# Evaluating an ontology-based e-Learning data model using the TAM model

**Mohammad Hossein KADIVAR[a], Chien-Sing LEE[b]**
*Faculty of Information Technology, Multimedia University, Cyberjaya, Malaysia*
mhkadivar@yahoo.com, cslee@mmu.edu.my

**Abstract:** E-Learning is more flexible than traditional learning in course development and delivery. It offers more interactions between learners and contents that correspond to learners' knowledge level and learning objectives in a self-paced, self-directed mode. Bloom's cognitive taxonomy has often been used to determine the knowledge level. However, there is little said about incorporating Gardner's theory on Multiple Intelligence and ontology with Bloom's taxonomy. In this model, OWL and LOM are used to build an ontological network of contents with several relations between contents. To test the usefulness and ease of use of our prototype, we used the Technology Acceptance Model (TAM) to evaluate the system. Results are promising.

**Keywords:** OWL, LOM, e-Learning, Bloom's taxonomy, Multiple Intelligence, TAM

## 1. Introduction

### 1.1 Learning Objects

E-Learning systems need to be flexible in content and course delivery and consequently, create meaningful interactions between the user and the system. Contents or learning objects should have direct pedagogical value to the learning goal. Furthermore, they should be referable (contributing to added reusability) and self-contained (contributing to their modular use or reuse) in different learning contexts. In this paper, we describe learning objects using LOM (Learning Object Metadata), an approved standard on technical aspects of e-learning, created and supported by IEEE Learning Technologies Standards Committee (IEEE LTSC). LOM is almost identical to the IMS metadata specification and compatible with the Dublin Core (DC) metadata. In future work, we will extend LOM to SCORM metadata.

### 1.2 Semantic

Semantic E-Learning defines and links contents in a way that enables more effective discovery, automation and integration to support reuse and interoperability. We have used OWL (Ontology Web Language) [2] to design the ontological relations between contents. We use these ontological relations to enable interchange of resources and the inference of knowledge while querying them.

### 1.3 Problem statement and objective

There are some object-oriented data models in e-Learning systems. However, we need a more flexible data model that can network the contents based on their learning attributes. In this study, we test our ontology-based e-learning data model (as described below) using the Technology Acceptance Model (TAM) [3] in terms of ease of use and perceived usefulness.

## 2. Data Model

### 2.1 Architecture

Fig. 1 shows the data model's architecture. At the first layer, learning content has a unique IRI (International Resource Identifier). At second layer, LOM metadata provides data specifications for the contents. The third layer is the semantic layer. We add the objective and Intelligence properties for the contents and create the network of contents. At the top layer, we use SPARQL to search OWL to find proper learning contents.

| Query | API | |
| --- | --- | --- |
| | SPARQL | |
| Semantic Rules | OWL Ontology | |
| | Objective | Intelligency |
| Metadata | LOM | |
| | RDF | RDF Schema |
| Content | IRI (International Resource Identifier) | |

Fig. 1 Ontology-based e-learning data model

### 2.2 Cognitive objective

Learning materials are usually matched to different levels of understanding and educational objectives based on Bloom's Taxonomy [4]. These materials should be delivered to the learner in a sequential hierarchy to obtain better results in knowledge acquisition. The Objective property is used at the ontological level to categorize contents based on their objective to help learners to choose proper contents.

### 2.3 Multiple intelligence

Howard Gardner [5] proposed the Multiple Intelligences theory that people use at least seven relatively intellectual capacities (linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, interpersonal and intrapersonal) to approach problems. We have tagged our contents with linguistic/verbal, musical/rhythmic, logical-mathematical and spatial/visual. Hence, a learner may filter or select the contents based on the types of Intelligence which is more suitable for him to learn.

### 2.4 Semantic contents

We have also captured the relations among contents using ontology. The ontological level adds Pre-, Post- and Similar-content as relations to refer to other contents. This creates the semantic network of contents, which are automatically linked based on LOM properties.

## 3. User acceptance

A prototype was developed based on the ontology-based e-Learning data model to help us evaluate our model's usefulness and ease of use. We present 2 hypotheses:
H1: An adaptable data model which categorizes the contents based on educational objective and Intelligence of the contents can deliver useful contents to Learners more efficiently and improve their attitude and increase their intention to use the system.

H2: An extensible data model, which creates a network of logical relations between contents based on Interactivity Level, Difficulty and Semantic Density will provide an easy-to-use sequence of contents for learners and improve their perceived usefulness of the system.

*3.2 Methodology*

We chose 30 people with IT background (10 tutors and 20 students) to use the system and answer the questionnaire based on the TAM model. There are 5 main factors in our system (cognitive objective, Multiple intelligence, Interactivity level, Semantic density and Difficulty). The questionnaire had 20 questions (4 questions for each factor) to evaluate the effect of them on ease of use, usefulness, attitude and intention to use the system.

*3.3 Results*

Cronbach's alpha was obtained for the test results reliability and Hypotheses were tested by Chi-square test method. The results are in Fig 2.

| Hypothesis | P-Value | Result |
|---|---|---|
| H1 | 0.01  < 0.05 | Proved |
| • Objective | 0.011 < 0.05 | Proved |
| • Intelligency | 0.01  < 0.05 | Proved |
| H2 | 0.015 < 0.05 | Proved |

Fig. 2 test Results

Cronbach's alpha exceeded the recommended level of 0.70 (Nunnally, 1978). Thus the result was reliable and has high internal consistency. Since P-Values are less than the significant level (0.05), we conclude that the data architecture typified in our prototype is easy to use. Furthermore, users are positive towards using it in the future.

## 4. Conclusion

E-learning systems require content-based data model that is flexible and easy to search. By including metadata and specifying ontological relations, it makes the learning contents shareable to provide knowledge sharing between E-learning systems. Our user testing shows that adopting contents with Objective and Intelligence properties can be easy to use and useful for tutors and students to deliver the proper contents based on their suitable Intelligence type and learning objective.

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