Eğitimde Kuram ve Uygulama *2011, 7 (2):364-374*
Journal of Theory and Practice in Education *Articles /Makaleler*
ISSN: 1304-9496 *http://eku.comu.edu.tr/index/7/2/masalahli_mozdemir.pdf*

USING OF USER-DEFINED METADATA DESCRIPTORS IN INTELLIGENT LEARNING OBJECT METADATA SYSTEMS

(KULLANICI TANIMLI ÜSTVERİ TANIMLAYICILARININ ZEKİ ÖĞRENME NESNELERİ ÜSTVERİ SİSTEMLERİNDE KULLANILMASI)

M. Ali SALAHLI[1]
Muzaffer ÖZDEMİR[2]

ABSTRACT

In the existing Learning Object Metadata Systems, information about user profile is determined by the authors or creators of the learning materials. This information is very important for choosing the learning materials corresponding to the knowledge level of the learners. However, the authors and the users' opinions about the same learning object may not sometimes match. Consequently, the retrieving learning objects from the repository may not always be appropriate to the user's knowledge level. In this paper, we propose new metadata descriptors, taking into account a user profile. Namely, we propose the descriptors "user's knowledge level" and "relevance degree". In this study, the method improved for determination of dependence between the users and authors' opinions about the learning objects by using the learning object metadata descriptors is explained. Moreover, the overall description of the Intelligent Learning Object Metadata System is given.

Keywords: Intelligent Learning Object Metadata System, User-Defined Metadata Descriptors, Learning Object Metadata

ÖZ

Mevcut Öğrenme Nesneleri Üstveri Sistemlerinde kullanıcı profili hakkındaki bilgiler, genellikle öğrenme nesnelerinin geliştiricileri tarafından belirlenmektedir. Bu bilgiler, öğrencinin kendi bilgi seviyesine uygun nesneleri öğrenme nesnelerini bulması açısından oldukça önemlidir. Fakat aynı nesnenin nitelikleri hakkındaki görüşler, geliştirici ve kullanıcı (öğrencinin) açısından farklılıklar gösterebilir. Bu sebepten dolayı öğrenme nesnelerinin, yalnız "geliştirici tanımlı" üstveri değerleri doğrultusunda seçilmesi çoğu zaman istenen sonuçları vermeyebilir. Bu makalede öğrenme nesnelerinin seçilmesi için kullanıcı görüşlerini dikkate alan yeni üstveri tanımlayıcıları ("kullanıcının bilgi seviyesi" ve "uygunluk derecesi") önerilmiştir. Bu tanımlayıcılarının kullanıldığı "Öğrenme Nesneleri Zeki Üstveri Sistemi"nin genel yapısı açıklanmış, aynı zamanda, geliştirici ve kullanıcının görüşleri arasındaki ilişkiyi belirleyen bir yöntem verilmiştir.

Anahtar Kelimeler: Öğrenme Nesneleri Zeki Üstveri Sistemi, Kullanıcı-Tanımlı Üstveri Tanımlayıcıları, Öğrenme Nesneleri Üstverisi

[1] Doç. Dr. Department of Computer and Instructional Technologies Education, Çanakkale Onsekiz Mart University, Turkey. **E-mail:** msalahli@comu.edu.tr
[2] Yrd. Doç. Dr. Department of Computer and Instructional Technologies Education, Çanakkale Onsekiz Mart University, Turkey. **E-mail:** mozdemir@comu.edu.tr

THE PROBLEM AND PROPOSAL

In the Mosby's Medical Dictionary (Mosby's Medical Dictionary, 2009) the concept "learning environment" is defined as "a sum of the internal and external circumstances and it influences surrounding and it affects a person's learning". Slightly modifying the definition, we can say that "learning environment" is a complex system, consisting of a set of interrelated and interacted components, which define "internal and external circumstances and influences surrounding and affect a person's learning". Components of the system are: Learner, or more strictly learner model, learning management system, learning objects, and teacher (Fig.1).

In e-learning and distance learning environments, the properties of a teacher are reflected in the learning object created by the teacher. In this sense, it can be said that the effective e-learning depends on learner model, learning management system, and learning object.

