heritage [6],<sup>3</sup> providing a shared platform for reading and a pattern for other forms of experience. As argued, the support of a common ontology of experience is limited to the *interoperability of research outputs* (e.g., annotation of sources). However, broad scope research programmes require an *interoperability of research case studies*, which introduces new challenges concerning the compatibility between different research designs (e.g., the combination of methods, sources and questions).

### 2.1 Research Interoperability

An example of this challenge with heterogeneous sources is the research programme of the EU JPI for Cultural Heritage project *READ-IT* (Reading Europe Advance Data Investigation Tool), which includes different case studies [7]. The *READ-IT* case studies rely on a wide range of sources, such as interviews, school diaries, war diaries, letters, authors' libraries, postcards, chat conversations, web scraping from online reading platforms, paintings, pictures, digital forms, reviews and social media comments. The *READ-IT* approach is based on data interoperability—that is, the encoding of research outcomes in a common format: the REO. This is achieved through the use of a shared toolbox including an annotation tool, contribution platform and machine learning services for text and image analysis.

At the same time, the sources used to generate these data tell multiple stories. Sources of reading experience are the result of different situations entailing specific constraints on the type of research and questions researchers can address. For instance, sources can hide different intrinsic characteristics of the evidences of reading experience, such as (a) the maturity of a reader's reflection, (b) the reader's freedom of expression or (c) the reason for giving testimony to their experience. Intuitively, the underlying conditions of sources entail a different set of ontological and epistemic assumptions that are understood clearly by the researchers who are working hands-on on the sources but not reflected in the research data that are derived from them.

The data-driven approach to interoperability hides two orders of issues (Figure 2). First, the reuse of data implies a form of indirect reuse of sources, hence a question of integrability—that is, which facets of the phenomenon could be used to explore the sources. Second, even though different sources could be integrated, there is a question of compatibility between the reused source and the research framing of a new case study: for example, can the reused source be employed to address the RQs of the new case study?

In the following section, we outline a parallel between the anatomy of reading and the generation of evidences of experiences, as reflecting the facets of the experiential phenomenon.

### 2.2 Anatomy and Evidence of Experience

The two issues of “integrability” and “compatibility” are critical, ultimately, because of the interference of the observation on the phenomenon in object. Indeed, the activity of generating an observation influences the phenomenon observed. Intuitively, human experience is the result of reflection, whereas, similarly, the generation of an evidence requires also a reflection *on the reflection* which can, for example, trigger a revision, and therefore a change in the experience.

On the one hand, in the case of historical sources, this interference is not controlled by the modern-day researcher and therefore requires expertise to enable a retrospective analysis. For instance, in school reading diaries from 20th-century Czechia, students were compelled to report on their reading in the context of a Communist

<sup>3</sup>REO and module for CIDOC-CRM on GitHub: <https://github.com/eureadit/reading-experience-ontology>.

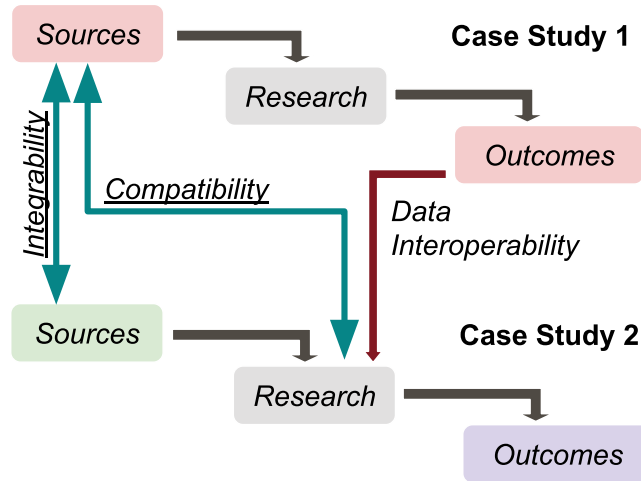


Fig. 2. Data interoperability enables the reuse of research outcomes through case studies, but it hides issues of “integrability” between sources and “compatibility” with a source being indirectly reused through research data within the framing of a new research study.

regime [8]. On the other hand, in the case of sources generated in a contemporary research framework, the interference is designed with the aim of fostering the emergence of specific facts on the experiential phenomenon in the resulting evidences. For instance, structured interviews are designed to (a) create a specific setting and (b) make specific information emerge, regardless of the participants being engaged.

Both cases of controlled and non-controlled interference require a disentanglement of the relations between the cause of experience and the source. Indeed, an observation is just one of many possible formulations of such experience: a choice about what facets of the experience to report (i.e., the meaning of the observation in Figure 3). In this view, the formulation of these relations specifically concerns (a) the “mapping of meaning” between the experience encoded in an observation and the situation causing the experience, and (b) the “mapping of condition” that generates the observation and the situation of the experience. These mappings reflect the relations between the elements of the anatomy of experience and the structure and content of the source, as mediated by controlled and uncontrolled interference, such as projections, alterations, omissions and transformations.

A fitting example of the mapping of condition concerns identifying the level of “maturity” of experiences. For instance, one source used in a READ-IT case study is a set of structured interviews asking about the lifetime effect of reading. On a close analysis, some of the transcripts include temporal clues about the age of the interviewee or about the temporal distance between the interview and the reading. This information could and should describe the whole set of interviews and thus the full dataset produced by the research case study. This form of encoding would rely on knowledge of the source—for example, from the interviewer or the researcher working on their annotation.

As the issue on hand concerns the description of sources rather than a specific type of experience, the state of the art focuses on how provenance and observations are addressed in ontologies and patterns for experiential and observational studies in general.

### 3 STATE OF THE ART

Our analysis of existing scholarly publications and of widely employed repositories for ontologies and design patterns highlighted a rather small set of relevant works. This is not surprising, as personal experience is subjective to an interpretation on what is relevant and therefore hard to model. From a broader perspective, evidences

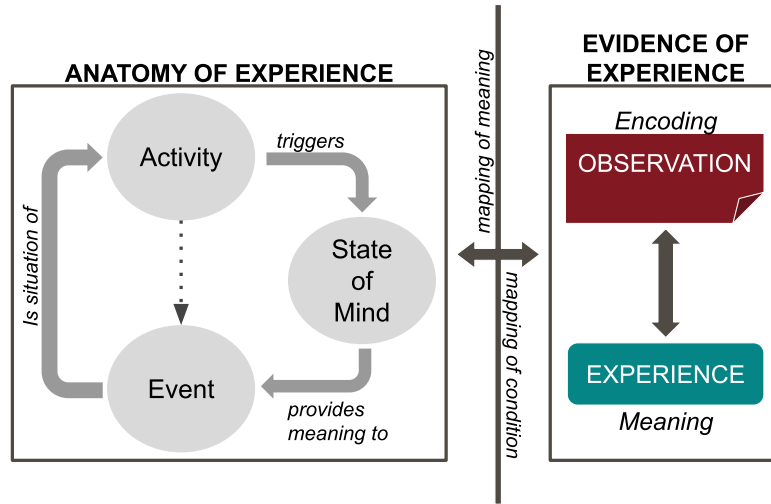


Fig. 3. From the presentation of REO [3]: an activity triggers a change in state of mind; this change is a reflection on some specific aspects of the activity (an event) within the context of the activity. In this view, a source is an evidence of experience when including an observation encoding a reflection of the experience, such as concerning the state of mind, event and activity. Thus, the in-depth understanding of the context of a source concerns its relation with the experience: the mapping of meaning and conditions connecting the different elements of the anatomy of the experience and the structure/content of the source.

of experience are indeed widely addressed, if mainly through their objective, material and factual properties. Indeed, the scope of the standards for sources, such as Prov-O<sup>4</sup> (which focuses on the activities behind the generation of data) and CIDOC CRM,<sup>5</sup> is limited by a focus on the artefact itself and its value for archival science or cultural heritage.

Therefore, we do not concern ourselves with a discussion of ontologies for sources and provenance but instead focus on specific ontologies and design patterns about the observation of events. Several ontology repositories could be queried for knowledge resources about event observations,<sup>6</sup> including BioPortal,<sup>7</sup> COLORE,<sup>8</sup> LOV (Linked Open Vocabularies registry),<sup>9</sup> OntoHub<sup>10</sup> and the ODP repository.<sup>11</sup> Having to search for examples of models across domains, we concentrated on a general-purpose ontology repository and opted for LOV, because it is the repository with the broadest collection of ontologies that are commonly reused from the Linked Open Data Cloud by ontology engineers [9], and because it is constantly being updated and maintained. In addition, we decided to also search for ODPs based on the idea of reusing not only ontologies but also other resources during ontology development [10]. In this specific scenario, the most exhaustive repository of patterns is the ODP portal [9].

Based on these decisions, in our search we found that LOV indexes four ontologies about observation: the ISO 19156 Observation Model, the Observation Method Ontology, the Sensor, Observation, Sample, and Actuator

<sup>4</sup><https://www.w3.org/TR/prov-o/>.

<sup>5</sup><http://www.cidoc-crm.org/>.

<sup>6</sup>It is outside the scope of this article to perform a comparative analysis of the existing ontology repositories.

<sup>7</sup><https://bioportal.bioontology.org/>.

<sup>8</sup><http://stl.mie.utoronto.ca/colore/>.

<sup>9</sup><https://lov.linkeddata.es/>.

<sup>10</sup><https://ontohub.org/>.

<sup>11</sup><http://ontologydesignpatterns.org/>.



(SOSA) Ontology, and OWL for Observations—all of them relate to sensor observations. Upon searching LOV using Experience as a term, we found one related ontology: the Experience API (xAPI), which is primarily about games and the interactions of gamers with them yet covers none of the arising subjective aspects. Conversely, the ODP portal includes patterns concerning observation, activities and transition. In the following sections, we discuss these patterns focusing on the interactions with E&O and on the opportunities for reuse.

Lastly, the research for relevant works was extended to ontologies, models and schemas developed within the frame of experiential studies, which include the ontologies of the UK RED, LED and the Reading Europe Advanced Data Investigation Tool (READ-IT).

### 3.1 Knowledge Patterns

This section is dedicated to the discussion of the findings of the search for ontologies and patterns, the ontologies of experience developed in previous projects, and an analysis of the gaps.

**3.1.1 Observation Pattern.** In describing “the observation of things, under a set of parameters”, the *Observation pattern*<sup>12</sup> assumes a “direct” observation of material, visible objects. Instead, E&O concerns indirect observations of mental events which cannot be measured but are instead evaluated through the mediation of the personal perspective of the person “owning” the experience and of the prompting activity from which the observation arises. This epistemic divergence prevents the reuse of the Observation pattern in the domain of experience.

**3.1.2 Activity Specification Pattern.** The *Activity Specification* pattern addresses the representation of activities and the observation of states as their effects<sup>13</sup> [11]. The pattern supports a parthood hierarchy (meronymy) of activities and also the temporal ordering of activities and states, identifying different roles of states as precondition or effects, terminal or non-terminal states. E&O connects to it via its Activity class, as the ODP provides the necessary elements for representing temporal distance and significant events (as change of states) reflected within the observations.

**3.1.3 Transition Pattern.** The *Transition* pattern<sup>14</sup> addresses transitions between states and is complementary to Activity Specification, adding to it the metaphysics of state transitions as caused by events, and the effect of changes on things. The E&O goal, however, is to describe the indirect study of an experience through the traces of its effect—that is, the observations. In this view, an observation’s content concerns states as effects of a transition resulting from carrying out an activity. E&O formulates a concept of (the agent’s) *engagement* that could be considered as a transition effect of an event activity and the cause of a state change in an agent involved in the activity. Since this does not supplement any concept *required* by E&O, Transition does not appear nor is subsumed in our CP.

