Towards Personalized Guidance and Support for Learning
Proceedings of the 10th European Distance and E-Learning Network Research Workshop, 2018
Barcelona, 24-26 October, 2018
ISBN 978-615-5511-25-7
ISSN: 2707-2819
doi: https://doi.org/10.38069/edenconf-2018-rw-0013

WIKI COURSE BUILDER, A SYSTEM FOR MANAGING AND SHARING DIDACTIC MATERIAL AND CONCEPT MAPS

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Summary

In this article we present an evolution of Wiki course Builder, a system for building courses, sharing and sequencing learning material taken from Wikipedia pages. The system has been expanded through the implementation of two new modules to provide teachers with different tools that optimize the course creation process. Taking advantage of the user model implemented in the system starting from Grasha's teaching styles, we have implemented a module that visualizes the graph of all the courses created by the teaching community and makes it possible to compare it with others. This graph can be filtered by macro categories of arguments (e.g. History, Philosophy...) and by teacher archetypes (e.g. expertize delegator ...). The second module is a graphical interface that makes it possible to design and build concept maps for the generation of different courses (alternative learning paths through the map). The comparison between these maps will enrich the model of the teacher who will receive recommendations more refined on the basis of the course method you prefer to make. For the future it will be interesting to extend the user model through the comparison of the concept maps generated by the creation of the course and the clustering of the teachers on the basis of this data. Furthermore, the study of the density of concepts within the materials and the complexity of learning difficulties would complete the user model by optimizing again the recommendation process.

Introduction

Over the years, the growth of the online repositories of educational and systems based on their use has grown exponentially. The web is now the largest source of knowledge, but also a source of unverified information. Moreover, online information is difficult to find due to the multitude of labelling systems used by the various online repositories that forces teachers to do multiple searches, allowing only in a few cases to use the past experience of other teachers. One of the biggest knowledge bases is undoubtedly Wikipedia, where most of the educational articles are written by domain experts as discussed by Mesgari et al. (2015). The proposed system is an extension of Wiki Course Builder, an online platform for the creation of online courses already presented by Gasparetti et al. (2016). The extension implements two new functions designed to encourage the development of shared knowledge among teachers in order to improve the quality of the courses provided. Specifically, from the user model created starting from the Teaching Styles of Grasha (1996) and from the results proposed in the analysis of the system reported by Gasparetti et al. (2015) a community graph based on archetypes is presented. Each course that the teacher will configure on the platform will enrich the graph, which can be explored, navigated and filtered to see what the other teachers with similar user models have done before. The extension also introduces a panel for the creation of concept maps for each topic created in *point and click* mode. To this aim we use ENCODE (Adorni & Koceva, 2016), a tool that supports teachers in the instructional design process of a course. The underlying idea of the tool is that the separation of the knowledge structure of a subject matter from its information resources serves two goals: making the knowledge structure re-usable with different information resources and allowing different learning paths through the same knowledge structure.

Furthermore, by resuming the work (Gasparetti et al., 2015) on the recognition of the prerequisites, it was possible to insert suggestions for the maps created, highlighting in red the arcs that probably reflect a prerequisite / successor relationship.

Related Work

A relevant problem in subject matter representation is that there is no canonical representation of knowledge structures, since different structures can satisfy the same learning goal as well as different structures can represent different perspectives over the same subject. This principle has been defined by Ohlsson (1987) as the "Principle of Non-Equifinality of Learning", according to which the process of acquiring a particular subject matter does not converge on a particular well-defined representation of that subject of study. Hence, the process of acquiring the subject matter have many different, equally valid, end states.

According to this, the approach presented in this paper does not aim to build the optimal concept map for a given subject matter: its aim is to support the teacher to build a map that takes into account the perspective of other teachers and the knowledge structure of a large community-based encyclopaedia, Wikipedia.

Wikipedia offers a quantity of high-quality content homogeneous in terms of presentation (Mesgari et al., 2015). The openness, easy availability, and freshness of data make Wikipedia of interest in a variety of research activities, such as natural language processing and translation tools. Links, categories and information in templates provide structured content that can be retrieved from raw XML dumps or Application Program Interface calls.

