Active E-Course for Constructivist Learning[1]

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ABSTRACT
An active e-course is a self-representable and self-organizable document mechanism with a flexible structure. The kernel of the active e-course is to organize learning materials into a "concept space" rather than a "page space". Besides highly interactive service, it supports adaptive learning by dynamically selecting, organizing and presenting the learning materials for different students. During the learning progress, it also provides assessments on students' learning performances and gives suggestions to guide them in further learning. We have implemented an authoring tool and a course prototype to support the constructivist learning.

Categories & Subject Descriptors: K.3.2 **[Computers and Education]**: Computer and Information Science Education – *computer science education, curriculum*.

General Terms: Management, Design, Human Factors.

Keywords: Active e-course, constructivist learning, course ontology, semantic link network.

1. INTRODUCTION
The literature in education suggests that students who are actively engaged in the learning process will be more likely to achieve success. Constructivist learning is a student-centered educational approach to effectively motivate the students by enabling a more active, explorative and interactive learning process. So, how to effectively support constructivist learning becomes an important issue with respect to e-learning. A number of adaptive and intelligent systems have been implemented to support constructivist learning [1, 2].

By incorporating the intelligent agent and adaptive hypermedia technologies, this paper proposes an active e-course that focuses on dynamic organization of learning materials with various semantic links to better support student-centered, highly interactive and adaptive learning approach.

2. GENERAL ARCHITECTURE
The general architecture for the constructivist learning is illustrated in Figure 1. The teaching agent serves as an intelligent tutor by interacting with students (such as course planning, evaluation of learning performance, and profile updating). The delivering agent is responsible for composing and presenting tailored courses for different students. Each student is equipped with a profile to describe his personal information and learning history. The authoring tool provides support for course structural modeling. Knowledge Grid is an Internet-based application platform for sharing and managing the distributed heterogeneous resources in a uniform way [3, 5, 6], which herein comprises two resource spaces: Knowledge Space and Information Space.

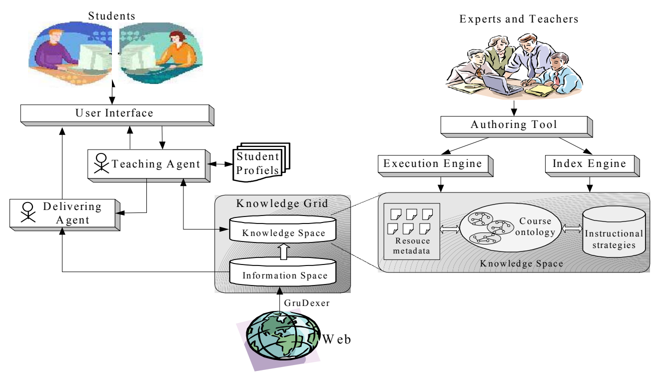

Figure 1. The general architecture for constructivist learning.

3. STRUCTURAL MODELING FOR ACTIVE E-COURSE
Course ontology defines course knowledge and structure within a specific domain, which includes course concepts and roles. A course concept represents a composite or atomic knowledge object with a unique object identifier, and a structure that includes attribute-value pairs and link anchors. The roles represent the binary relationships among knowledge objects, and the relationship can be one of the following types: *Subtype*, *Sequential*, *Cause-effect*, *Implication*, *Similar-to*, *Reference*, *Part-of*, *Corequisite*, *Supplement*, *Contrast*, and *Inhibitor*. The reasoning rule can be used for chaining the semantic relationships and obtaining the reasoning result from the chaining. We use the semantic link network (SLN, http://www2003.org/cdrom/papers/poster/p172/p172-zhuge/p172-zhuge.htm) to represent the course ontology [4]. Course ontology is modeled as a nested SLN.

The metadata of learning materials are semi-automatically specified based on the course ontology that provides a shared meaning of used vocabulary. The metadata falls into three broad categories: structure (the structural information), content (what is about) and context (when to present).

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4. BUILDING AN ACTIVE E-COURSE

4.1 Semantic Linking

By referring to the students' different demands and activities, semantic links are automatically added into documents, as shown in Figure 2. In this way, an active e-course dynamically adapts to different students with an open and flexible structure.