**3.1.4 News Reporting Event.** The *News Reporting Event* ontology pattern [12] addresses indirect observations, such as news reporting based on third-party direct observations. In this view, the pattern enables an articulated description of the situation of the event and its direct observation and the relation with the report and reporter. Interestingly, this pattern introduces a secondary indirect source in the observer as grounding the report, defining an epistemic chain between report end event through two agents: the observer and the reporter.

**3.1.5 Social Reality.** The *Social Reality* ontology pattern [13] implements Searle’s theory about social reality. In *The Construction of Social Reality*, Searle [14] addresses the tension between the objectivity of social reality and the subjectivity of its interpretation by defining a scoping rule: X acts as Y in C. This rule frames the objectivity of

<sup>12</sup><http://ontologydesignpatterns.org/wiki/Submissions:Observation>.

<sup>13</sup><http://ontologydesignpatterns.org/wiki/Submissions:ActivitySpecification>.

<sup>14</sup><http://ontologydesignpatterns.org/wiki/Submissions:Transition>.



social facts within a specific social context (e.g., an organisation) in which their meaning, as social/institutional artefacts, has a value of fact [14]. In this view, this pattern supports a form of subjectivity in the relation between “brute” facts and the plurality of contexts of interpretation.

**3.1.6 Architecture of Knowledge.** Among full-fledged ontology networks, we note ArCo [15] as an effort to model cultural properties on a grounding of foundational ontologies rather than domain ones like CIDOC-CRM. Its Context Description module is of particular interest to us, due to its richness in describing that which has a potential to influence an engagement or to be affected by the observation offered in response, as exemplified by its Interpretation framework. Whilst extracting context and situations falls beyond the extrapolation of a minimal CP, ArCo offers multiple points of contact for ontologies that instantiate such a pattern.

### 3.2 Evidences of Experience

Unlike external observations, human experience can be observed only through the lenses of the person involved: as an auto-observation. Furthermore, an experience is unique and personal, meaning that (a) two subjects cannot have the same experience, regardless the replicability of the settings, and (b) the same subject exposed to the same interaction twice will have two different distinct experiences. This is a well-known characteristic of human experience, addressed and studied in Phenomenology (a field of philosophy focused on the rigorous study of experience) and in Human-Computer Interaction. As such, the study of experience is usually limited to its visible effects—that is, an indirect study of the effect of experience.

In this context, we focus on the testimonies of experience rather than on its effect: what subjects recall about their experience rather than the factual correlation with, for example, activities, choices or performances. In this view, experiences are reported indirectly and mediated by how and why the report is prompted. Sources are widely diverse, as are the possible conditions and rationales that give rise to them.

In the field of the Humanities, most sources are cultural heritage artefacts, such as the personal correspondence of authors or their private libraries including notes and marginalia, but also paintings of experiences, poetry and other aesthetic expressions. There is a partial overlap between the description of cultural heritage artefacts, such as their provenance and content, and the description of the experiences included. In what follows, we take three research projects into consideration, which address the experiences of reading and listening and in doing so have faced the challenge of extending and complementing the description of cultural heritage to support the analysis of evidences under the light of aesthetic experience.

**3.2.1 RED.** The UK RED is a digital humanities project which, for more than 20 years, has collected and annotated evidences of reading from cultural heritage sources. Its unprecedented and rich dataset is accessible through its portal<sup>15</sup> and as Linked Open Data.<sup>16</sup>

RED uses cultural heritage sources of different types, such as correspondence, diaries and reports. These sources were collected during multiple campaigns by scholars, students and volunteers. The heterogeneous provenance of RED sources is addressed from a bibliographical approach (e.g., reference, author and editor). Notes are used for additional observations such as provenance:

“Letter (original in Polish) from Conrad to Aniela Zagorska, Pent Farm, Christmas 1898”—from RED, resource 32273.<sup>17</sup>

From these sources, contributors identified and annotated the fragments of text relative to the experience and context of reading: where, when, who and how, which takes the shape of properties like century, country, reader, time, place, type of experience (i.e., reading or listening) and conditions (e.g., aloud, silent).

<sup>15</sup><http://www.open.ac.uk/Arts/reading/UK/index.php>.

<sup>16</sup>RDF graph: <http://data.open.ac.uk/context/red>.

<sup>17</sup>[https://www.open.ac.uk/Arts/reading/UK/record\\_details.php?id=32273](https://www.open.ac.uk/Arts/reading/UK/record_details.php?id=32273).

3.2.2 *LED*. LED addresses the experience of music and performances. Differently from RED, LED integrates multiple digital archives to reconstruct musical performances, events, performers and listeners. LED includes information about the provenance of sources and data (framed as a cooperative annotation work).

The FRBR-based LED ontology connects the notions of Listening Experience, Source, Agent and Music. In LED, listening experiences are described by reusing the concept of event from existing ontology literature. Regarding sources, LED reuses and extends the Bibo ontology<sup>18</sup> with a vocabulary of types of sources, such as oral history or official documents.

3.2.3 *READ-IT*. The EU-funded JPI for Cultural Heritage READ-IT project builds from the experience of RED, increasing the scope from the UK to Europe, and extending the conceptualisation of experience.

READ-IT includes a wide range of sources, not limited to cultural heritage but also including scraped reading websites, interviews, social media and crowd-sourced testimonies. In this regard, the READ-IT data model is agnostic to sources but relies on domain-specific schemas and ontologies, such as FRBR for library resources, CIDOC-CRM for cultural heritage and Schema.org<sup>19</sup> for web sources.

### 3.3 Direct, Indirect and Experiential Observations

The overview highlighted a specific gap concerning the integration between concepts (i.e., a cross-domain generalisation) rather than the concepts themselves.

For instance, in terms of Schema.org, a “CreativeWork” can be used to represent the evidence of experience (e.g., a review blog post) that is “about” an “Event” source of experience (e.g., a concert), with the “creator” of the “CreativeWork” being an “attendee” to the “Event”. Then, the specific aspects of the experience reported in the “CreativeWork” can be described by the REO concepts of “State of Mind”, such as encoding an emotional response. This example showcases the need for a definition of a common approach bridging different experiential domains and independent from the ontology or schema.

A second gap concerns addressing the differences between external observation and internal observation. As highlighted in the discussion of the Observation pattern, the description of an external direct observation concerns the measure of events. Similarly, the patterns News Reporting Event and Social Reality address a different form of external observation. In the first case, it can be traced to a direct observation (“ActualEventView”) or, in the second case, to the observation of “BF” (brute facts) as being relative or representative of social/institutional facts in a given context. All of these approaches address the objectivity of observation as either being material (direct observation), epistemic (report) or context related (social structures).

By contrast, personal experiences are legitimately subjective. Indeed, the human agent, subject to an experience, is both the object of change (the experience) and the subject observing the experience (the source of the testimony). In this regard, we can strive to provide an objective description of the possible changes triggered by an experience, such as attempted with REO. However, which changes occur and how these changes are being investigated is, for now, an intimate process that cannot be observed. Testimonies of experience are to be understood as post facto reconstructions and teleological explanations of the experience itself. In this view, the activity of reconstructing the experience is of great relevance in guiding the explanation (e.g., in focus, length and results).

The importance of *prompting* is also not new in psychology and social studies. In these fields, the problem concerns achieving a specific predictable response (e.g., during therapy or large-scale studies); however, we face the opposite problem: to reconstruct the effects of the prompting on the reporting of experience through a variety of heterogeneous settings.

To sum up, human experience can be *observed*, although indirectly, through the testimonies of people. The development of an experience is the result of the direct *engagement* within an *activity*. The engagement is

<sup>18</sup><https://bibliontology.com/>.

<sup>19</sup><https://schema.org/>.

significant (i.e., leading to an experience) when it results in a *transition* of mental state, such as the emergence of an emotion, the acquisition of an important memory or the learning of something new.

Experiential observation is intangible and unique, but the conditions in which we extract and report our experience are recurrent. If provided with the specific necessary information, researchers can identify how the different settings influence the reuse of research data. The scope of this contribution lies in defining what these information elements are beyond the specific domain.

## 4 E&O PATTERN

The rationale behind the E&O pattern is that an experience is too articulated to be ontologically captured as a single entity in a satisfactory manner. The complexity of the phenomenon of experience combines with the emergence of multiple datasets that offer examples of domain-specific kinds of experience as Linked Open Data to determine the need for a CP.<sup>20</sup> This complexity is also the reason why a named *experience* class is not to be found in this CP.

From a pragmatic perspective, as an example, we can consider annotating diaries or letters (e.g., an excerpt): the scholar would highlight passages describing, for example, the reader's memories elicited during reading. However, the setting of a personal diary and a letter to someone (e.g., the author in the role of an editor) inform the scholar about why and what is included in the diary or letter in terms of experience of reading. In other words, the experience *per se* can be seen as being evidenced by the excerpt as a whole. The E&O pattern describes the contextual information about the form and purpose of the testimonies of experience.

### 4.1 Methodology

From a methodological perspective, the E&O pattern was mainly developed drawing inspiration from the NeOn Methodology [10], which incorporates elements of eXtreme Design, a pattern-based methodology for developing domain ontologies [16], and allows for an ODP to be treated as a compact model of a reality abstraction. The development team consisted of two ontology engineers and two domain experts working in pairs.

Of the general-purpose scenarios listed in NeOn, the relevant ones for our use case were numbers 1 ("From specification to implementation"), 3 ("Reusing ontological resources") and 7 ("Reusing ontology design patterns", such as those listed in Section 3). Scenario 1 predicates that ontology requirements should be established. Requirements were gathered from experts and presented in the form of **Competency Questions (CQs)** as recommended by Suárez-Figueroa et al. [10]. An intermediate step was to extract domain-level scenarios by gathering (a) the definitions of the READ-IT project case studies [17], as well as (b) application scenarios for the materials implemented by the project, which included interoperability with reading and listening experience datasets of prior projects (further described in Section 6). These scenarios, especially in the light of the examples in Section 6, may be considered akin to the user stories contemplated by eXtreme Design and can be summarised as follows:

- (1) Studying whether and how the emotions of a reader have changed over history within one region of the world.
- (2) Identifying the kinds of transaction that exist between a reader and a text, or between a listener and the music, as well as the roles played by the environment in these transactions.
- (3) Creating a data model for digital humanities research on aesthetic experience that unifies data from several case studies, thus making them interoperable within the project.
- (4) Collecting evidence of reading from everyday users, both during dedicated events and at leisure (e.g., using a mobile chatbot).
- (5) Extracting evidence of aesthetic experience from legacy datasets, thus achieving external interoperability.

<sup>20</sup> Content pattern: <http://ontologydesignpatterns.org/wiki/Category:ContentOP>.

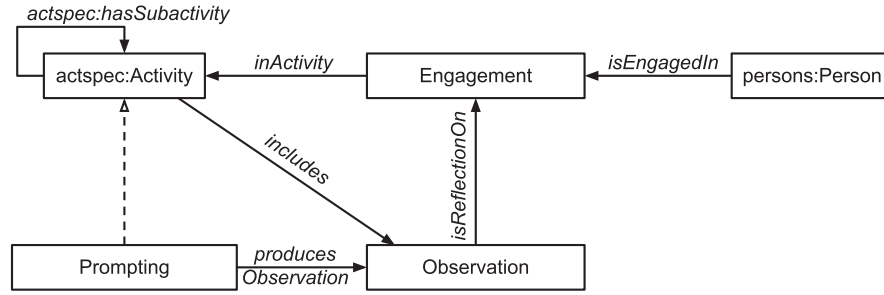


Fig. 4. Entities, specialisations (dashed) and relations in E&amp;O.