Wikipedia had its peak of contributions in 2007, however, even with the advent of other alternatives, such as Google's Knowledge Graphs Project (launched in 2012) that may be gobbling up Wikipedia users, it remains one of the most used source of information. Moreover, although user accesses have fallen on average by 10 in 2013, it is a matter of fact that most of the teachers, about 87% (Purcell et al., 2013), use the online Wikipedia encyclopaedia in their didactic activities. The reliability of Wikipedia (primarily of the English-language edition) has been also assessed: an early study in Nature journal said that in 2005, Wikipedia's scientific articles came close to the level of accuracy of the Encyclopaedia Britannica (Giles, 2005).

ISBN 978-615-5511-25-7

As already described in previous works (Gasparetti et al., 2016; Grasha, 1996), the proposed system is quite innovative. With respect to the two proposed extensions, we see that in the literature there are some attempts to incorporate selected Wikipedia content into the curriculum as a collaborative environment (Forte & Bruckman, 2006) or to categorize learning resources (Meyer et al., 2007). In any case, we have not found any system that guides and helps teachers to build and share didactic learning paths, by exploiting Wikipedia.

The System

In this section, we present the architecture of the system with a focus on the features introduced in the extension. In this system each course is created by multiple topics, which are composed by one or more pages taken from Wikipedia. The system architecture is presented in Figure 1 Initially, the teacher must compile the registration form and a questionnaire in order to be profiled. With this data the *Authentications Manager* module initialize the user model. Then the teacher can start creating his first course by entering his first search query; the *Query Terms Manager* will take care of the query expansion that will be processed by the *Search Engine*. This module, using a local version of Wikipedia updated periodically on no-SQL DB (MongoDB), performs a search to find the initial concept from which to start building the course. The *Recommendations* module will be used to calculate the metrics presented by Gasparetti et al. (2015) used to create the Wikipedia graph from which the recommendations will be made for users. Finally, using the classifier for the prediction of the prerequisites / successors, a sequencing from the *sequencing* module will be presented. The courses are stored by the *Page Manager*.

