Rikamap—An educational application using RDF-formatted learning paths

Makoto Urakawa, Hiroshi Fujisawa

NHK (Japanese Broadcasting Corporation), 1-10-11,Kinuta,Setagaya-ku,Tokyo,Japan

{urakawa.m-gi, fujisawa.h-ja}@nhk.or.jp

Abstract. Amid the growth of educational services and content on the Internet, it is expected that an increase in services with material suited to the path of learning and systems that bundle materials together. There is research being done on ways to systematize connections between preparatory and review items and to coordinate the content of educational materials. The authors have developed Rikamap("Science Map"),[1] an application that utilizes resource description framework (RDF)-formatted learning paths to connect these stages of learning and systematically organize and present educational video content relevant to each stage for the user. In this paper, we will discuss the underlying data structure and system of the Rikamap, as well as the importance and issues of using a linked structure as revealed by the usage of the system.

Keywords: Ontology, resource description framework, RDF, knowledge graph, learning path, linked data, curriculum, education

1. Introduction

The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) publishes curriculum guidelines for each grade level and subject in HTML and PDF formats.[2] [3] Textbook publishers and other companies that provide educational services develop their content and plan their lessons based on these guidelines. AS a public broadcaster, NHK not only produces and broadcasts television programs with content developed according to the guidelines, but publishes educational video content on the web as well.[4] However, because the curriculum guidelines are not made available as linked open data or even as structured data, it is difficult for a single company's educational materials to be organized within an system and with other companies' content.

[1] http://www.nhk.or.jp/school/rikamap/

[2] http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/chu/ri.htm

[3] http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_5.pdf (referred for explanation in English)

[4] http://www.nhk.or.jp/school/

We have been done to parse the text of the curriculum guidelines to estimate the relationship of new words to previously appearing words, then extract learning connections and write them in the resource description framework (RDF) format [1]. By labeling the learning items with relational designations like "preparation" and "review," it is possible to use these RDF data as learning paths. In this paper, we will introduce Rikamap—an application that uses these RDF-formatted learning paths—and talk about its usefulness as analyzed and evaluated from usage logs.

Section 2 of this paper gives a brief overview of related work. Section 3 describes the structure of the backend system. Section 4 introduces Rikamap and its examination results. Finally, Section 5 summarizes this research.

2. Related Work

The British Broadcasting Corporation (BBC) published a curriculum ontology[5] that describes the United Kingdom (UK) national curricula [2]. It represents the importance of organized learning resources. However, it does not enable us to learn the relative subjects continuously and dynamically. Study of ontology design [3] [4] can help classify ontology for teachers, learners, syllabus, and subjects. These approaches focus on a system to manage a layered ontology, and the syllabus is classified by string similarity based on only common words [4]. The Knewton offers an adaptive courseware by using learning paths. The learning path is one of the keys for adaptive learning, however it can be generated by a trained subject matter expert in a few weeks [5].

3. Backend Structure

Rikamap's backend data structure consists of information from the national curriculum guidelines and NHK's video. The leaning paths does not need to be updated as long as the guidelines do not change, however new videos are produced daily. Therefore, we designed a system to allows video content to be connected to learning paths. Figure 1 shows the structure of the system, which is deployed on Amazon web services (AWS). It takes information about the videos from a pre-existing digital archive system in TSV. The video information has a pointer written in character string to related to items of the curriculum. The system converts it and ties the video information to the learning path data that is already stored in an RDF store. Meanwhile, queries from the web service Rikamap are converted to SPARQL format on the API server and return a response with data from the RDF store. This is done to hide the SPARQL query and to handle the log data in a unified way. For the RDF store, we chose Stardog after performing speed tests on the response to property path queries for learning path extraction. Please refer to past paper [1] to learn more about how the learning path data and video information are structured.

[5] http://www.bbc.co.uk/ontologies/curriculum

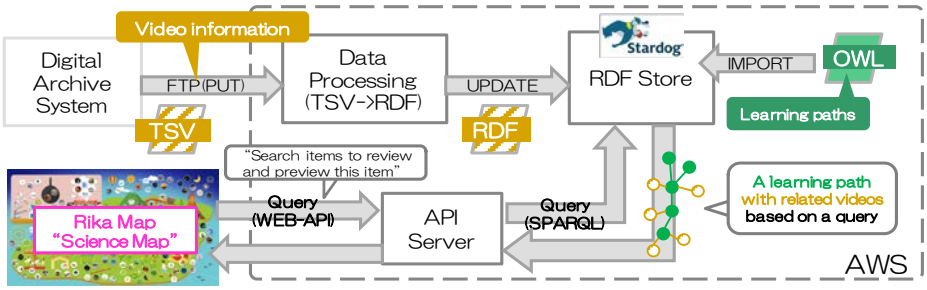

Fig. 1. Backend structure

4. Overview of Rikamap and examination of usage patterns

In this section, we will introduce Rikamap, which not only allows learners to learn with videos whose content suits their interests, but also allows them to navigate between and watch videos corresponding to preparatory and review items. As the screenshots in Figure 2 show, when the learner clicks on an icon representing a learning item in the Top Screen, they are taken to the Navigation Screen. The Navigation Screen displays relevant learning paths corresponding to that icon (marked "hasReview/hasPreview" in the figure) and related videos (marked "hasVideo"). These relationships are dynamically generated from the learning path data. Using Rikamap, learners can prepare and review according to their own understanding.