The E&O pattern focuses on the engagement in an activity, and on the creation of an observation as a result of another activity that prompts it (Figure 4). As such, it is predicated on the following CQs:

CQ1: In what ways can one person be engaged in each activity?

CQ2: What personal observations were produced by reflecting upon an activity being carried out?

CQ3: Which activities performed by someone have prompted an observation from that person?

The first user story depends on CQs 2 and 3 being answered, the second one depends on CQ1 and CQ3, and the fourth depends on all of them. The third and fifth user stories are intrinsic to research activities and thus do not give rise to domain-specific CQs; however, being able to answer the preceding indirectly supports scholarly work that hinges on the availability of the entities mentioned, such as activities and observations.

## 4.2 Pattern Structure

The E&O pattern is composed of the entities shown in Figure 4, and which are detailed in the sections to follow. In the figure, as well as in the figures and code segments that follow, the default prefix is assumed to be mapped to the namespace <http://modellingdh.github.io/ont/odp/term/>, whereas the Activity Specification pattern namespace is <http://ontology.eil.utoronto.ca/icity/ActivitySpecification/> and the general persons pattern namespace is <http://www.ontologydesignpatterns.org/cp/owl/persons.owl>.

### 4.2.1 Fragment About Activity.

*Class. Activity.* An occurrence being led by an active—although not necessarily conscious—agent. We accept the notion of activity as defined in the CP Activity Specification [11], due to its flexible relationship to events and its ability to capture states and the transitions of which they are extremes.

### 4.2.2 Fragment About Engagement.

*Class. Engagement.* This class is the core type of entities that represent a reification of one’s involvement in an activity. If, for example, the participant’s reason for their interaction was to write a review for a magazine, this will be encoded in instances of this class.<sup>21</sup> Although one could directly connect a person or agent to the activity itself, as already allowed by the participant properties of Activity Specification, reifying it here (using the *n-ary relation* logical pattern<sup>22</sup>) becomes a necessity, as the participant’s reflection upon the activity itself (e.g., “The concert would have sounded better if I had picked one spot and stayed there all the time, instead of

<sup>21</sup>In implementations of the pattern, one could think of a subclass denoting a critical engagement as opposed to, for example, an emotional one.

<sup>22</sup>[http://ontologydesignpatterns.org/wiki/Submissions:N-Ary\\_Relation\\_Pattern\\_%28OWL\\_2%29](http://ontologydesignpatterns.org/wiki/Submissions:N-Ary_Relation_Pattern_%28OWL_2%29).

moving around”) typically differs from the reflection on their engagement with it (e.g., “The sound came out more powerful than I had expected when listening to their live recordings at home”).

*Property.* *isEngagedIn*. Connects the participant being engaged in an activity with the engagement itself. We assume *Person* from the seminal CP *Persons* to denote the domain of this property with sufficient generality.

*Property.* *inActivity* and its inverse property *hasEngagement*. Connects an activity with the many possible ways to engage in it. Note that neither this property nor *isEngagedIn* is functional: this is intentional, as an individual may in fact be engaged with an activity in a multitude of ways. For example, a critical engagement may arise from the fact that the subject attended a concert because they were being paid to write a review, whilst an emotional engagement may coexist with it, if the performers also happened to be the writer’s favourite artists.

#### 4.2.3 Fragment About Observation.

*Class.* *Observation*. An engagement, depending on whether it is emotional, critical or of another nature, is a cognitive process which may or may not generate conscious output, which is represented by this type. Note that different engagements give rise to potentially different observations, hence the further need for n-ary relations as explained previously. For the purpose of the pattern definition, we do not provide here a vocabulary of the various types of engagement: the place for this is the ontology where this CP will be instantiated.

*Property.* *isReflectionOn* and its inverse property *isReflectedUponIn*. A two-way connection between an engagement and the observation it contributes to, if any. Once again, the properties in this inverse pair are not functional: one observation may be the collective outcome of multiple engagements (e.g., both the emotional and critical engagements may end up being documented in the same written review) and one engagement may give rise to multiple observations (documented, e.g., in tweets) at separate times.

*Property.* *producedObservation*. This property can be used as a shortcut to denote that something is (even indirectly, not necessarily through direct reflection) responsible for the existence of an observation. The following property chain is encoded in this CP for the case of activities.

$$hasEngagement \circ isReflectedUponIn \sqsubseteq producedObservation$$

#### 4.2.4 Fragment About Prompting.

*Class.* *Prompting*. Not every activity is expected to give rise to an observation if, for example, the engagement in it was not a conscious one: those that do may be specially labelled as prompting [activities] to be set apart from the others. This is a defined class whose defining axiom is specified as follows.

$$Prompting \equiv Activity \sqcap \exists producedObservation.Observation$$

*Property.* *includes*. This property is used to establish a parthood-based structure within an activity, which can then be seen as composed not only of sub-activities (as mandated by the Activity Specification CP) but also of observations. We use a bespoke property here, not lifted from other CPs, to denote that it does not necessarily define containment in the spatial-temporal “topology” of an activity, since observations can result from an ex post reflection as well, but in this way we stress that their very existence depends on that activity.

### 4.3 E&O Pattern Implementation

The E&O pattern was implemented in the OWL language using the tools *Protégé* [18] for development and *OnToology* [19] for managing the collaborative aspects of development. Since E&O is considered a CP, we created an OWL building block for representing the pattern following the eXtreme Design methodology. The code of its

RDF serialisation is available on GitHub.<sup>23</sup> In addition, the documentation of the E&O pattern is available as a CP submission to the ODP portal.<sup>24</sup>

From an OWL 2 logical profile standpoint, this implementation of E&O falls within the OWL 2 RL tractable fragment: its use of inverse object properties rules out OWL 2 EL, whereas the use of property chain axioms excludes OWL 2 QL.<sup>25</sup>

## 5 E&O PATTERN EVALUATION

Evaluating an ODP shares methodological elements with the ways of evaluating ontologies *tout court*. The next two sections document the efforts undertaken to reach an evaluation as complete and as close to the few existing frameworks as possible, along with their results.

### 5.1 Methodology

In his doctoral thesis, Hammar [20] distills a set of quality characteristics from the existing literature on ontology patterns, which are intended for use as evaluation criteria. These are grouped under the macro-categories of *functional suitability*, *usability*, *maintainability* and *compatibility*, for the details of all of which we refer to Hammar's work [20]. By contrast, quantitative methods for ontology pattern evaluation, such as presented in the work of Alghamdi et al. [21], are primarily concerned with the *selection* of patterns for the construction of ontologies such as life sciences. After performing a prior selection process and considering E&O only in conjunction with the domain ontologies that instantiate it, we saw fit to adopt the aforementioned qualitative evaluation approach.

About the ability of the ODP to meet the stated needs, all the functional suitability criteria that pertain to the ontology as a stand-alone artifact have been validated as such (cf. Section 5.2). Usability of the ODP is evaluated as the combination of the ontology and its documentation (cf. Section 5.3). Finally, the aspects pertaining to maintainability and compatibility, which concern applications and relationships of the pattern with the other models in the Web of Data, are covered in Section 6.

### 5.2 Functional Suitability Evaluation

We assess whether the E&O pattern satisfies functional suitability criteria through engineering mechanisms along the self-testing of the pattern when treated as an ontology.

One such criterion is *functional completeness*—that is, the degree to which the ODP meets its modelling requirements, defined in Section 4 as CQs. To that end, it is customary in ontology design methodologies to re-formulate these as queries in the SPARQL language [22], the results of which are shown in Listings 1 through 3.

*CQ1: In what ways can one person be engaged in each activity?*

```
SELECT DISTINCT ?engagement
WHERE {
  ?who :isEngagedIn ?engagement .
  ?engagement :inActivity ?activity
}
```

Listing 1. SPARQL query for CQ1.

It should be noted that using individuals of type Engagement to represent the different “ways of engaging” as expressed in CQ1 comes at no loss of expressivity, as the distinguishing features of an engagement vary depending on the experiential domains at hand. E&O itself is not concerned with modelling these features. However,

<sup>23</sup>[https://github.com/modellingDH/odp\\_experience](https://github.com/modellingDH/odp_experience).

<sup>24</sup>[http://ontologydesignpatterns.org/wiki/Submissions:Experience\\_%26\\_Observation](http://ontologydesignpatterns.org/wiki/Submissions:Experience_%26_Observation).

<sup>25</sup>OWL 2 profiles: <https://www.w3.org/TR/owl2-profiles>.



examples of these are present in the legacy datasets described in Section 6.3 and offer useful insights as to how such “ways” could be modelled.

*CQ2: What personal observations were produced by reflecting upon an activity being carried out?*

```
SELECT DISTINCT ?observation
WHERE {
  ?activity a activity:Activity
            ; :includes ?observation .
  ?observation a :Observation
}
```

Listing 2. SPARQL query for CQ2.

*CQ3: Which activities performed by someone have prompted an observation from that person?*

```
SELECT DISTINCT ?activity ?person
WHERE {
  { ?activity a :Prompting
  } UNION {
    ?activity a actspec:Activity
              ; :producedObservation [
                :isReflectionOn/^isEngagedIn
                ?person ]
  } .
  ?activity
    actspec:hasParticipant ?person
}
```

Listing 3. SPARQL query for CQ3.

The query for CQ3 covers the explicit case where activities are typed as Prompting, as well as a second case where a more generic type expression statement allows promptings to be inferred by means of their ability to produce observations. Activities that satisfy neither condition will not appear in the results.

We also note that these queries contain property paths of length no greater than 3 and otherwise make use of commonplace domain coverage stratagems such as UNION (see CQ3), thus attesting to the *functional appropriateness* of E&O.

Another criterion for verifying functional suitability is *consistency* [20]. This criterion is ensured by the fact that, although all the classes explicitly defined in the pattern are disjoint, no equivalence or multiple subsumption occurs between them. This was confirmed by running the HermiT 1.4 reasoner on the imports closure over the ODPs that E&O depends on.

Lastly, as there is no established modelling standard for experiential data, the *accuracy* [20] of this CP cannot be assessed, other than by demonstrating its ability to represent the domain modelled by existing datasets, which will be covered in Section 6.3.

### 5.3 Usability Evaluation

It is also crucial to evaluate an ODP with respect to its usability in specific scenarios. This usability dimension implies six quality characteristics [20]. From these, we consider in this section (a) *appropriateness recognisability*, regarding whether the final user is able to recognise the pattern as suitable for their objective, and (b) *user*



*interface aesthetics*, which refers to how appealing the ODP documentation is. Both quality characteristics refer to intuitiveness.

To evaluate the usability of the E&O pattern, we conducted a user experiment<sup>26</sup> involving Master students at Universidad Politécnica de Madrid (UPM).<sup>27</sup> Almost 85% of the students attended a master in data science programme, and around 15% were students in a master in data analytics in health and medicine programme. Thus, students had no specific knowledge about digital humanities. In addition, most of the students (84.4%) had previous experience using ontologies and ODPs in different domains. The students, working in groups of four or five members, were asked to reuse the E&O pattern (among other ontological resources) in the development of an ontology network that describes a particular domain. Students had the freedom to select among the following domains: “Webcomics”, “Resonance in collective reading”, “School diaries”, “The places where we read”, “Correspondences” and “‘Stalking’ on social media”. After developing the ontology, students were required to fill a questionnaire that included, among others, questions regarding the reuse activity. Those questions were created with the goal of gathering information about the following usability indicators [20]: accompanying text description, documentation completeness, structure illustration and usage example count.