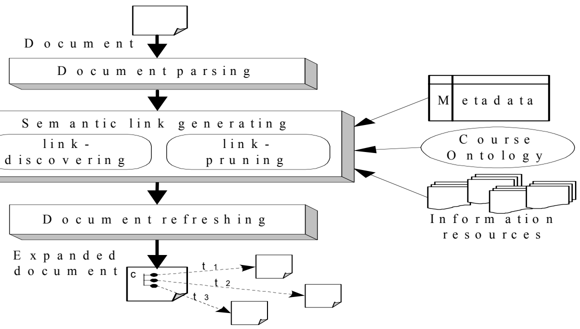

Figure 2. Framework for constructing semantic links.

4.2 Course Generation

The teaching agent firstly finds an optimal learning path with required knowledge objects for different students by following a two-step process: *selecting knowledge objects* and *structuring knowledge objects*. According to the student profiles, the required knowledge objects are selected. By using the reasoning rules, the knowledge objects are then sequenced and structured in a reasonable pattern (such as linear, flat, tree, or hybrid pattern).

Following that, the delivering agent generates the course by substantiating each knowledge object with one or more learning resources. An active e-course is presented with adaptive content and semantic links to the students. Figure 3 shows the interface for displaying the demo course.

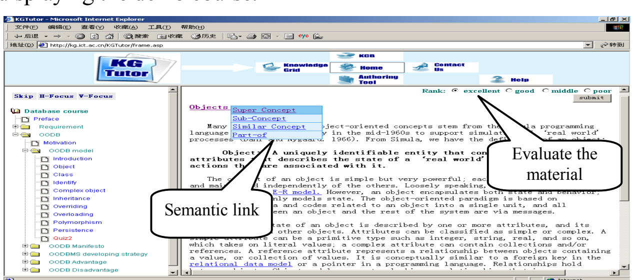

Figure 3. Interface for displaying course content.

5. LEARNING EVALUATION

Students' learning effects are evaluated mainly based on the test result. Each question may be related to multiple knowledge objects with different association degrees. Obviously, correctly answering a more difficult question shows higher comprehension ability than correctly answering an easier question. Likewise, failing to answer a more difficult question contributes less to the comprehension ability than that of failing to answer an easier question. Thus, we use the following formulas to compute the positive influence (P_g) and negative influence (N_g) on the comprehension of knowledge object K_g, respectively.

$$P_g = \frac{\sum_{Q_j \in T} (d_j * a_{gj})}{n} \quad ...(1) \qquad N_g = \frac{\sum_{Q_k \in F} ((1-d_j) * a_{gk})}{m} \quad ...(2)$$

Where d_i denotes the difficulty level of the ith question, a_{gj} denotes the association weight between the knowledge object K_g and the question Q_j. T and F are the set of questions that are correctly answered and not correctly answered by a student, and the number of the questions in T (F) is denoted as n (m). The following formula is used to compute the error ratio (ER) of comprehending a knowledge object.

$$ER(K_g) = \frac{N_g}{P_g + N_g} \quad ......(3)$$

According to the pre-specified threshold, the learning level on a knowledge object is determined based on the error ratio. Accordingly, the evaluations and suggestions are presented to students for their reference. Figure 4 shows an interface for displaying the testing results and evaluations. The student's answers are clearly itemized while relevant knowledge objects are attached to the questions.

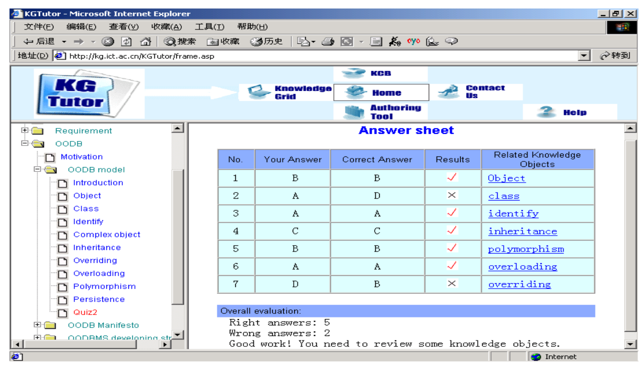

Figure 4. Interface for showing the test results.

6. CONCLUSIONS

Being separating from the concept-centered structural model, the learning materials can be adaptively organized and reused in a more flexible and interoperable manner. In this way, active e-courses with tailored content and open structure are presented to different students. Furthermore, students' learning effects are automatically evaluated to provide corresponding suggestions. An authoring tool for constructing course ontology and a course prototype have been implemented to support the constructivist learning (available at http://kg.ict.ac.cn/KGTutor/KGTutor.htm).

7. REFERENCES

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