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Adaptive Question Generation Support in Semantic Open Learning Space

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Abstract: This research aims to give learners more content-dependent scaffolding in the self-directed learning of history. Learners use a system to build a concept map containing a chronology. The system is able to generate content dependent support adapted to the learners. To enable this support, we built a semantic open learning space using a natural language online encyclopedia and semantic information using the open linked data. The support is provided by the automatically generated questions and documents. The learners request questions when they need and the system will generate the questions depending on the concept map of the learner. The generated questions aim to leads the learners to new knowledge deepening their understanding.

Keywords: Semantic Open Learning Space, Self-directed Learning, Question Generation, History Learning, Adaptive Learning Support

1. Introduction

When learners are confronted with a self-directed situation, their interests will influence their learning. The advantage of this is that the learners will be more motivated than they are by with classroom learning. Learners can proceed at their own rhythm and take more time to study the concepts in which they are interested. However, the disadvantage is that to study in a self-directed way and reach their learning objective, learners must use their self-regulation skills (Biswas, Roscoe, Jeong and Sulcer, 2009). If these skills are insufficiently developed, the resulting learning will be of a lesser quality than classroom learning, and learners will waste a considerable amount of time trying to extract the information they need, especially in an open learning space where the information is not limited to the studied subject.

Previous research already created systems to overcome this disadvantage such as the Navigation Planning Assistant (Kashihara and Taira 2009), which provides a scaffolding environment used to describe learners' learning plans and state of understanding to prompt their self-regulation in an open learning space. Also using scaffolding is the research of Segedy and al.(2013) which provide Guided Skill Practice in an open environment. The limitation of this system, however, is that its support is '*content independent*' due to the difficulty of working with natural language information on the Web. Of course, we overcome the difficulty when we can prepare learning materials in advance. Teachers, however, cannot regulate the learning materials in principle in self-directed 'exploratory' learning: if teachers specify the learning materials, self-directed learning loses its meaningful advantages. Other notable related research is Kit Build Method (Hirashima, Yamasaki, Fukuda and Funaoi, 2011), which provides a knowledge externalization environment for building a concept map and providing support during the concept map construction.However, in both cases, as the learning material needs to be prepared beforehand, this requires a considerable amount of time even for constructing the closed space of learning. The underlying difficulty of this is also that the system cannot use the semantic information to prepare the domain concept structure of a target field.

Therefore, our approach for building a system able to generate content dependent support in an open learning space is to use semantic information. This is build based on Wikipedia for the natural language information and enhanced by semantic information using open linked data (Heath and Bizer, 2011) to make it a semantic open learning space. This research has two advantages for learning support:

A) The system can provide content dependent questions in accordance with the learners' interests to deepen their understanding by enhancing their internal self-conversation.
B) The system can provide suitable documents in accordance with the questions that learners try to answer and highlight the information on which they should focus. Even learners, less skilled at self-regulated learning, can continue motivated learning, since they are released from extracting suitable information from huge amounts of information.

Both for A) and B), one key issue is the adaptability to the learners' interests and learning topics. To realize the above advantages, we adopt ontology and a linked open data technique to eliminate the difficulty of the natural language understanding problem in the history domain. Then, the system can automatically construct respective concept structures of the learning topic in accordance with learners' circumstances.

Regarding A), the problem is that learners cannot always generate good questions (Otero, 2009).The quality of the learning depends on the quality of the questions during this process (Bransford, Brown and Cocking, 1999), it is important to support the learners' question asking and answering activities in the learner's internal self-conversation in self-directed learning. By answering good questions that lead to a deeper understanding, the learner will be motivated to pursue his/her learning. Thus, learners need to be able to generate good questions by themselves. However, learners without support tend to focus on their interests and may not explore others subjects but if the support ignores these interests, the motivation of the learner will be reduced. To make this self-conversation explicit, the system suggests a list of questions depending on the learner's situation represented by the concept map to help the learner's question asking activity.

Regarding B), to support learners without strong self-regulation skills, the system introduces semantic information into the documents. When studying an important number of different concepts, learners may have difficulties in managing new information. It can become difficult to extract the suitable resources to answer the current questions and separate the information in a document into what is already known and what is (ir-)relevant to answer the questions. The system provides documents with a dynamic enhancement based on Wikipedia text with semantic information. These documents can highlight on demand concepts that appear in the text.

2. Overview of the System

The system has three main windows: the question window in Fig. 1(a), the document window in Fig. 1(b), and the concept map window in Fig. 1(c). The question window contains the list of questions generated by the system and the questions already answered by the learner. The document window displays the document answering the selected questions.