After analysing the students’ responses, we concluded that, on the one hand, the intuitiveness of the E&O pattern needed to be improved since only 34.5% of the students considered the pattern as an intuitive ODP. In this sense, students reported (a) incomplete documentation (detailed descriptions of pattern elements are missing) and (b) lack of examples of use. As an illustration of point (a), students were confused about the meaning of class Prompting and the meaning of the relation between Prompting and Activity, since in-depth description of such elements was not included in the on-line documentation of the pattern. Regarding point (b), students explicitly asked for examples of Engagement and Prompting.

On the other hand, almost 60% of the students expressed that the pattern was useful during their ontology development. The remainder argued that the pattern was not applicable to the domain they were asked to model. These students had to represent the following domains: (a) “Webcomics” (50%), (b) “School diaries” (16.6%), (c) “The places where we read” (16.6%) and (d) “Correspondences” (16.6%). This situation can be explained by a combination of more general issues: (a) almost 60% of such students had no previous experience on reusing ODPs in the first place; (b) 33% of such students agreed on the statement “Domain was difficult to understand”; and (c) 25% strongly agreed on the statement “Reusing ODPs is a difficult activity”, whereas 33% agreed on the same statement.

In addition to the data gathered from students’ responses, we also analysed the outcomes provided by the students. In particular, we focused on examining (a) how the E&O pattern was reused by the students, that is related to the *coverage*, and (b) the modelling agreement between groups working on the same domain, that is related to the *convergence*. On the first aspect, 77% of the students reused the pattern as a whole, whereas the rest reused only individual elements such as Person, Engagement, and Activity. The following are examples of the reuse of some pattern elements: (a) in the domain of “School diaries”, Writing a diary is modelled as a subclass of Engagement, whereas Diary Entry as a subclass of Prompting, and (b) in the domain of “The places where we read”, Person is modelled as equivalent to Reader, Reading Process as equivalent to Engagement, and Reading as equivalent to Activity. On the second aspect, the comparison between the ontologies developed for representing the domain of “WebComics” showed that the class Engagement was used for representing different knowledge such as reflection or state of mind, whereas in the case of the domain of “School diaries” the modelling possibilities were broad and the most controversial concepts were Observation and Engagement. Finally, regarding the domain of “‘Stalking’ on social media”, the agreement on how the pattern was used is almost complete; the only concept that is used in different fashions is Engagement, to which very different sets of custom properties were associated: this comes to no surprise, since the axiomatisation of that class is

<sup>26</sup>Details about this user experiment are available at <https://doi.org/10.21954/ou.rd.14156624>.

<sup>27</sup>A total of 59 students were involved in the user study.

intentionally lax to accommodate external context models. For the remaining domains, the convergence analysis could not be performed due to different misunderstandings students included in their ontologies. On the whole, it is worth mentioning that the class Prompting was the least used by the students, presumably due to issues with its documentation.

All the aspects considered and presented in this section revealed that the intuitiveness of the E&O pattern should be improved. The pattern documentation needed to be updated by means of (a) providing detailed natural language descriptions of the different ontology elements in the pattern so that the key elements are well understood by non-experts in humanities, (b) including clear examples of pattern use that help ontology developers to better grasp the knowledge modelled by the pattern, and (c) publishing the pattern documentation by means of applying the usual ontology documentation structure and layout.<sup>28</sup>

Following this feedback, the pattern documentation was since updated and a new documentation page<sup>29</sup> was generated by using the LODE (Live OWL Documentation Environment) tool [23].

## 6 APPLICATIONS

Beyond the formal validity, the E&O was assessed through a case study based approach. Similarly to what was done with the Explanation ODP [25], we applied the E&O to typical settings of activities and prompting of testimonies. The purpose of this exercise is twofold. Firstly, we provide a practical result useful for finding commonalities between sources and therefore results of research case studies. Secondly, the presented case studies are used to assess the ODP with domain experts and on real data with a variety of sources of reading experience.

The pattern was developed within the scope of READ-IT, although not as part of it. The READ-IT project provided the motivation for the development of E&O and the opportunity to identify a gap in the description of evidences of reading. It allowed the evaluation of E&O in addressing an open challenge concerning the interoperability of research case studies and the interoperability of heterogeneous sources of evidence of reading collected through a multi-modal, multi-lingual contribution ecosystem.

Outside the scope of READ-IT, E&O was applied in a retrospective analysis to data of legacy digital humanities projects<sup>30</sup> RED and LED. The aim of this retrospective analysis is to support the reuse of their data and therefore to renew their value within the context of new edge research programmes. This retrospective analysis was carried out on both RED and LED.

### 6.1 Interoperability of Research Case Studies

READ-IT is a multi-disciplinary project aiming to develop a toolbox for investigating the different facets of reading. The motivation for building common tools is twofold: firstly, to converge research data through the adoption of the same data models across the tools; secondly, to support a cross-disciplinary reuse of data among research case studies, thus achieving interoperability of research work on data and sources.

READ-IT produced an ontology of reading experience (REO), used in annotation tools and algorithms, that supports the interoperability of research data in terms of annotation on evidences of reading experience (sources). At the same time, there remains a gap in the description of sources from the perspective of the experiential studies—that is, not of the content or provenance of sources but of the contextual information necessary for their correct interpretation. Indeed, the reuse of research data requires an understanding of the evidences of reading experience. In this regard, E&O is used to describe the underlying assumptions of the research case studies about the constraints on the available sources that are not self-inclusive nor self-evident from their content.

For example, a reception study of a 19th-century author would focus on the analysis of that author's correspondence—for example, discuss setbacks with editors and comments of other fellow authors. Differently,

<sup>28</sup>Tools such as LODE [23] and Widoco [24] support these tasks.

<sup>29</sup>E&O documentation: [https://modellingdh.github.io/odp\\_experience/](https://modellingdh.github.io/odp_experience/).

<sup>30</sup>Legacy digital humanities project in terms of the end of the research projects and investment on data modelling and curation.

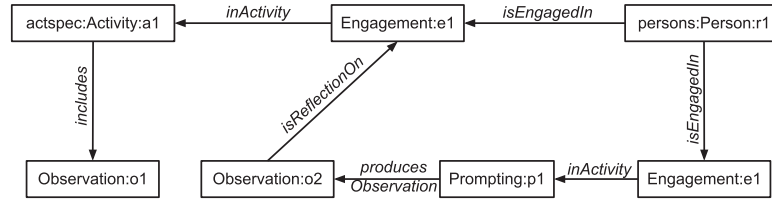


Fig. 5. A passive reader *r1* is engaged in an activity *a1* which includes an observation *o1*; the activity *a1* and included observation *o1* are reflected in the observation *o2* created through prompting *p1*.

a reception study today would be grounded on a more systematic analysis of book sales, book reviews and interviews with readers. The key difference between historical and contemporary reception studies is in the nature of sources between, for example, correspondences and comments. In the first case, the study of correspondences considers several filters and mediations that occur in a communication with an employer, for example. By contrast, social media comments are not as polished or articulated: rather, they tend to be more spontaneous and informative of the emotional response of the reader.

These differences are carefully considered in mapping RQs with sources when setting up a case study. However, data reuse does not include such information necessary to identify the correct epistemological boundaries of the case study.

In this case study, we used E&O to encode the information about sources, complementing the ontology developed to describe their content. The researchers involved in the project provided a general classification of case studies [7]: (a) reading through social media, (b) self-reflection, (c) places where we read and (d) historical sources. This classification expresses a form of comparability, or similarity, among case studies that cannot be reduced to features of sources, period, contents or readers. Using E&O, we revisit two of the categories, reading through social media and historical sources, under the light of structural differences between case studies.

**6.1.1 Reading Through Social Media.** The new practices of reading through social media re-frame reading as an active form of social engagement, thus configuring practices of collective reading. A study analyses the “tsukkomi”, humorous comments placed by readers directly on comic canvases [26] and the webcomics author-readers sections [27]. This category concerns the reading experiences of two different types of readers:

- (1) Passive readers exposed to comments from other readers;
- (2) Active readers engaged in online discussions.

Passive readers are those whose reading activity includes being exposed to other readers’ observations and therefore to an experience mediated by comments, votes, sponsorship and other types of social media feedback surrounding the content. The others are the active readers, for whom the social engagement, like engaging in discussions with other readers after each issue, is part of the experience. Thus, the prompting activity leading to the observation must be considered as part of the reading activity.

These two categories differ on the relation between activity and prompting. In Figure 5, the observation included in the activity is not the result of the activity itself. In Figure 6, the observation is created within the frame of the activity, through a sub-activity prompting. Their structural similarity is clearly expressed by the mereological relation between the activity and the prompt within it.

**6.1.2 Historical Sources.** In the READ-IT project, an important set of sources include 19th- and 20th-century letters, diaries and libraries (annotated books) of famous authors [28]. These sources provide different types of experiences concerning different types of prompting and timings of the observations. Indeed, the experiences reported in diaries and letters are the result of matured reflections, whereas book notes (marginalia) are mostly first impressions and emotional reactions jotted down while reading. In this view, the information content of

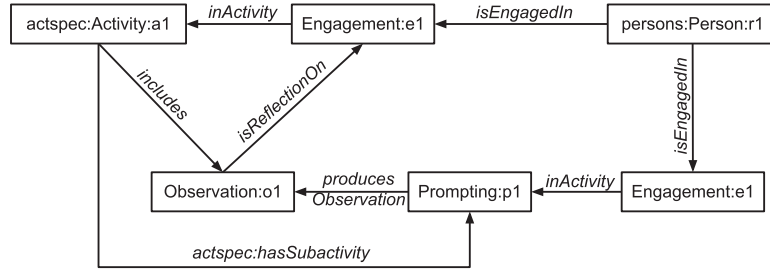


Fig. 6. An active reader *r1* is engaged in an activity *a1* which includes an observation *o1* created through prompting *p1*, a sub-activity of *a1*.

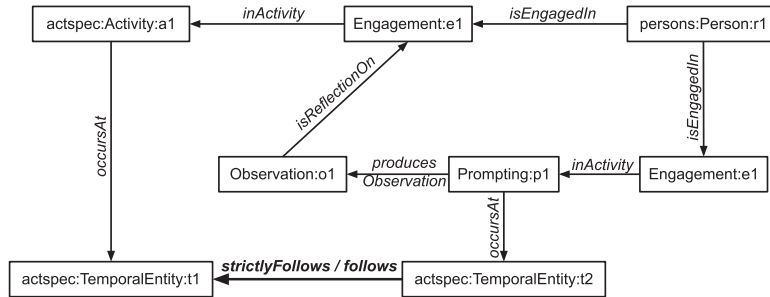


Fig. 7. In this example, a reader *r1* is engaged in an activity *a1* at time *t1* and in a prompting *p1* at time *t2* producing an observation *o1*, reflection on *a1*. The difference between a fast-paced and a matured observation can be encoded through properties (e.g., dates) or through an ordering relation between *t1* and *t2*. For example, *t2* *closely follows* *t1* in a fast-paced observation or simply *t2 follows* *t1* for a matured observation.

the experiences included in the marginal notes are nowhere similar to diaries and correspondence and should be considered akin to social media.

