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論　文　名　　　　LOD Based Question Generation Framework and Its Application to
History Learning in Open Learning Space

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Abstract

The purpose of this thesis is to enable support for learners in self-directed learning on the Internet using the current state of the semantic web. To provide support in an open learning space such as the Internet, all support functions must be generated automatically because open learning spaces have a quantity of information too large to prepare support manually. The main problem of generating meaningful content-dependent support automatically is that an understanding of the domain is necessary. It is difficult for a machine to fully understand the contents of documents because of the difficulty of working with natural language. The originality of this work is that it uses Linked Open Data (LOD) to enable meaningful content-dependent support in an open learning space. LOD is a developing source of fully machine-understandable semantic information. In this thesis, we aim to demonstrate the potential of LOD based support.

By linking LOD to natural language documents, we created a "semantic open learning space": an open learning space where learners have access to machine understandable natural language information without limitation of topic. To be able to use the semantic open learning space to support learners, two objectives must be reached. First, we must generate meaningful advice using data from the LOD. The data cannot be used as it is and must be processed. Second, we must provide the advice to the learners in a way that enhance their engagement and learning outcomes. The advice must be provided in an adequate way or it may have negative effects instead of beneficial ones.

To generate meaningful advice, we create a question generation framework that can be used to generate natural language questions using data from the LOD. The method described in this thesis is applied to the domain of history. It integrates two LOD sources, Freebase and DBpedia, to create an information source that can cover the historical knowledge required. The integrated data is combined to a history domain ontology and a history dependent question ontology to generate content-dependent questions.

To verify whether the generated questions have a potential to support learning, a human expert conducted an evaluation comparing our automatically generated questions with questions generated manually. The results of the evaluation showed that the generated questions could cover more than 80% of the questions supporting knowledge acquisition generated by humans. In addition, we confirmed the automatically generated questions have a potential to reinforce learners' deep historical understanding for the topics of World War I and World War II.

To provide this advice to learners, we built a learning environment, the Semantic Open Learning System (SOLS), which supports learners in self-directed learning of history in an open learning space. Learners use the system to build a concept map representing their knowledge. A timeline of the events is automatically generated depending on the events that the learners choose to add to the map. The concept map contains not only the events but also their context and is machine understandable, which let the system understand what learners describe about the domain. To enhance the development of learners' historical understanding, SOLS support learners following the principle of inquiry based learning. Learners that request help are provided with questions that give them learning objectives.

The questions in the system have two functions. First, they support the acquisition of basic knowledge and help learners develop their concept map. The questions used for this are simple questions with a definite answer that can be described in the concept map. Second, they support the learners' deep historical thinking. The questions used for this are complex questions with no definite answer. They require learners to thinking about their knowledge and build their own opinion to be able to answer.

To verify whether the current system can support learners with fully automatically generated support, we evaluated the system with four objectives of: judge whether the LOD based support was feasible, whether the question support improved the knowledge acquisition of learners, whether the question support improved the development of historical considerations in the learners' mind and whether the engagement of learners was improved by the question

support. The evaluation involved 24 university students separated in two homogeneous groups. The results showed that LOD based support was feasible and learners felt that the support provided was useful and helped them learn. The question support did not improve significantly knowledge acquisition. Nevertheless, the question support succeeded in improving the development of learners' historical considerations and deep historical thinking skills. In addition, the engagement and interest in history of learners was improved by the questions. The results are meaningful because they show that LOD based support can be a viable tool to support learners in open learning space and that the question support has potential to support learners during a long time study.