Development and Analysis of an Enhanced Multi-Expert Knowledge Integration System for Designing Context-Aware Ubiquitous Learning Contents

Gwo-Haur Hwang, National Yunlin University of Science and Technology, Douliou, Taiwan
Beyin Chen, Ling Tung University, Taichung, Taiwan
Shiau-Huei Huang, iReach Marketing Pty Ltd, Taichung City, Taiwan

ABSTRACT

This article describes how in context-aware ubiquitous learning environments, teachers must plan a theme and design learning contents to provide complete knowledge for students. Knowledge acquisition, which is an approach for helping people represent and organize domain knowledge, has been recognized as a potential way of guiding teachers to develop real-world context-related learning contents. However, previous studies failed to address the issue that the learning contents provided by multiple experts or teachers might be redundant or inconsistent; moreover, it is difficult to use the traditional knowledge acquisition method to fully describe the complex real-world contexts and the learning contents. Therefore, in this article, a multi-expert knowledge integration system with an enhanced knowledge representation approach and Delphi method has been developed. From the experimental results, it is found that the teachers involved had a high degree of acceptance of the system. They believe that it can unify the knowledge of many teachers.

KEYWORDS

Context-Aware Ubiquitous Learning, Delphi Method, Knowledge Integration, Learning Content Design

INTRODUCTION

In recent years, with the vigorous development of mobile technology and wireless networks, the learning paradigm has transformed from traditional classroom learning to digital learning (e-learning), mobile learning (m-learning) and ubiquitous learning (u-learning) (Yang, Li, & Lu, 2015). The broad-sense definition of u-learning refers to “learning anywhere and at any time,” while the narrow-sense of u-learning refers to “learning in the real-world environment with supports from the digital systems using mobile, wireless communication and sensing technologies” (Hwang, Tsai, & Yang, 2008). In this paper, the latter definition is adopted. In such a u-learning environment, individual learners are equipped with a mobile device with wireless communication and sensing facilities. It is important to
provide learning guidance and supplementary materials in the right location at the right time when situating them in u-learning contexts for making observations and inquiries (Huang, Huang, & Hsieh, 2008). Some researchers have further called such a narrow-sense u-learning approach “context-aware ubiquitous learning” to emphasize the technologies employed in the learning environment (Chu, Hwang, & Tsai, 2010).

Although the effectiveness of the u-learning approach has been reported by a number of previous studies, it often takes a tremendous amount of time and effort for teachers to plan a theme and design learning contents for u-learning (Chu, Hwang, & Tseng, 2010). One of difficulties of developing u-learning contents is the lack of an effective tool to help individual teachers develop and organize the real-world and digital-world materials associated with the u-learning environment. Another difficulty is due to the challenge of integrating u-learning contents provided by several teachers. It is possible that the teachers interpret the same concept from different aspects or using different terminology. It is also possible that some teachers are more familiar with a part of the learning contents than other teachers. Without an easy-to-follow strategy for integrating the knowledge of several teachers, the derived learning materials could contain inconsistent or even incorrect contents (Chen, Kao, Sheu, & Chiang, 2002).

Researchers have tried to develop u-learning contents or guide students to learn using the knowledge acquisition approach, which is originally used for helping domain experts organize their knowledge for developing expert systems (i.e., the computer systems that simulate human experts’ decision-making behaviors based on the knowledge provided by the experts) (Chu, Hwang, & Tseng, 2010; Chen, Chen, & Sun, 2014). A knowledge acquisition system is able to assist teachers or learners to organize learning contents by guiding them to describe the learning targets, concepts or theorems as well as the relevant characteristics or attributes in a systematic way. Among the knowledge acquisition methods, the repertory grid proposed by Kelly (1955) is the most widely used. A repertory grid is constituted of elements, constructs, and a linking mechanism. Elements represent decisions to be made, targets to be identified or concepts to be learned. For example, in a natural science course, elements could be a set of plants to be identified. Constructs include positive and negative attributes for identifying elements. For example, a construct “leaf phyllotaxy” for identifying plants could consist of the positive attribute “alternate” and the negative attribute “not alternate.” The linking mechanism is usually an integer ranging from 1 to 5 to express the relationship between objects and attributes, where “1” and “5” indicate the tendency toward the positive attribute and the negative attribute, respectively. An illustration example of the repertory grid is shown in Table 1.

However, it is usually difficult to fully describe the relationships between elements and constructs with simply an integer; that is, using the repertory grid method might lose important knowledge during the learning content development process (Chen, Kao, & Sheu, 2003). Hwang and Tseng (1990) further indicated that the repertory grid method is unable to acquire important information during the knowledge acquisition process; for example, it treats all of the constructs or attributes as being equally important for identifying the elements, which is incorrect in most cases. To cope with this problem, they proposed the “Embedded Meaning Capturing and Uncertainty Deciding” (EMCUD) method by adopting a multi-data type linking mechanism to represent the relationships between objects (i.e., elements) and attributes (i.e., constructs) in a knowledge table (i.e., the grid);

<table>
<thead>
<tr>
<th>Phyllotaxy is alternate.</th>
<th>Fu Wood</th>
<th>Magnolia Denudate</th>
<th>Hibiscus Syriacus</th>
<th>Phyllotaxy is not alternate.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touches of Leaves are smooth.</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 1. An illustration example of the repertory grid
K-Nearest Neighbors Relevance Annotation Model for Distance Education
Xiao Ke, Shaozi Li and Donglin Cao (2011). *International Journal of Distance Education Technologies* (pp. 86-100).
www.igi-global.com/article/nearest-neighbors-relevance-annotation-model/49719?camid=4v1a