Unlike modern-day messaging, authors' letters were carefully polished observations of artistic and scholarly value. This activity was part of the authors' work in which they invested a relevant part of their time and which could have a huge impact on their career and opportunities. Similarly, diaries contained personal notes about the creative process, inspirations and ideas sourced from readings and personal experiences. The main difference between letters and diaries concerns the time frame for reflections. As today, diaries were used to keep track of daily events through fast-paced observations, whereas the interval between letters could be of weeks or months through slow-paced or matured observations.

The differences between fast-paced or matured observation is represented by either implicit or explicit temporal relations between the two—that is, through dates or temporal ordering. In Figure 7, the sequentiality of activity and prompting is highlighted by their distance over time, which is represented by their occurrence at two distinct times. These are rendered explicit through instances of the `TemporalEntity` class, made available by the Activity Specification pattern, which in turn lifts it from the seminal OWL-Time ontology [29].<sup>31</sup>

## 6.2 Collecting Evidences of Reading

Part of the READ-IT toolbox is a multi-modal, multi-lingual contribution platform. This platform is used to collect evidences of reading experience during engagement events, conferences and workshops, from reading groups

<sup>31</sup>To remain strictly in the ODP realm, dedicated CPs, such as *Time Indexed Situation* (<http://ontologydesignpatterns.org/wiki/Submissions:TimeIndexedSituation>) could also be used for representing the time of an event.



Fig. 8. READ-IT postcard including QRcode for scanning and uploading to the contribution portal.

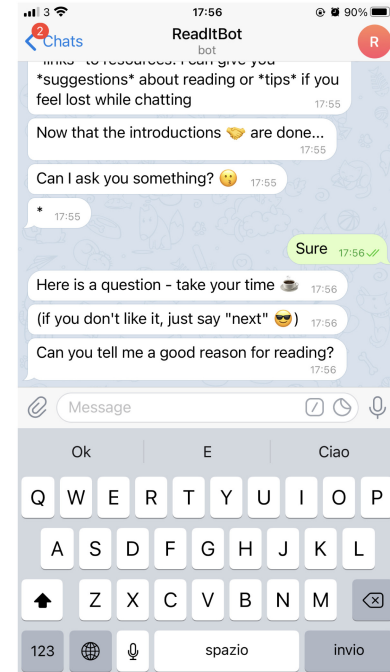


Fig. 9. TellMeWhatUReadingbot, the English READ-IT chatbot on Telegram (<https://t.me/TellMeWhatUReadingbot>).

or scholars and from project followers. Data collection includes the use of physical postcards, online forms, uploaded documents or pictures, web-scraped data and conversations with chatbots, in the different languages supported by the project.

The contribution platform is a tool for data collection. The collection is structured into campaigns aiming to collect specific types of evidence. In this regard, the collected evidences should include a description of the aims of the campaign, as well as the constraints related to the specific modality adopted.

The contribution platform is used to build a common set of sources available to the project network. In this regard, the collected sources should be described by considering, as for the research case studies, the characteristics of the modality of collection and their expected content.

*Example 1.* Postcards (Figure 8) distributed during dissemination events including a question (similar to the chatbot), an empty box for writing a reply and a QRcode linking to the contribution platform for scan and upload. Filling postcards during events is a collective activity that allows little time for reflection.

*Example 2.* The READ-IT chatbot @TellMeWhatUreadingbot (Figure 9) guides users through targeted questions such as “What are you reading today and why?” The chatbot uses a starting question—a particular prompting—but then engages the user using a preset of follow-up prompts to extend their contributions. A chatbot conversation can take hours and is an intimate activity.

Postcards and chatbot use a similar set of questions and generate anonymous data. Thus, in terms of tasks and expected content, they are almost identical. However, the conditions in which the observation is generated are different, as are the audiences and modalities of engagement. In the first case, the chatbot gives time to reflect and does not expose readers to external judgement. Differently, during events the audience is mostly composed

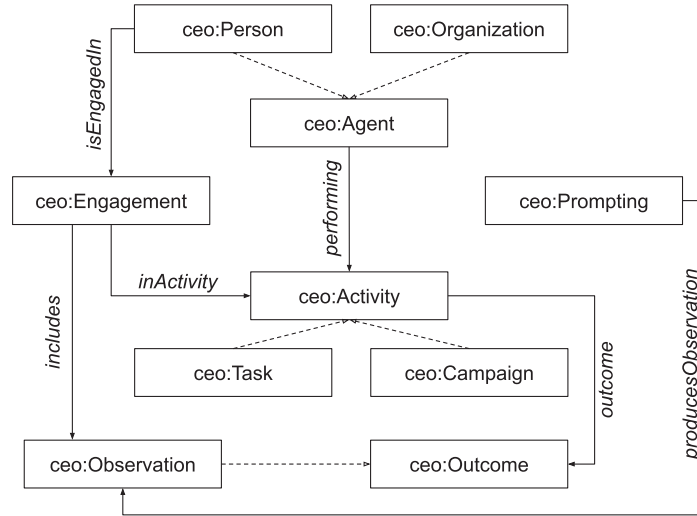


Fig. 10. CEO uses E&O concepts to address, for example, the relation between the produced observations and being engaged in prompting activities.

of scholars and enthusiasts dedicating a few minutes of their time to fill the cards while chatting during a coffee break, for example.

In this case study, we used the E&O pattern as the base for the **Crowd-sourcing of Evidences Ontology (CEO)**<sup>32</sup> used for describing the sources collected from the different streams funnelled within the READ-IT contribution portal. CEO implements E&O and incorporates elements from the crowd-sourcing management ontology [30]. CEO describes the connections between a `ceo:Observation`—a type of `ceo:Outcome`—with the `ceo:Engagement` within a `ceoActivity`, and as a result of (`ceo:producedObservation`) a `ceo:Prompting` (Figure 10).

As for Examples 1 and 2, CEO is used to describe the two engagement settings, similarities between the tasks, language and the duration of campaigns (e.g., 2/3-day events or a long-term campaign through the project website embedding the chatbot).

### 6.3 Experience in Legacy Humanities Datasets

Regardless of the actual “age” of a digital humanities project, there are several ways in which the assets it produced may become obsolete. Firstly, a successful project addresses its own RQs, exhausting the value of data through the publication of results in more accessible forms, such as articles and books. Secondly, the morphology (schema, format, etc.) of the data is usually designed to support the addressing of those specific RQs. Although the data may still be open for reuse, without further investments their accessibility and practical value may be diminished by the fact that they were not designed with enough flexibility to lend themselves to future RQs. This issue concerns, for instance, the use of ad hoc project terminology that is related to edge research and therefore to hypotheses rather than consolidated knowledge, which is the focus of the research agenda.

In this view, a common problem of legacy digital humanities is reconciling data with schemas and structures that in time have become mainstream thanks to, for example, the emergence of Wikidata and authority files, or new extensions to CIDOC-CRM. At the same time, although contextual information may have been encoded by using standard ontologies, the core research concepts may transcend the scope of standards for several years or

<sup>32</sup><https://github.com/eureadit/crowdsourcing-ontology>.



decades. In this regard, a possible approach would involve the development of research-oriented upper ontologies with an orthogonal focus on research design instead of the object of the research.

In this scenario, E&O provides an agnostic description of experiential studies that can be retrospectively applied to legacy digital humanities, regardless of reaching a consensus on how to define potentially controversial concepts about human experience.

We therefore approached RED and LED as legacy digital humanities projects in a retrospective application of E&O, with the aim of breaking out of the silos between research topics (experience of music and experience of reading), thus enabling reuse of the data beyond the contextual information (e.g., people, locations, time of experience). The datasets of these projects, although both available in RDF format and with references to external entities, are modelled in ways that reflect the research interests of project leaders and Humanists in the respective research groups rather than their own intrinsic potential for future study.

Two main differences are worth highlighting between RED and LED. Firstly, they both focus on aesthetic experiences that profoundly differ in the way they are triggered and engaged in: RED focuses on reading, an experience which requires an active and conscious effort of the reader in engaging with a medium and text, such as a book, which is mostly individual. Differently, LED focuses on the experience of music such as concerts, opera or recordings, which are frequently collective experiences and more prone to occur incidentally or unintentionally.

A second key difference concerns the type of sources and their content. RED is based on “traditional” literature sources that mostly report on self-reflections on reading. These sources present little contextual information as to the when, where and how of reading, focusing on their understanding and opinions on contents. Differently, the value of LED is in the use of “non-traditional” sources and the use of Semantic Web technologies to integrate and expose several archival data as one research repository of listening experiences, combining, for example, records of events, locations, artists, performances and participants.

RED data do not present the same level of detail as READ-IT but could theoretically be updated with a re-curation effort. However, the new curation process would have to rely on the reuse of RED data as sources for new case studies. Thus, there is a need for exploring RED from the perspective of identifying, among the different sources, the ones compatible with a given research design—that is, aims, methods and tools. Similarly, LED data concentrate more on documenting the experience than on describing it, and although some parameters such as simple condition descriptors (e.g., whether it was public, indoor, performed live or in playback) are present, drawing a more richly structured context would require a re-curation effort over the textual evidence.

To demonstrate the suitability of a flexible representational model for experiences as is the E&O pattern, one should lift the schemas of both of these legacy datasets so that they can be represented in terms of this pattern. Since pattern-based ontology methodologies recommend that published modules implement CPs rather than being the patterns themselves [16], the RED and LED models were aligned to an ontology that implements E&O, as well as to each other. The implementation in question is the previously described CEO ontology (cf. Section 6.2). CEO redefines the classes and properties that constitute E&O (including those from the Activity Specification pattern) in its own namespace and is isomorphic with E&O, in that it preserves the morphology that emerges from class definitions, subsumption axioms, and property domains and ranges. The alignments of CEO with each project ontology were performed in separate modules, both of which are available as code repositories on GitHub.<sup>33, 34</sup> Alignments were performed manually, either by direct class subsumption or equivalence axioms, or by subsuming class restrictions that further refine property domains and ranges [31]. The process has resulted in the mappings described in the following.

As discussed previously, E&O does not offer a stand-alone concept as a synthesis of the experience. Classes so named, however, exist in both the RED and LED ontologies: in both cases, they are primarily modelled as events, following the specification of the Linked Open Description of Events [32] and the event model present in the

<sup>33</sup>RED alignments, <https://github.com/modellingDH/UK-RED>.

<sup>34</sup>LED alignments, <https://github.com/modellingDH/LED>.