In our research, the learner is given the task to build a timeline of the events of the studied period with causal relationships between these events. Our system provides a specific knowledge externalization environment to improve the understanding of chronology depicted as Fig. 1(c). To learn history in a satisfying way, learners need to understand the relations between the events (Stow and Haydn, 2000). They must study the events as a whole, not every event separately. The learner's concept map is designed on this principle. In the center of the concept map in Fig. 1(c) is a timeline of the events ordered by time as usual, but learners also need to add relations between these events as well as other related concepts. All non-event concepts are displayed around the timeline. The motivation for this is to enhance causal understanding of the historical epoch events according to the time series which are backbone of history learning. The surrounding concepts (countries, alliances, commanders, etc) contribute to deepening their causal understanding. The timeline has to contain the important events of the studied period, which are chosen by a teacher from a timeline of all events in the studied period generated by the system to limit the preparation time, but the learner is free to add every event he/she considers relevant. The required events are present in the concept map of the learner at the beginning but they appear in grey until the learner adds them from a document.When using the system, all learners have the same starting point. They are given a document about the main subject of study.

When learning without support in self-directed exploratory learning, learners have to keep their focus on achieving their objective. If they do not, they will lose their way among irrelevant information. It is also possible for learners to stay on topic but study documents of little importance,

like searching detailed information irrelevant to reach the learning objective. While the interests of the learners are important for motivation, they often become a problem in self-directed open learning. Our system aims to give adaptive advice to suit the learner. The interests of the learners influence their concept map, which is used to generate the questions to be answered (Fig. 1(a)).

The learning is divided into two mains step. First, the learners start their learning with a document given by the system in the document window, in Fig. 1(b). While working on a document, they update their concept map, shown in Fig. 1(c), with all concepts and relations they consider interesting. They can add concepts in Fig. 1(b) to the concept map Fig. 1(c) by selecting them in the document, shown in Fig. 1(b). To add relationships between concepts, learners need to select two related concepts in their concept map, shown in Fig. 1(c). Then the system will generate a list of possible types of relation which includes invalid answers: (i) if the system shows one valid answer, they can easily construct their concept maps without enough understanding by choosing the answer the most relevant, and (ii) the system can understand the meaning of each link chosen by learners.

The created concept maps will be different depending on each learner since all learners will perceive the importance of the concepts in accordance with their interests, and we do not regulate the parts used for constructing the concept map to enhance their self-exploratory learning.

Then, when the learner thinks all concepts considered important have been added to the concept map shown in Fig. 1(c), a list of questions from the system appears in the question window, shown Fig. 1(a). The timing of showing the questions when they complete learning is important to become aware of the importance of questioning and answering activities. This list of questions will contain questions that will lead the learner to new relevant information that can deepen his/her understanding. The learner can also simply choose a question from the list without refreshing it. The list of questions is only refreshed when the learner requests it.

3. Current Work

For the learning aspect, the system still doesn't have strong support function intended to control the end of the learning.

For the technical aspect, to make this system possible the system needs to include semantic information. The system uses 3 sources of information: Wikipedia for the natural language and Freebase and DBpedia for the semantic information. Currently, we are working on solving the communication problems between these information sources to be able to use them in the system. The system is still in development phase.

After this has been solved, the next step is the evaluation. It will consist of two groups of

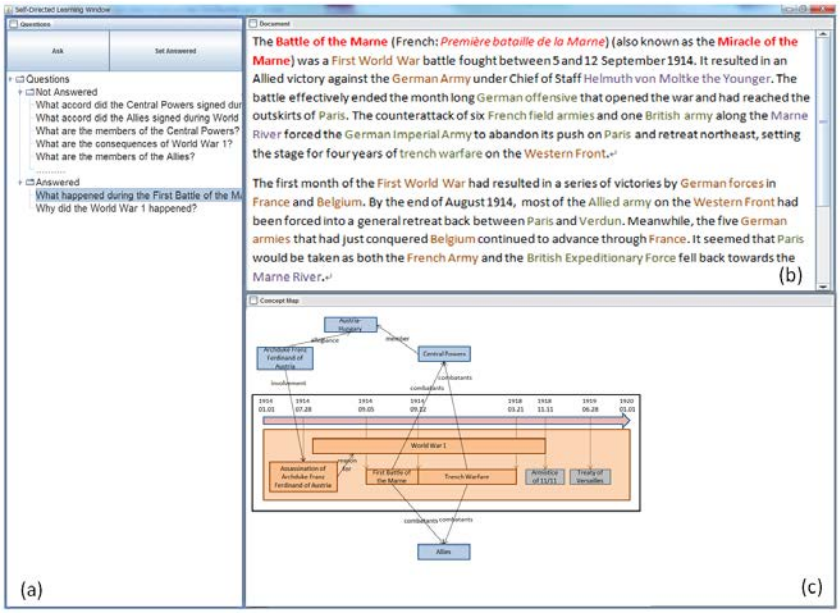

Figure 1. System Image

learners. The first group will use the system, and the second will be a control group. First, the two groups will learn about the same subject, one group will use the system with advice and the other without advice. Both groups will have to create a timeline. Then in a second session, both groups will use the system without the advice. They will have to learn about a second subject by generating questions by themselves. They will have to use as many questions as possible to generate the best timeline that they can. We will evaluate the quality of the timeline by taking into account its complexity and the density of the relations. We also want to evaluate the quality of the questions through the experiments.

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