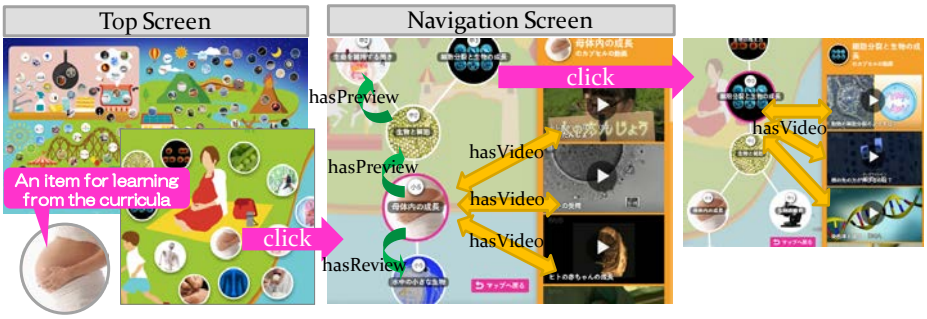

Fig. 2. Screenshots of Rikamap

We analyzed the first 2 weeks of system logs following the April 27, 2017 launch of the application. The Top Screen had 3319 views, and there were 1731 click-throughs to the Navigation Screen. On the Navigation Screen, users clicked on preparatory and review items 2149 times, with an average of 1.2 such items being clicked per session. Furthermore, upon checking whether users navigated more to preparatory or to review items, we found that review items were clicked 1.2 times more than preparatory items. That is to say, it seems that, rather than developmental content, learners need content that will help them understand in greater depth what they are already learning. Moreover, upon reaching the Navigation Screen, users played 3.2 times as many preparatory and review videos along the learning path in

comparison with other related videos that were shown when they reached at the Navigation Screen. This implies that users more frequently watch videos that have a meaningful relationship to what they are learning. From the content producer perspective, this means that rather than simply displaying related videos, it is more useful to provide content designated for specific use cases such as preparation and review. However, the video service on the existing NHK for School website had 3.1 times as many completed video plays than Rikamap. We believe this is because Rikamap also focuses on the user interface to enable and prompt users to view various videos smoothly. As a result, they do not finish watching videos that are even a slight mismatch with what they were looking for. The way of providing the appropriate videos and making them view with concentration should be needed.

5. Summary

In this paper, we described the structure of an application that uses RDF-formatted learning paths extracted from existing curriculum guidelines which the Japanese ministry published, and examined the usage patterns of this application. This application "Rikamap" enables users to explore learning items and relevant videos. RDF, which expresses data as triples, enables the flexible expression of learning paths, which actively change depending on what is being learned. The query about the property path from RDF data is especially effective for this application. In examining the usage logs, we saw that Rikamap users searched for content to review rather than preview what they were studying. It is also revealed that there is a greater tendency to watch videos that have meaningful "preparatory" and "review" connections to their learning items. These results prove the usefulness of semantically-constructed learning paths, and give a pedagogical insight to educational content providers. In the future, we will try to improve the algorithm that bundles a learning item and videos in order to offer more appropriate videos what users want to study.

References

1. Makoto Urakawa, Masaru Miyazaki, Hiroshi Fujisawa, Masahide Naemura, Ichiro Yamada: Constructing Curriculum Ontology and Dynamic Learning Path Based on Resource Description Framework. In: Proceedings of the ISWC 2016 Posters & Demonstrations Track (ISWC2016) (2016)
2. Liu, D., Mikroyannidi, E., Lee, R.: Semantic Web Technologies Supporting the BBC Knowledge & Learning Beta Online Pages. In: Proceedings of the Linked Learning Meets LinkedUp Workshop: Learning and Education with the Web of Data (LILE 2014) (2014)
3. Chung, H.S., Kim, J.M.: Ontology Design for Creating Adaptive Learning Path in e-Learning Environment. In: Proceedings of the International Multi-Conference of Engineers and Computer Scientists 2012, Vol. 1 (IMECS 2012) (2102)
4. Chung, H.S., Kim, J.M.: An Ontological Approach for Semantic Modeling of Curriculum and Syllabus in Higher Education. International Journal of Information and Education Technology, Vol. 6, No. 5 (2016)
5. https://www.knewton.com/wp-content/uploads/knewton-technical-white-paper-201501.pdf