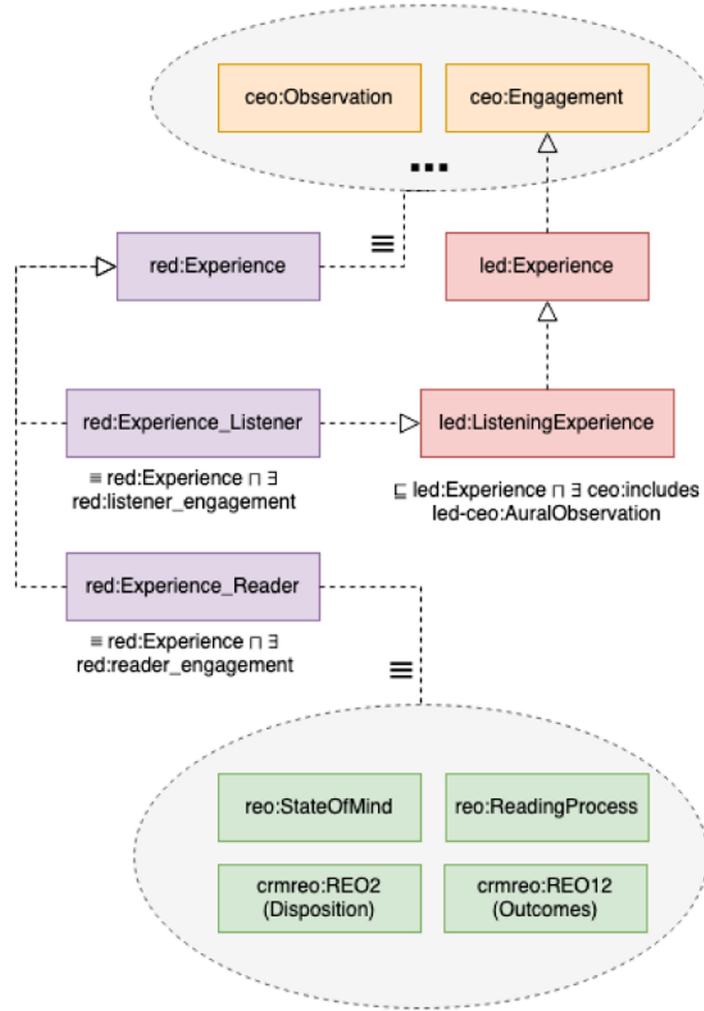


Fig. 11. Mappings of the various Experience classes in RED and LED to each other and to CEO and REO.

Music Ontology [33], respectively. Both projects also offer specialisations of this Experience concept, centered on the listener (both in RED and LED, as listening to someone read aloud is contemplated as an experience in its own right) or on the reader (applicable to RED only). As this level of detail escapes the remit of CEO, it was seen fit to map these specialised concepts directly to each other.

Figure 11 offers a summary of how the classes labelled Experience in the legacy datasets are aligned within the CEO-RED-LED environment. We observed that, in the RED data, red:Experience is used as a non-discerning concept that encompasses the practical activity of reading as much as the resulting observations that are reported in the evidence as outcomes of the activity: no distinction between such activities and events is offered by the data. red:Experience also incorporates indicators of the subject’s state of mind (e.g., whether the listener is being reactive), or of their engagement (e.g., whether solitary or in the company of others). However, as the concepts of activity, engagement and observation are disjoint in E&O, and by extension in CEO, the mapping to red:Experience had to be asserted as an OWL disjoint union, to reflect the manifold nature of

this class whilst preserving logical consistency. This is an example of the side effects of modelling experiences in an overly synthetic way, as stated at the beginning of this article. Other alignments were carried out between the subsuming class `red:Experience_Reader` and concepts specific to reading due to being defined in REO: these include the reading process, its outcomes and resulting states of mind, again mapped to RED via a disjoint union.

The LED data model, however, separates the competences of the Experience event from those of the event that denotes the sound performance. The latter can be as simple as the playback of a record album and constitutes at least one of the activities that prompt the observation. For that reason, `led:Experience` subsumes `ceo:Engagement` rather than `ceo:Observation`, yet its “listening variant” links to the latter by means of a `ceo:includes` relationship of at least one `ceo:Observation` produced by a musical performance, which we have materialised as `AuralObservation` for convenience. It follows that whenever a `mo:Performance` (from the Music Ontology) gives rise to an observation, it is also a `ceo:Prompting`, another class derived from E&O. This is not optimal, as we have discussed in Section 4 that promptings are likely to be activities where the subject participates actively rather than the performances themselves: the mapping covers cases where the experience is entirely incidental, or where the experiencing one is a performer, but for most other cases additional activities should be materialised, which are not made explicit in LED.

No other suitable mappings to the concept of prompting were found among the terms explicitly defined in either model, thus reflecting the fact that neither project had in its research interests to systematically study the stimuli and motivations that give rise to experiences. To that effect, it should be borne in mind that it was in the mandates of both projects that they should exclude any professional or otherwise solicited reviews as acceptable source material, which naturally limited the scope of prompting.

Similarly to the previous case study, E&O is used to describe the different types of evidence of experience. The application of E&O works as an upper ontology between two very different datasets, regardless of their discussed differences. This enables orthogonal queries on, for example, which activities are collective or individual, or on the timing of evidence collection.

## 7 RECURRING CONFIGURATIONS

The use of E&O in the four case studies highlighted nine realistic permutations of activity, reflection and observation, which provide opportunities to collect observations. These configurations may interchangeably be regarded as orthogonal knowledge patterns, or as cognitive frames. Ultimately, these identify an alternative classification system relating evidences. Interestingly, they highlight connections among types of sources otherwise deemed distant or incompatible. In this section, we describe these nine patterns/frames aggregated by considering the different configurations concerning prompting, engagement and process of reflection. Although modelling these configurations as frames escapes the remit of this article, we acknowledge that this has been previously attempted in research [34] and are considering its systematic adoption for future studies.

### 7.1 Prompting

In regard to prompting, the possible configurations concern the proximity between activity and observation (Figure 12): the temporal distance between activity and observation (i.e., timing of prompting) and the interrelation between activity and observation (i.e., the context of prompting).

Figure 13 reflects prompting distant from the activity. Observation and activity are distant in terms of time and absence of interrelation. The distance allows room for reflection and a clear distinction between the outcomes of the activity and the experience (outcome of the reflection).

*Example 1.* A study of the formative influence of reading during significant life events, such as conflict or migration, collected years or decades later in structured oral history interviews. One example is the work of the Reading Communities project [35].

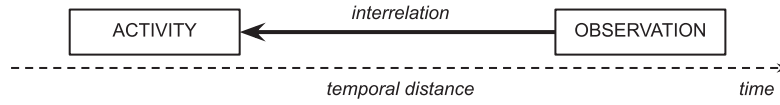


Fig. 12. The possible configurations of prompting concern the temporal distance and interrelation between observation and activity.

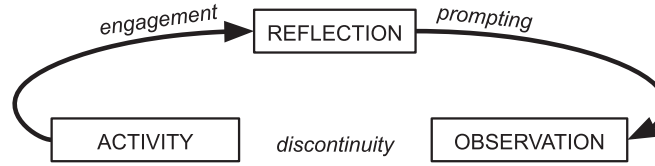


Fig. 13. Discontinuity between observation and activity.

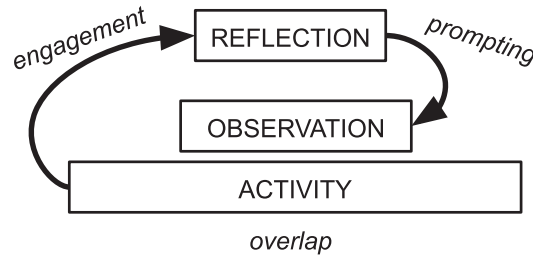


Fig. 14. Temporal overlap between activity and observation.

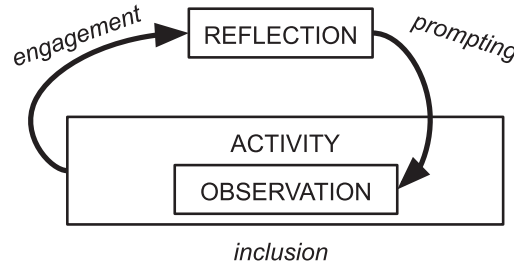


Fig. 15. Prompting of observation is part of the activity, and the observation is an output of the activity.

Figure 14 reflects prompting during the activity. Observation and activity co-occur in the same temporal interval (overlap). The overlap allows only a partial acquisition of input from the activity and resulting reflection, influencing the content of the observation.

*Example 2.* A study of comments and social media reactions to YouTube videos concerning, for instance, conspiracy theories [36].

Figure 15 reflects prompting as a part of the activity. The creation of an observation is a component of the activity (inclusion). The temporal overlap is also combined with an interrelation between the activity and the prompting of the observation such that the creation of an observation is a task of the activity.

*Example 3.* A study of “marginalia”, notes written by authors in their books to prepare future writings. The marginalia are written as part of the reading activity, for example, for the sake of and as reference to future works [37].

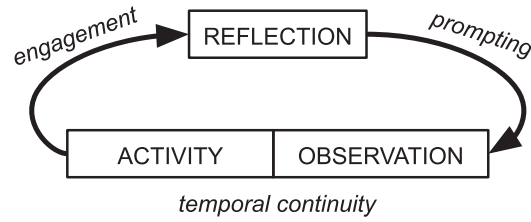


Fig. 16. Observation is a follow-up to the activity.

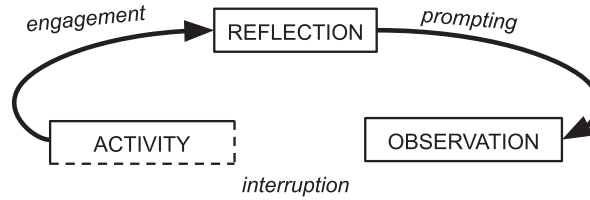


Fig. 17. Activities not completed or interrupted provide partial information for the creation of observations.

Figure 16 reflects prompting right after the activity. The prompting of the observation is so close to the completion of the activity that can be considered subsequent. The short or non-existent gap between activity and observation results in collecting a first impression (or response) to the activity.

*Example 4.* Study on social media engagement features such as “follow” and “like” buttons placed at the end of issues of webcomics. Readers are nudged to express their approval and willingness to continue reading by using these functionalities, often by other readers reminding them to “like” or to “subscribe” to show support for the author. See, for example, the “Smash that like button” prompt at the end of Rachel Smythe’s *Lore Olympus* no. 151.<sup>35</sup>

## 7.2 Engagement

The conditions of engagement within the activity contribute to the acquisition of the inputs for the reflection and therefore to the experience reflected in the observation. In this view, the completion of an activity or the exposure to other observations as part of the activity result in different types of input.

Figure 17 reflects interrupted activity. An activity is interrupted before its completion, and therefore the information considered for the creation of the observation is just partial. In this case, the completion of the activity is delayed or unplanned, leading to a reflection based on few elements of the activity and on a guess of its outcomes.

*Example 5.* In 1797, poet Samuel Taylor Coleridge had a powerful vision. He began to write the poem “Kubla Khan” to record his observations of this activity but was interrupted after 55 lines by an unnamed “person from Porlock” and never completed the poem [38].

Figure 18 reflects socially mediated experience. The engagement in an activity includes the exposure to third-party observations about the activity. In this scenario, the weighting of the activity factors considered and the outcomes of the experience are suggested by the activity simulating in the person a form of (positive or negative) prejudice based on prior experiences. The reflection then takes into account the direct experience (engagement in the activity) and indirect experience reported in the third-party observations.

*Example 6.* Reading the classics of literature in an edition that includes reviews from literary critics. According to Italo Calvino, when new readers approach a classic of literature, their reading is filtered through the interpretations of previous readers and through the influence of that classic on subsequent texts [39].

<sup>35</sup>[https://www.webtoons.com/en/romance/lore-olympus/s2-episode-146/viewer?title\\_no=1320&episode\\_no=151](https://www.webtoons.com/en/romance/lore-olympus/s2-episode-146/viewer?title_no=1320&episode_no=151).

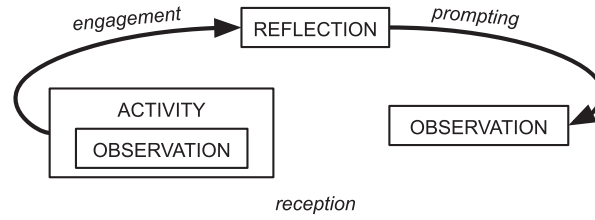


Fig. 18. The activity involves being exposed to third-party observations, feeding a prejudice (or indirect experience) as a part of the input for reflection.