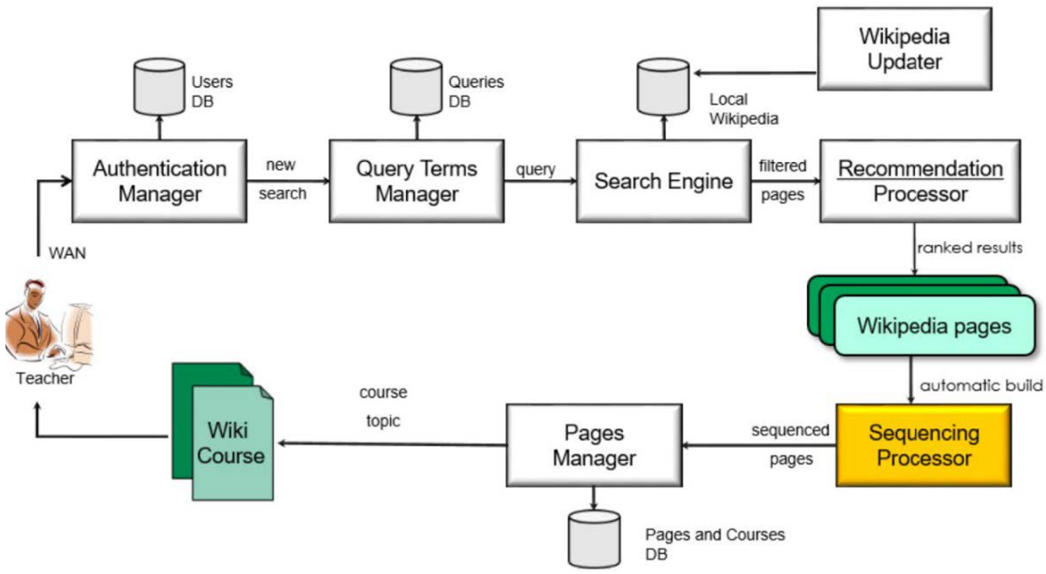

Figure 1. The System Architecture

ISBN 978-615-5511-25-7

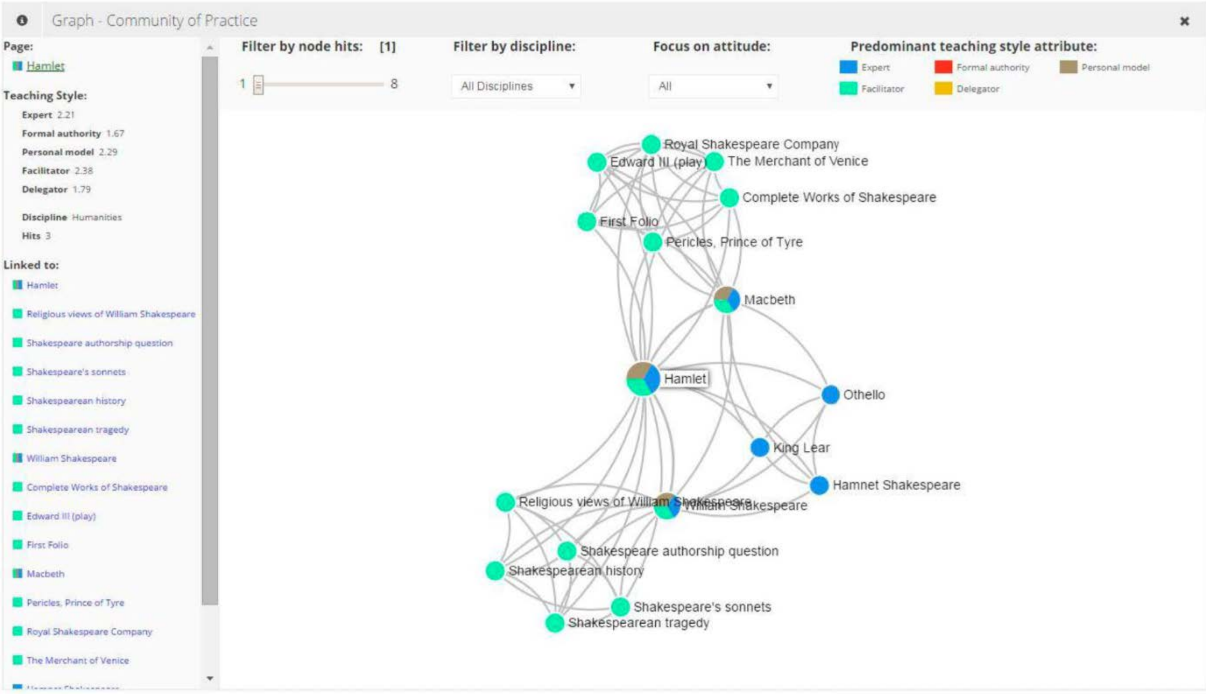

Figure 2. Focus on a course on the community graph

The first function implemented in the extension is the Community graph. The graph is available in the community section from the main menu and shows all the courses developed by the teachers on the platform. Moreover, for each course, the system reports all the topic's relationships to each other. The teacher will then be able to look for courses related to the one he wants to create and before starting the construction he can look at how the community has dealt with the same topics before him. Finally, the teachers can filter the graph looking only for the courses of the teachers most related to him, or those with teaching style closer to his. An example of how a specific section of the graph appears is presented in Figure 2. In the future the analysis of the relationships of this graph will expand the user model by an analysis between similarities between graphs of similar teachers.

Tool for Concept Map Design

The most important function integrated in this extension is the graphical tool for the creation of concept maps ENCODE (Adorni & Koceva, 2016). Once the materials have been selected for the topic, the teacher has the possibility, using a *point-and-click* panel, to manually enter the relationships between them. The result will be an acyclic graph that can be exported. The tool communicates with the prerequisite / successor relations recognizer; for each relationship created the tool will make a call to the classifier that can label the arc in the following ways:

- green agrees with the teacher,
- red discord with the teacher,
- grey not expressed.

Based on the labels the teacher can review the graph and, if needed, modify it. Finally, the reports saved in these graphs will be analysed for future recommendations of materials.

10th EDEN Research Workshop Proceedings, 2018, Barcelona
ISBN 978-615-5511-25-7

ENCODE

The tool is based on the conceptual model of the Educational Concept Maps. An ECM is a logical and abstract annotation model that represents the concepts of a subject of study, their educational relationships and the learning outcomes. It has been designed by taking into account the pedagogical requirements defined by the Educational Modelling Language research group (Koper & Manderveld, 2004).

