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A Proposal of Question Relevance in Web-based Investigative Learning:  
Criteria based on LOD Corresponding to Change of Learner's Interest

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In recently, development of ICT is changing our daily life. In the educational field, researchers and practitioners aim to enhance the quality of education through ICT in education. One of the components of ICT in education is to cultivate the information literacy of learners. Web-based investigative learning is one of the ways to achieve this goal. In such learning, learners select resources suitable for knowledge construction from the Web by themselves, which has a vast number of resources. Then, learners extract and connect information related questions that learners want to learn. However, Web resources in the form of hyperspace are often unstructured. Therefore, learners must create learning scenarios by themselves, which consist of items and order that they should learn. It is not so easy for learners to create their own scenarios concurrently with the knowledge construction process.

In order to address this issue, Kashihara et al. proposed a model of Web-based investigative learning with Web resources. Based on this model, they also developed the interactive learning scenario builder (iLSB) to support Web-based investigative learning. The model supposes that learners set a question which they want to learn at first and learn about it. However, learners often find information that has no relation to the question. At that time, learners' interest may shift to other topics. Of course, learners can also learn another question instead of learning the first question. To deal with this issue, Sato et al. diagnosed learning scenario creation by using linked open data (LOD).

When we focus on learners' self-initiative, the system should follow the learning process from not only the original question but also the new question that they are newly interested. In these cases, learners may create multiple learning scenarios in their learning process. When learners connect these scenarios or questions, learners are expected to obtain effective learning outcomes. However, it is not easy for learners to connect with different knowledge. Therefore, we propose indexes for question relevance, which are criteria based on LOD to represent the strength of the relationship among the questions belonging to different learning scenarios.

The proposed method computes question relevance using related words connected to each question by LOD. If two questions have some relations, they would have common related words in LOD. Thus, the method calculates the distance of such a combination of questions on the LOD and takes question distance, question similarity, and question

coupling. Question distance is defined by the number of nodes that appear in the shortest path to connect two questions on LOD. Question similarity is calculated by Simpson's coefficient between two sets, which are consisted of related words of each question. Question coupling is determined by the number of found elements connecting with question keyword in both directions on LOD. Finally, question relevance is defined by using these parameters.

In this research, we had a case study to classify the combination of questions following each strength of the relation. We compute question relevance using seven learning scenarios created in previous research and obtain 542 combinations of questions. We analysed each tendency of question distance, question similarity, and question coupling using these combinations. As a result, we set thresholds of each parameter. Question distance and question coupling are divided into four levels, and question similarity is divided into three levels. Next, we combined question distance with question coupling and question similarity each, and two planes were constructed. The plane made by a combination of question distance and question coupling was divided into 16 areas. The plane made by a combination of question distance and question similarity was divided into 12 areas. Then, we classify these areas based on the tendency of obtained combinations of questions in each area.

In addition, we had an experiment to analyse/evaluate the validity tendency of question relevance. We computed question relevance using nine learning scenarios created in previous research and obtained 566 combinations of questions. We sampled 40 combinations of questions from these combinations. Further, we divided the sampled combinations into four groups. One of these groups had ten combinations. Each group were rearranged in the order of strength of relation by two teachers. Then, we compared the results with rearranged groups by question relevance.

As a result, we found that question relevance focused on question similarity tended to be correlated with subjective scoring. Moreover, we thought that question relevance focused on question distance had a different tendency from the associations by subjects. Such relation seems to have a possibility to indicate the relationship that the subjects did not notice.

In conclusion, learners would be expected to obtain awareness regarding the relationship between two questions by using question relevance in Web-based investigative learning. It is a important topic of future research to consider how to suggest question relevance for learners and develop a system to support learners using question relevance.