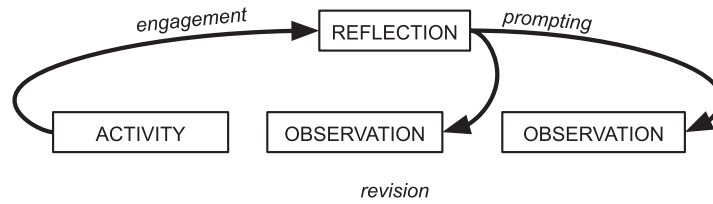


Fig. 19. The person creates observations concerning the same activity at different points in time and stages of reflection.

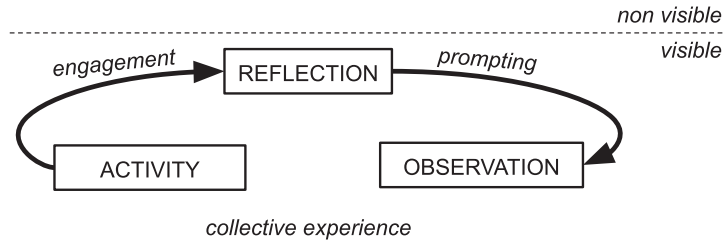


Fig. 20. The reflection is carried out in public.

### 7.3 Reflection

The multiplication of activities, observations and subjects involved configure different types of reflections, leading to revision, comparison, cumulative effects and negotiation of the experience.

Figure 19 reflects revision of the experience. The reflection on an activity lasts for a period of time giving the opportunity to generate several observations at different points in time. The multiple observations could be contradictory or address different aspects of the activity, highlighting the evolution of the reflection.

*Example 7.* A study of a diary or letters reporting the experience of reading a serial text—for example, published weekly or monthly. The observations are created after reading increasingly greater amounts of text. See, for example, *The Guardian's* online reading group on Charles Dickens's *Bleak House*, which read the book over several weeks [40].

Figure 20 reflects collective experience. The reflection is part of a collective activity involving several people and therefore visible and exposed to a public. The scope and aim of a reflection is influenced by being either in an intimate setting or subject to public evaluation and therefore affecting the content of the observation.

*Example 8.* Social reading practices, such as face-to-face reading groups. The presence of other people influences how readers react and express their observations, such as exploring the association among location, devices and conditions [41].

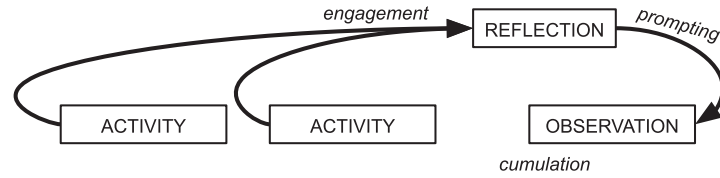


Fig. 21. The observation concerns a series of activities combining their distinct characteristics in the description of the difference of experience.

Figure 21 reflects cumulative experience. The reflection concerns a series of activities: as a result, an observation combines elements of the experience of different activities. In this scenario, the experiences of different activities are interwoven and described by comparison, distinction and difference among each other.

*Example 9.* A study of the influence of different authors carried out on the correspondence and diaries of influential scholars. See, for example, 19th-century Italian poet Giacomo Leopardi assessing the influence of reading several authors, including Petrarch and Germaine de Staël, on his own style.<sup>36</sup>

## 8 DISCUSSION AND CONCLUSIONS

In Section 6, we presented four direct applications of E&O to support the comparability of research case studies and consequently the potential interoperability of research activities on evidences of experience. The value of E&O is grounded on the limits of focusing exclusively on the content of evidences, decoded and annotated through research activities, while overlooking the background knowledge on the context of sources. In this regard, E&O provides a language to define the features of experiential studies on the assessment of the “potential information content” of sources, described in terms of the articulation of observation, activity and prompting.

E&O enables the documentation of the dynamics of activity and observation, thus complementing research data. This new form of description sheds new light on the differences between evidences and therefore on the constraints to research design. It is useful, for instance, in identifying compatible sources and defining new comparative studies reusing data. An emblematic example is the comparability between author’s annotations in books and social media comments, in terms of the timing of prompting and the embedding of observations in the reading. This new perspective provided by E&O opens new scenarios for the reuse of research data through a data-driven definition of multi-source datasets—for instance, about emotional responses including both book and social media commentary.

In this view, E&O can be used to define a qualitative or quantitative measure of the variations between evidences of experience. For instance, in the case of active and passive readers, a measure would consider the ratio between the number of observations generated by the reader vs. the observations the reader is being exposed to (i.e., comments created vs. comments visible in the appendix). As a further example, the difference in the maturity of the observation (e.g., between fast-paced and slow-paced observations) could be measured as a time difference, considering the interval between the creation of the observation and the time of the activity.

The case of the READ-IT project is somehow unique. Indeed, READ-IT contains several sub-projects and therefore can directly benefit from E&O for the reconciliation of its internal activities and from a measure of comparability across datasets. On the same line, the retrospective analysis of legacy digital humanities projects, RED and LED, exemplified how this perspective could be applied to “restore” legacy data back to the edge of research [42].

The adoption of the E&O can support breaking domain silos beyond the scope of academic research. This is achieved by providing means for an *epistemic comparability* of study designs—that is, the settings of experiential

<sup>36</sup>See Leopardi’s Zibaldone, 28 November 1821: <https://digitalzibaldone.net/?entry=1255>.

data collection. In this view, the presented applications focused on observation of aesthetic experiences in the context of academic research, but we do not see a reason for limiting the scope of E&O. More broadly, experiential studies are of great relevance not only in Human-Computer Interaction and Computer Supported Cooperative Work (CSCW) but also in management and professional fields of user experience (UX), interaction design (ID) and Information Systems (IS) (e.g., in usability studies).

At the core of E&O is the necessity to provide an epistemic-focused description, alternative or complementary to an ontological description of evidences of experience. Indeed, sharing an ontological view of a phenomenon does translate into compatibility of results and alignment between different approaches to knowledge acquisition. In other words, the focus of the alignment should not be limited to defining the facets of the experience, but on how these facets emerge (i.e., experiences become visible).

The limitations of the presented work concern the narrow scope of the application to the research domain and aesthetic experience. Future work should focus on applying E&O to professional applications and to management, social science and design.

This work makes evident the need to further investigate and describe the relation between observations in hard and social science, with phenomenological observations. On this note, a priority is the reconciliation of the E&O with the Observation pattern, addressing the epistemic differences between a direct and an indirect observation, such as that between a physical event and a mental one.

Finally, in the field of the Semantic Web, future work should tackle the focus of models, in terms of being description of epistemic or ontological aspects of a phenomenon—that is, how to know or what there is to know, providing a language for the relations between the two perspectives.

## REFERENCES

- [1] Matthew Bradley. 2010. The reading experience database. *Journal of Victorian Culture* 15, 1 (2010), 151–153. <http://dx.doi.org/10.1080/13555501003607792>
- [2] Alessandro Adamou, Simon Brown, Helen Barlow, Carlo Allocca, and Mathieu d’Aquin. 2019. Crowdsourcing linked data on listening experiences through reuse and enhancement of library data. *International Journal on Digital Libraries* 20, 1 (2019), 61–79. <http://dx.doi.org/10.1007/s00799-018-0235-0>
- [3] Alessio Antonini, Mari Carmen Suárez-Figueroa, Alessandro Adamou, Francesca Benatti, Francois Vignale, Guillaume Gravier, and Lucia Lupi. 2021. Understanding the phenomenology of reading through modelling. *Semantic Web* 12, 2 (2021), 191–217. <http://dx.doi.org/10.3233/SW-200396>
- [4] Martin Doerr and Patrick LeBoeuf. 2007. Modelling intellectual processes: The FRBR–CRM harmonization. In *Digital Libraries: Research and Development*. Lecture Notes in Computer Science, Vol. 4877. Springer, 114–123. [http://dx.doi.org/10.1007/978-3-540-77088-6\\_11](http://dx.doi.org/10.1007/978-3-540-77088-6_11)
- [5] Silvio Peroni and David M. Shotton. 2018. The SPAR ontologies. In *The Semantic Web—ISWC 2018*. Lecture Notes in Computer Science, Vol. 11137. Springer, 119–136. [http://dx.doi.org/10.1007/978-3-030-00668-6\\_8](http://dx.doi.org/10.1007/978-3-030-00668-6_8)
- [6] Martin Doerr. 2005. The CIDOC CRM, an ontological approach to schema heterogeneity. In *Semantic Interoperability and Integration*, Yannis Kalfoglou, W. Marco Schorlemmer, Amit P. Sheth, Steffen Staab, and Michael Uschold (Eds.). Dagstuhl Seminar Proceedings, Vol. 04391. IBFI, Schloss Dagstuhl, Germany. <http://drops.dagstuhl.de/opus/volltexte/2005/35>.
- [7] François Vignale, Francesca Benatti, and Alessio Antonini. 2019. Reading in—Challenge and case studies of READ-IT project. In *Proceedings of the 2019 Digital Humanities Conference*.
- [8] Jiřina Šmejkalová. 2001. Censors and their readers: Selling, silencing, and reading Czech books. *Libraries & Culture* 36, 1 (2001), 87–103. <http://www.jstor.org/stable/25548893>.
- [9] Johannes Frey, Denis Streitmatter, Fabian Götz, Sebastian Hellmann, and Natanael Arndt. 2020. DBpedia Archivo: A web-scale interface for ontology archiving under consumer-oriented aspects. In *Semantic Systems: In the Era of Knowledge Graphs*. Lecture Notes in Computer Science, Vol. 12378. Springer, 19–35. [http://dx.doi.org/10.1007/978-3-030-59833-4\\_2](http://dx.doi.org/10.1007/978-3-030-59833-4_2)
- [10] Mari Carmen Suárez-Figueroa, Asunción Gómez-Pérez, and Mariano Fernández-López. 2012. *The NeOn Methodology for Ontology Engineering*. Springer, Berlin, Germany, 9–34. [http://dx.doi.org/10.1007/978-3-642-24794-1\\_2](http://dx.doi.org/10.1007/978-3-642-24794-1_2)
- [11] Megan Katsumi and Mark Fox. 2017. *Defining Activity Specifications in OWL*. University of Toronto. <http://ceur-ws.org/Vol-2043/paper-07.pdf>.
- [12] Ewa Kowalczyk and Agnieszka Lawrynowicz. 2016. The reporting event ontology design pattern and its extension to report news events. In *Advances in Ontology Design and Patterns [revised and extended versions of the papers presented at the 7th edition of the Workshop on Ontology and Semantic Web Patterns, WOP@ISWC 2016, Kobe, Japan, 18th October 2016]*, Karl Hammar, Pascal Hitzler, Adila Krisnadhi,