The relationships modelled in the ECM are the following: prerequisite relation (is_requirement); hierarchy and aggregation relation (is_item); correlation (is_related); association with a concept that can be suggested to go into more detail on the matter (is_suggested). Among these relationships, the most relevant from the instructional design point of view is the prerequisite relation. The prerequisite relation between two concepts A and B represents what a learner must know/study (concept A), before studying concept B. Thus, A is a propaedeutic concept, i.e. a requirement, for B and the learner should first understand A in order to understand B.

The main properties of the prerequisite relation are defined as follows:

- asymmetric and binary relation;
- anti-reflexive relation: concept A cannot be a prerequisite of itself;
- transitive relation: if concept A is prerequisite of B, and concept B is prerequisite of C, then concept A is also prerequisite of concept C.

The prerequisite relation can represent a hyponymy or meronymy relation in the case where the hyponym/meronym concept is going to be further in-depth studied and therefor it is itself a prerequisite to another concept. Conversely, the hyponymy/meronymy relation is represented by the is_item ECM relation.

The prerequisite relation represents the learning dependencies between the concepts and is the basis for the creation of learning paths through the map. A learning path is a linearization of the ECM that satisfies the prerequisite constraint and provides ordering (a sequence) of the concepts and thus of the content associated to them.

To implement the ECM model, ENCODE adopts the Topic Maps (TM) standard. TM is an ISO multi-part standard designed for encoding knowledge and connecting this encoded knowledge to relevant information resources (http://www.isotopicmaps.org). The standard defines a data model for representing knowledge structures and a specific XML-based interchange syntax, called XML Topic Maps (XTM).

The main elements in the TM paradigm are: *topic* (a symbol used to represent one, and only one, subject), *association* (a relationship between two or more topics) and *occurrence* (a relationship between a subject and an information resource). Therefore, two layers can be identified in the TMs paradigm:

- The knowledge layer representing topics and their relationships, forming a graph.

ISBN 978-615-5511-25-7

- The information layer describing information resources, to be attached to the ECM topics.

Each topic can feature with any number of names (and variants for each name) and any number of occurrences, and its association role, that is a representation of the involvement of a subject in a relationship represented by an association. All these features are statements and they have a scope representing the context a statement is valid in. Using scopes, it is possible to avoid ambiguity about topics; to provide different points of view on the same topic (for example, based on users' profile) and/or to modify each statement depending on users' language, etc. Therefore, to solve ambiguity issues, each subject, represented by a topic, is identified by a subject identifier. This unambiguous identification of subjects is also used in TMs to merge topics that, through these identifiers, are known to have the same subject (two topics with the same subject are replaced by a new topic that has the union of the characteristics of the two originals).

The current implementation of the tool is based on Wandora (https://github.com/wandora-team/wandora), a general-purpose information extraction, management, and publishing environment based on Topic Maps and Java.

Encode provides: a graphical visualization/navigation and editing interface which lets the map-designer to incrementally populate the concept map and the associated materials. In addition, the tool provides a utility to build a lesson plan as a linearization of the ECM (using a topological ordering algorithm) and utilities for the consistency checks. The tool allows to export both the ECM and the lesson plan in XML format. Finally, a utility enables the teacher to generate a simple web site of the lesson plan. Based on Wandora, ENCODE is a desktop application but a web-based version is under development. An example of Educational Concept Map is available (http://teldh.dibris.unige.it/ecm-example/).

Conclusions

WCB is a system that supports teachers through the entire course creation process. It models teachers following Grasha's teaching style and keeps track of all users' interactions to recommend materials taken from Wikipedia. The System labels pages with a 5-dimensional array that reflect the Teaching Style presented by Grasha; all this measures makes possible to explore and filter the community graph containing all the courses delivered by the platform, with the relationships between materials. Furthermore, the possibility to create and export concept maps has been added, as well as the course in various formats. For the future it will be very interesting to see how the study of the concept maps implemented by teachers can expand the user model, trying to integrate the work presented by Limongelli et al. (2017) on similarity between maps by analysing a set of features associated with them. This information would improve the page recommendation module and the usability of the courses.

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ISBN 978-615-5511-25-7