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A language learning support system using course-centered ontology and its evaluation

Jingyun Wang [a, b, *], Takahiko Mendori [a], Juan Xiong [b]

[a] Kochi University of Technology, Japan
[b] Xiamen University of Technology, China

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ABSTRACT

This paper presents a course-centered ontology for assisting learning support systems to embody the relations among knowledge points and also among the learning materials for those knowledge points. An "individual-class-individual" ontology design (first an individual-class design, then an innovative design about relations among bottom individuals), was applied to the construction of a course-centered ontology for an existing Japanese grammar course. Furthermore, a customizable language learning support system was built to manipulate the course-centered ontology to provide an interface for the learning objects arrangement which displays the visual representation of knowledge points and their relations. The intention underlying the development of the system is to encourage instructors to orient their teaching materials to specific knowledge points and even directly to relations between knowledge points. With these orientations, the learning support system is able to provide an environment in which learners can readily distinguish between related knowledge points. Finally, based on the result of a preliminary evaluation, a study to explore the impact of learning styles and learning habits on learning performance was conducted to further evaluate our ontology-based learning support system. The results of the study suggest three main points: (a) the experimental students who learned with our system achieved significantly better learning achievement than those who just did self-study with textbooks after studying the same target contents for 60 mins; (b) the learning achievement of experimental group was not related to either their learning style in Sequential/Global dimension or their habit of "learning from comparison"; (c) in terms of the learning perception of experimental group, compared to "Sequential learners", most "Global learners" had a stronger feeling that the comparison function is useful in improving their learning performance, and the learners who don't habitually "learning from comparison" were more likely to suffer from lack of the attention and feel more pressure than those who do habitually "learning from comparison".

1. Introduction

Nowadays, learning/content management systems (LMS/CMSs) such as Moodle (Dougiamas & Taylor, 2003) are widely used in language teaching. In such systems, the instructor can organize a course by topic or by schedule. In one topic or one lesson, the course content description is followed by the related learning materials. In other words, the course content is normally organized in a tree structure (as shown in Fig. 1, in which the yellow circles (in the web version) represent the learning contents while the blue rectangles (in the web version) represent learning objects), the branches of which represent either topics or class schedule elements.

For effective second language learning, it is essential that the learners are able to make connections between related knowledge points (KPs) and distinguish between similar ones. However, those older systems utilizing tree structures usually do not support the development of those skills because they cannot characterize essential relations between KPs.

* Corresponding author. Kochi University of Technology, Japan.
E-mail addresses: warmplam@gmail.com (J. Wang), mendori.takahiko@kochi-tech.ac.jp (T. Mendori), xiongjuanxmut@126.com (J. Xiong).

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For example, in Fig. 1 there are two KPs, “d” and “t”, which are located in Lesson 1 and Lesson 10 respectively. In Lesson 10, to compare the KP “t” with the prior KP “d”, the instructor has to indicate the location “d” (this can be done by hyperlink) and explain the relation between “d” and “t”. Even so, it is still difficult for the learners to locate the learning materials, which directly address the relation between these two KPs, unless they look through all the learning material in lessons 1 and 10. The searching will be even more time-consuming if the learner is comparing three or more KPs (for example, comparing “t” with “d” and “s”) in the course at one time.

In order to support the development of learner ability to compare related KPs, this research presents a “course-centered ontology” (i.e. ontology based on a specific course) with a map structure that could assist e-learning systems to encourage the instructor to produce and arrange teaching materials that directly address specific KPs and even directly address relations between KPs. The construction of a course-centered ontology for an existing Japanese grammar course is discussed in this paper as an instance of “course-centered ontology”. Furthermore, this course-centered ontology was incorporated in the development of an ontology-based language learning support system which provides learning content in response to the learner's learning knowledge structure. Also, a series of experiments was conducted to evaluate the effectiveness of this ontology-based system.

The remainder of this paper is structured as follows: Section 2 introduces some former studies related to our work; Section 3 discusses the construction of the course-centered ontology of an existing Japanese grammar course and also introduces an effective“individual-class-individual” technique for the ontology design of general courses; Section 4 presents the personalized learning support system based on the course-centered ontology and also compare our systems with the authoring environment TM4L (Dicheva & Dichev, 2006); Section 5 describes a study which is designed based on the result of a preliminary evaluation to further explore the impact of learning styles and learning habits on learning performance and demonstrates the analysis of the results in details; finally, the conclusion and the direction of the further work are provided in Section 6.

2. Related work

2.1. Maps and meaningful learning

To encourage meaningful learning patterns, using maps, which have nodes as key concepts and links as relationships between key concepts (Lee & Segev, 2012), can solve the problem caused by tree structure. According to Ausubel's learning psychology theories (Ausubel, 1963; 1968; Ausubel, Novak, & Hanesian, 1978), meaningful learning is achieved when new knowledge is assimilated into existing frameworks of the learner. However, individuals vary not only in the quantity and quality of the relevant knowledge they possess, but also in the strength of their motivation to seek ways to incorporate new knowledge into relevant knowledge they already possess.

Human memory is a complex set of interrelated memory systems which interact with affective and psychomotor inputs. After reaching short-term memory, all incoming information will be organized and processed in the working memory which could incorporate knowledge into long-term memory. However, the working memory's processing capacity limits the transformation of unrelated concepts into long-term memory (Miller, 1956).

Although the retention of information learned by rote still takes place in long term memory, that knowledge tends to be quickly forgotten unless repeat rehearsed and cannot contribute to enhance learner's knowledge framework. In further problem solving, there is little or no potential that the persisting knowledge learned by rote will be used (Novak, 2002). (A full discussion of memory mechanisms is beyond the scope of this research.) Evidence from diverse sources of research suggests that knowledge finally gets incorporated into human brain when organized in hierarchical frameworks and that learning approaches that facilitate this kind of organization significantly enhance the learning capability of all learners (Bransford, Brown, & Cocking, 1999; Tsien, 2007). From this point of view, maps can serves as a kind of scaffold to help learners to organize knowledge and structure their own knowledge framework (Novak & Cañas, 2008); this facilitate the meaningful learning.

Organizing knowledge concepts in map structure, e-learning systems can present/provide progressively more explicit knowledge to help learners to slowly develop conceptual frameworks; learners also can clearly understand large general concepts before learning more specific concepts and incorporate new knowledge into their prior knowledge frameworks to foster meaningful learning. In addition, when learners have different levels of prior domain knowledge, using maps they can jump directly to a specific chapter interested. Although a search

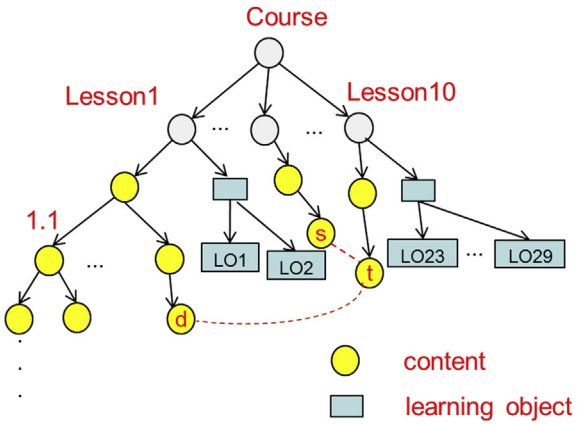

Fig. 1. An example of the tree structure in Moodle system.