- Agnieszka Lawrynowicz, Andrea Giovanni Nuzzolese, and Monika Solanki (Eds.). Studies on the Semantic Web, Vol. 32. IOS Press, 105–117. <http://dx.doi.org/10.3233/978-1-61499-826-6-105>
- [13] Rinke Hoekstra. 2010. Representing social reality in OWL 2. In *Proceedings of the 7th International Workshop on OWL: Experiences and Directions (OWLED 2010)*, San Francisco, California, USA, June 21–22, 2010, Evren Sirin and Kendall Clark (Eds.). CEUR Workshop Proceedings, Vol. 614. CEUR-WS.org, 1–10. [http://ceur-ws.org/Vol-614/owled2010\\_submission\\_29.pdf](http://ceur-ws.org/Vol-614/owled2010_submission_29.pdf).
- [14] John R. Searle. 1995. *The Construction of Social Reality*. Free Press, New York, NY.
- [15] Valentina Anita Carriero, Aldo Gangemi, Maria Letizia Mancinelli, Ludovica Marinucci, Andrea Giovanni Nuzzolese, Valentina Presutti, and Chiara Veninata. 2019. ArCo ontology network and LOD on Italian cultural heritage. In *Proceedings of the 1st International Workshop on Open Data and Ontologies for Cultural Heritage Co-Located with the 31st International Conference on Advanced Information Systems Engineering, ODOCH@CAiSE 2019, Rome, Italy, June 3, 2019*, Antonella Poggi (Ed.). CEUR Workshop Proceedings, Vol. 2375. CEUR-WS.org, 97–102. <http://ceur-ws.org/Vol-2375/short3.pdf>.
- [16] Valentina Presutti, Eva Blomqvist, Enrico Daga, and Aldo Gangemi. 2012. Pattern-based ontology design. In *Ontology Engineering in a Networked World*, Mari Carmen Suárez-Figueroa, Asunción Gómez-Pérez, Enrico Motta, and Aldo Gangemi (Eds.). Springer, 35–64. [http://dx.doi.org/10.1007/978-3-642-24794-1\\_3](http://dx.doi.org/10.1007/978-3-642-24794-1_3)
- [17] Francesca Benatti, François Vignale, Alessio Antonini, and Edmund King. 2022. Reading in Europe—Challenges and lessons learned from the case studies of the READ-IT project. *Digital Scholarship in the Humanities*. Early access, November 7, 2022.
- [18] Mark A. Musen. 2015. The Protégé project: A look back and a look forward. *AI Matters* 1, 4 (2015), 4–12. <http://dx.doi.org/10.1145/2757001.2757003>
- [19] Ahmad Alobaid, Daniel Garijo, Maria Poveda-Villalón, Idafen Santana-Pérez, Alba Fernández-Izquierdo, and Óscar Corcho. 2019. Automating ontology engineering support activities with OnToology. *Journal of Web Semantics* 57 (2019), 100472. <http://dx.doi.org/10.1016/j.websem.2018.09.003>
- [20] Karl Hammar. 2017. *Content Ontology Design Patterns: Qualities, Methods, and Tools*. Ph.D. Dissertation. Linköping University, Sweden. <http://dx.doi.org/10.3384/diss.diva-139584>
- [21] Sarah M. Alghamdi, Beth A. Sundberg, John P. Sundberg, Paul N. Schofield, and Robert Hoehndorf. 2019. Quantitative evaluation of ontology design patterns for combining pathology and anatomy ontologies. *Scientific Reports* 9 (March 2019), 4025. <http://dx.doi.org/10.1038/s41598-019-40368-1>
- [22] Eva Blomqvist, Karl Hammar, and Valentina Presutti. 2016. Engineering ontologies with patterns—The eXtreme Design methodology. In *Ontology Engineering with Ontology Design Patterns—Foundations and Applications*, Pascal Hitzler, Aldo Gangemi, Krzysztof Janowicz, Adila Krisnadhi, and Valentina Presutti (Eds.). Studies on the Semantic Web, Vol. 25. IOS Press, 23–50. <http://dx.doi.org/10.3233/978-1-61499-676-7-23>
- [23] Silvio Peroni, David M. Shotton, and Fabio Vitali. 2012. The live OWL documentation environment: A tool for the automatic generation of ontology documentation. In *Knowledge Engineering and Knowledge Management*. Lecture Notes in Computer Science, Vol. 7603. Springer, 398–412. [http://dx.doi.org/10.1007/978-3-642-33876-2\\_35](http://dx.doi.org/10.1007/978-3-642-33876-2_35)
- [24] Daniel Garijo. 2017. WIDOCO: A wizard for documenting ontologies. In *The Semantic Web—ISWC 2017*. Lecture Notes in Computer Science, Vol. 10588. Springer, 94–102. [http://dx.doi.org/10.1007/978-3-319-68204-4\\_9](http://dx.doi.org/10.1007/978-3-319-68204-4_9)
- [25] Ilaria Tiddi, Mathieu d’Aquin, and Enrico Motta. 2015. An ontology design pattern to define explanations. In *Proceedings of the 8th International Conference on Knowledge Capture (K-CAP’15)*. ACM, New York, NY, Article 3, 8 pages. <http://dx.doi.org/10.1145/2815833.2815844>
- [26] Francesca Benatti and Alessio Antonini. 2022. From glosses to Tsukkomi: Readers and the written word in digital comics. See [46].
- [27] Alessio Antonini, Samuel Brooker, and Francesca Benatti. 2020. Circuits, cycles, configurations: An interaction model of web comics. In *Interactive Storytelling*. Lecture Notes in Computer Science, Vol. 12497. Springer, 287–299. [http://dx.doi.org/10.1007/978-3-030-62516-0\\_26](http://dx.doi.org/10.1007/978-3-030-62516-0_26)
- [28] Alessio Antonini, Francesca Benatti, Edmund King, François Vignale, and Guillaume Gravier. 2019. Modelling changes in diaries, correspondence and authors’ libraries to support research on reading: The READ-IT approach. In *Proceedings of the 1st International Workshop on Open Data and Ontologies for Cultural Heritage Co-Located with the 31st International Conference on Advanced Information Systems Engineering, ODOCH@CAiSE 2019, Rome, Italy, June 3, 2019*, Antonella Poggi (Ed.). CEUR Workshop Proceedings, Vol. 2375. CEUR-WS.org, 73–84. <http://ceur-ws.org/Vol-2375/paper7.pdf>.
- [29] Jerry R. Hobbs and Feng Pan. 2004. An ontology of time for the semantic web. *ACM Transactions on Asian and Low-Resource Language Information Processing* 3, 1 (2004), 66–85. <http://dx.doi.org/10.1145/1017068.1017073>
- [30] Ari Sivula and Jussi Kantola. 2015. Ontology focused crowdsourcing management. *Procedia Manufacturing* 3 (2015), 632–638.
- [31] Jérôme Euzenat and Pavel Shvaiko. 2013. *Ontology Matching* (2nd ed.). Springer.
- [32] Ryan Shaw, Raphaël Troncy, and Lynda Hardman. 2009. LOD: Linking open descriptions of events. In *The Semantic Web*. Lecture Notes in Computer Science, Vol. 5926. Springer, 153–167. [http://dx.doi.org/10.1007/978-3-642-10871-6\\_11](http://dx.doi.org/10.1007/978-3-642-10871-6_11)
- [33] Yves Raimond, Samer A. Abdallah, Mark B. Sandler, and Frederick Giasson. 2007. The music ontology. In *Proceedings of the 8th International Conference on Music Information Retrieval, ISMIR 2007, Vienna, Austria, September 23–27, 2007*, Simon Dixon, David Bainbridge, and Rainer Typke (Eds.). Austrian Computer Society, 417–422. [http://ismir2007.ismir.net/proceedings/ISMIR2007\\_p417\\_raimond.pdf](http://ismir2007.ismir.net/proceedings/ISMIR2007_p417_raimond.pdf).

- [34] Pavel Lomov and Maxim G. Shishaev. 2014. Creating cognitive frames based on ontology design patterns for ontology visualization. In *Knowledge Engineering and the Semantic Web*. Communications in Computer and Information Science, Vol. 468. Springer, 90–104. [http://dx.doi.org/10.1007/978-3-319-11716-4\\_8](http://dx.doi.org/10.1007/978-3-319-11716-4_8)
- [35] Edmund G. C. King, Maya Parmar, and Shafquat Towheed. 2019. Reusing historical questionnaire data and using newly commissioned oral history interviews as evidence in the history of reading. *Participations: Journal of Audience & Reception Studies* 16, 1 (2019), 530–553.
- [36] Daniel Allington, Beatriz L. Buarque, and Daniel Barker Flores. 2020. Antisemitic conspiracy fantasy in the age of digital media: Three “conspiracy theorists” and their YouTube audiences. *Language and Literature* 30, 1 (2020), 0963947020971997.
- [37] Alessio Antonini, Francesca Benatti, and Sally Blackburn-Daniels. 2020. On links to be: Exercises in style# 2. In *Proceedings of the 31st ACM Conference on Hypertext and Social Media*. 27–36.
- [38] Daljit Nagra. 2014. *Kubla Khan* and Coleridge’s Exotic Language. Retrieved March 17, 2023 from <https://www.bl.uk/romantics-and-victorians/articles/kubla-khan-and-coleridges-exotic-language/#>.
- [39] Italo Calvino. 1986. Why read the classics? In *The Uses of Literature*. Translated by Patrick Creagh. Harcourt Brace Jovanovich, New York, NY.
- [40] The Guardian. n.d. Reading Group | Page 25 of 27 | Books. Retrieved March 17, 2023 from <https://www.theguardian.com/books/series/reading-group?page=25>.
- [41] Anežka Kuzmičová, Patrícia Dias, Ana Vogrinčič Čepič, Anne-Mette Bech Albrechtslund, André Casado, Marina Kotrla Topić, Xavier Mínguez López, Skans Kersti Nilsson, and Inês Teixeira-Botelho. 2018. Reading and company: Embodiment and social space in silent reading practices. *Literacy* 52, 2 (2018), 70–77. <http://dx.doi.org/10.1111/lit.12131>
- [42] Alessio Antonini, Francesca Benatti, and Edmund King. 2020. Restoration and repurposing of DH legacy projects. In *Proceedings of the 15th Annual International Conference of the Alliance of Digital Humanities Organizations (DH’20)*. [https://dh2020.adho.org/wp-content/uploads/2020/07/138\\_RestorationandRepurposingofDHLegacyProjects.html](https://dh2020.adho.org/wp-content/uploads/2020/07/138_RestorationandRepurposingofDHLegacyProjects.html).
- [43] Alessio Antonini, Gustavo Gomez Mejia, and Lucia Lupi. 2019. All we do is “stalking”: Studying new forms of reading in social networks. In *Proceedings of the 30th ACM Conference on Hypertext and Social Media, HT 2019, Hof, Germany, September 17-20, 2019*, Claus Atzenbeck, Jessica Rubart, and David E. Millard (Eds.). ACM, New York, NY, 111–115. <http://dx.doi.org/10.1145/3342220.3343646>
- [44] Eva Blomqvist, Óscar Corcho, Matthew Horridge, David Carral, and Rinke Hoekstra (Eds.). 2018. *Proceedings of the 8th Workshop on Ontology Design and Patterns (WOP 2017) Co-Located with the 16th International Semantic Web Conference (ISWC 2017), Vienna, Austria, October 21, 2017*. CEUR Workshop Proceedings, Vol. 2043. CEUR-WS.org. <http://ceur-ws.org/Vol-2043>.
- [45] ADHO. 2019. *Book of Abstracts of the DH Conference 2019*. ADHO.
- [46] Society for the History of Authorship, Reading and Publishing. 2022. *SHARP 2020: Power of the Written Word*. Society for the History of Authorship, Reading and Publishing.
- [47] Alessio Antonini. 2021. Appendix to “experiential observations: Capturing the potential content within evidences of experiences.” *The Open University*. Retrieved March 17, 2023 from <http://dx.doi.org/10.21954/ou.rd.14156624.v2>.

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