



# The Construction of an Ontology-Based Ubiquitous Learning Grid

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## ABSTRACT

*The purpose of this study is to incorporate adaptive ontology into ubiquitous learning grid to achieve seamless learning environment. Ubiquitous learning grid uses ubiquitous computing environment to infer and determine the most adaptive learning contents and procedures in anytime, any place and with any device. To achieve the goal, an ontology-based ubiquitous learning grid (OULG) was proposed to resolve the difficulties concerning how to adapt learning environment for different learners, devices, places. OULG through ontology identifying and adapting in the aspects of domain, task, devices, and background information awareness, so that the adaptive learning content could be delivered. A total of 42 freshmen participate in this study for four months to learn Java programming. Both of pretesting and posttesting are performed to ensure that the OULG is useful. Experimental results demonstrate that OULG is feasible and effective in facilitating learning. [Article copies are available for purchase from InfoSci-on-Demand.com]*

**Keywords:** *Grid Services; Learning Grid; Ontology; Ubiquitous Learning*

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## INTRODUCTION

An ontology-based ubiquitous learning grid (OULG) proposed in this study is aim to achieve ubiquitous learning. On the other hand, although the components of most current learning management systems conforms to SCORM standards (ADL, 2004), SCORM standards do not govern service and learning procedures between learning management systems, which makes

learning services on different learning systems cannot share and communicate. In this sense, although learning management system (LMS) and network infrastructure are widespread, there exists two main problems: incapability between learning management systems, which makes sharing difficult, and the fact that learning material can not be delivered to different types of client devices and to different learner preferences, which fails the fundamental objectives of

ubiquitous learning. As network infrastructure is maturing, some scholars, advocating transforming traditional electronic learning to ubiquitous learning, propose realizing the concept of u-Learning through the use of various mobile devices for ubiquitous computing. Most learning management systems, for example, Blackboard (2007), WebCT (2007) and open-source Sakai (2007), Moodle (2007), Claroline (2007), focus more on the authoring and delivery of learning material and assessment and learning progress management, and address less about the statement of environment awareness capability, therefore, learning services can not be easily shared between different learning management systems, despite most Learning Objects, or LOs, conform to SCORM specification.

OULG was constructed with adaptive ontology and ubiquitous computing environment to infer and determine the most adaptive learning contents. Current learning management systems have less description about context awareness capability. Grid services is a method in a grid computing that comprises learning service. The key issue about achieving adaptive learning with grid services is how to adapt learning. Adapting learning refers to making adjustment based on the input and output of a learning process, therefore, adding ontology to ubiquitous learning grid is a way to strengthen adaptiveness. Ontology uses a controlled hierarchy of terminology to describe knowledge structure, abstracting the ontology of concepts, and to distinguish different classes and individuals and can also define the relation between concepts. Therefore in this study, a set of ontology were used to enhance capability of the ubiquitous learning grid in the aspect of seamless learning. Since the production of learning material could be costly and the components incorporated into learning management are rarely shared and reused, Learning Ontology, or OntoL is used, to rectify this drawback. In addition, Context Awareness Ontology, or OntoCA is used to detect new client devices and, with the reference to learner preference settings, the system can and automatically convert learning material to be more user-friendly.

The study uses current ubiquitous learning grid as foundation and, on the grid middleware, globus toolkit, build prototyping of the OULG. JSP (Java Server Pages) technology is employed to implement Grid portal, while Java-related development technology is employed to develop other components needed for this research, on the Fedora Core, a Unix-like operating system. On the other hand, ontology design is conducted with Protégé (2007), which is developed by Stanford Medical Informatics. In the aspects of learning and context awareness, this research utilizes six ontologies definitions to cover the scope of research: domain ontology, task ontology, service composition ontology, device ontology (FIPA, 2002), preference ontology and adaptation ontology. Although there are numerous parameters and complex rules governing them, this research only look into those parameters relevant to the designing and defining of the Ontology used in the research.

The remainder of this paper is organized as follows: related work are discussed in Section 2. Section 3 details the proposed framework of OULG. Section 4 presents and discusses the system implementation and experimental results. Finally, Section 5 gives conclusions and directions for future research.

## RELATED WORK

The works related to our proposed framework are presented here in a way how we leverage existing solutions from grid technologies and ontology to provide the learning adaption.

### Grid Technologies

Grid computing owns better abilities of workflow collaboration and sharing resources for integrating e-Learning platforms. The sharing resource of grid computing primarily focuses on direct access to computers, software, data, and other resources, as required by various collaborative problem-solving and resource-brokering strategies emerging in industry, science, and engineering (Foster, 2002). Currently, grid

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