



Open linked data and mobile devices as e-tourism tools. A practical approach to collaborative e-learning



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ABSTRACT

Collaborative e-learning is based on a model where knowledge is created through interaction between members that interact by sharing experiences and knowledge.

Linked Open Data (LOD) allow to link data with other related data in which people are interested. As a practical approach we introduce a system where is built cultural heritage knowledge from collaboration between open data published by a regional government, enriched with data from other sources of open linked data cloud like DBPedia.

Mobile technologies in e-learning allow learning in any place and moment. We try to take advantage of mobile and semantic technologies, like LOD, in a collaborative e-learning environment. Knowledge is built by enriching open data that are shared by institutions to knowledge shared on Semantic Web, by using LOD techniques, leading a scenario of collaborative and human learning by linking data sources and people who share these data.

The collaboration between web of data and open data from a public institution has resulted in practice, in a mobile tourism application that works as a tourist guide for citizens. Application also allows the collaboration of tour guides to add new knowledge about the cultural heritage resources. In brief, collaboration between different profiles generates knowledge and collaborative learning.

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1. Introduction

Collaborative learning is situation where more than one people learn together and interact by sharing knowledge and experiences. People should learn for each other and share information and knowledge. That is, the data are shared in order that somebody can use them and usually to add new value to these data by developing new citizens services.

For instance group-work is a usual example of collaborative learning. Collaborative e-learning is something not new; nevertheless new technologies and social media have transformed collaborative learning in collaborative e-learning.

Mobile learning is a newer way to learn by using mobile devices. Between other, this allows user to learn in any place and time.

Finally, Semantic Web, also named web of data, is considered as a new way to understand the web, where data are fitted with semantic meaning. Linked data is the technology used to link data

in this Web of data. When we add the word “open”, Linked Open Data (LOD), we speak about how to link data that are shared in an open way, usually but not only by public institutions. That is, the data are shared in order somebody can use them and usually to add new value to these data by developing new citizen services.

In this paper we propose to merge all these concepts to build knowledge in a collaborative way. The idea is that open data published in an open format enrich their knowledge with other data of the web of data to build new knowledge. In this way, through the collaboration between those that publish these data, it will be possible to learn and generate knowledge in a mobile and e-learning environment. Actually, this is not a traditional approach to online collaborative learning with people collaborating on line, but one where data systems collaborate in a practical sense.

In this introduction section we are also going to explore other collaborative environments and their possible relation to web semantic technologies. In the next sections of this paper we will see our method to take advantage of semantic technologies in collaborative e-learning as well as its practical approach to a specific use case. Finally, we will present our results and conclusions after our study.

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1.1. Background

1.1.1. Collaborative e-learning and LOD

In order to study the relationship between collaborative e-learning and LOD there exist in research area two main points of view.

On one hand, we are going to see some research that join LOD and web semantic to e-learning in general, not only to collaborative e-learning.

On the other hand, another research works relate linked open data to collaborative data in order to solve some different problems or provide knowledge, such as in our case.

- LOD in e-learning

Tiropanis, Davis, Millard, and Weal (2009) speak about the future possibilities of LOD in learning in higher education using interoperable semantic data. They rely on the potential of applications based on learning repositories linked to unstructured data by means on ontologies. In the same way Krieger and Rösner (2011) introduce a new concept and trend, Educational Semantic Web, that is to say, application of LOD in e-learning.

Dicheva (2008) speaks about the new generation, the third, of Web education systems. He describes this new generation as an ontology-aware software that uses semantic standards and technologies to guarantee scalability, reusability and interoperability of educational material distributed on the Web.

In other research (Todor, Paschke, & Heineke, 2011) and (David et al., 2010) mention some projects which work with ontologies in learning contexts. Some of them produce and consume linked data in different areas, for instance, mathematics or chemical.

Finally, Yang (2004) proposes an ontology annotation to manage knowledge for collaborative learning in Virtual Learning Communities. Namely, they use ontologies to make personalized annotations in the knowledge, find related knowledge, relate collaborators to knowledge or motivate collaborators to share their knowledge.

- Collaborative data and LOD in different contexts

In this second group of research we will see different examples where collaborative data and LOD are used to solve different problems. In our research we also use collaborative data to a purpose, to learn about a topic.

Some authors (de Faria Cordeiro, Marino, Campos, & Borges, 2011) propose an LOD based architecture to integrate different open data sources from citizens and public media, to give an answer and to management emergency situations.

Some research's (Abanda, Zhou, Tah, & Cheung, 2013) study the relation between LOD and Building Information Modeling and its application to building information management.

Mäkelä, Hypén, and Hyvönen (2012) propose to improve searches and recommendations in fiction literature by using ontologies and LOD.

Heitmann and Hayes (2010) use LOD to solve the collaborative recommendation system problems and other authors, Meimaris, Alexiou, and Papastefanatos (2014) use LOD to collaborative management of heterogeneous resources.

In our practical approach we use LOD and ontologies to relate collaborative data sources in order to learn about a topic, cultural heritage in our case.

1.1.2. Relationship between Semantic Web, linked open data, ontologies and collaborative e-learning

Semantic Web (Tim Berners-Lee, 2001) is the extension of the World Wide Web that enables people to share content beyond

the boundaries of applications and websites. It has been also described as web of data. The goal of Semantic Web technologies is that web based information and services can be understandable and reusable by humans and machines.

Ontologies (Gruber, 1995), one of the major components of Semantic Web, are defined as a representation of a shared conceptualization in a particular domain.

Linked data, other important concept of Semantic Web, is a term used to describe recommended best practices to expose, share, and connect pieces of data, information and knowledge on the Semantic Web, by using URIs or the RDF language (Doods & Davis, 2012). In this way the web could be understood as a data base of linked data. The linked data cloud, which is specially growing since 2011, provides data sets in semantic format in the Web of data (Fig. 1).

Open data (Open Knowledge Foundation) is a piece of data or content that people are free to use, reuse, and redistribute, without any legal or social restriction. Open knowledge is what open data becomes when it is useful, usable and used. For these reasons open data should have key features of openness such as:

- The data must be available in a convenient and modifiable form. In this sense, RDF and ontologies could be considered the best way to format the data.
- The data must be provided under terms that permit reuse and redistribution including the intermixing with other data sets (linked data is perfect for this).
- Everybody must be able to use, reuse and redistribute the data. The “collaboration” among persons and groups would be desirable.

There are many kinds of open data that have potential uses and applications and that have been usually provided, but not only, by public institutions. In our use case we are going to work with cultural data, data about cultural heritage, to generate knowledge in a collaborative way.

Linked Open Data (LOD) (Florian Bauer, 2012) is the next concept. To fully benefit from open data, it is crucial to put information and data into a context that creates new knowledge and enables powerful services and applications. LOD facilitate innovation and knowledge creation from interlinked data and it is an important mechanism for information management and integration.

The path from open data to linked open data was best described by Sir Tim Berners-Lee when he first presented his 5 Stars Model at the Gov 2.0 Expo in Washington DC in 2010. Since then, Berners-Lee's model has been adapted and explained in several ways; the following adaptation of the 5 Stars Model

1. Information is available on the Web (any format) under an open license.
2. Information is available as structured data (e.g., Excel instead of an image scan of a table).
3. Non-proprietary formats are used (e.g., CSV instead of Excel).
4. URI identification is used so that people can point at individual data.
5. Data is linked to other data to provide context.

All of these concepts, Semantic Web, ontologies, open data and linked open data, are related to: using ontologies to semantically find the right thing; data and knowledge sharing, as linked open data promote, can ensure learning and knowledge enriched; ontologies could be the nexus, the common format to share and link open data and data of open linked data cloud in the Web.

Namely, LOD is certainly a challenge to command rapidly growing data sets and to provide your own linked data along with the data of another institution. The complexity involved means that

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