Learners differ in learning preferences (language, perspective, typical learning time, interactivity type and level, learning resources, semantic density, etc.), in the amount and kind of prior knowledge, in cognitive skills, etc. As a result of this, the same instructional content cannot provide optimal knowledge for all students (Pedrazzoli & Dall'acqua, 2009).

A learning management system (LMS) is a software application or a web-based technology used to plan, implement, and assess a specific learning process[*]. Effectiveness of this system depends on the functionality and content of the system's components and interaction between them.

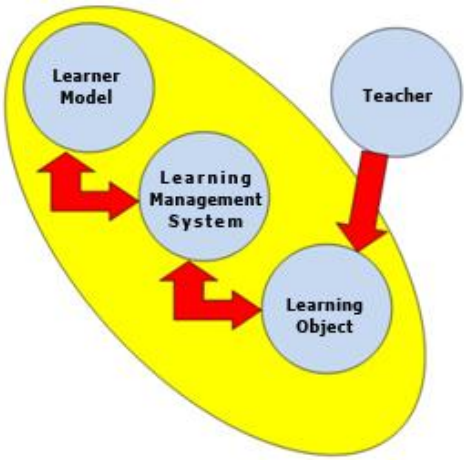


Figure 1. A Learning Environment

[*] http://searchcio.techtarget.com/definition/learning-management-system

In this paper, we will discuss the impact of learning object metadata on improving learning systems. Learning Object Metadata (hereafter LOM), defined on related International standards, can be divided into two classes: content dependent and content non-dependent. Content non-dependent metadata generally expresses the technical characteristics of the learning object. This metadata includes in particular the information about the author, size and date of creation. The values of the content non-dependent metadata are objective. Some of them are determined by the author or editor of the learning objects. There are also automatic methods to determine these values (Brasher & McAndrew, 2004). Metadata, which contains information about the topic, difficulty level, the level of interaction, semantic keyword density and so on, is dependent on the content. The values of some of this metadata (keywords, topic, type, etc.) are objective to great extent although some degree of subjectivity exists in the evaluation of this metadata. The values of some metadata are subjective and can receive different values from different authors. Some of the metadata values are often subjective in nature and differs from one author to another.

In IEEE Standard (IEEE LTSC, 2002), the metadata “Difficulty" (LOM 5.8) defines the level of the related object’s difficulty for the typical user. The "Difficulty" may take the following linguistic values: “very easy”, “easy”, “medium”, “difficult”, and “very difficult”. The “Semantic Density” (LOM 5.4) refers to the degree of conciseness of a learning object. The Semantic density may take the following linguistic values "very low", "low", "medium", "high", and “very high”. These types of metadata are also called the human-interpreted metadata (Riley *et al.*, 2009).

As is clear from the definitions, the values of the metadata “semantic density” and “difficulty” are based on subjective assessments of the authors.

This metadata is very important for choosing the learning materials, which are more appropriate to the knowledge level of the students. However, as we noted above, this metadata is evaluated subjectively and for this reason the student and the author’s (creator) assessment may not match. In this regard, the results of retrieving learning objects from the Learning Object Repository (LOR) may not always be effective. In this sense, the use this metadata is not practical from the user’s perspective.

To improve the effectiveness of the use of the metadata, the use of user-defined metadata is proposed in this study. In the proposed system, two types of user-defined metadata - the metadata “knowledge level” and the “relevance” have been used. The metadata “knowledge level” expresses the knowledge level of the student on the related topic. The value of the metadata is determined by the student. The metadata “relevance” shows the “relevance” of the retrieved objects to the knowledge level of the student. Moreover, architecture of the Intelligent Learning Object Metadata System including adaptive learning module and knowledge is proposed.

RELATED LITERATURE

Educators admit that effective learning is done on the basis of personalization of the education. However, most of the current Learning Management Systems (hereafter LMS) do not possess the properties of personalization. They offer determined set of services to the user and do not take the user-profiles into account.

To improve personalization aspects of the learning systems, some authors propose to adding intelligence properties to these systems. There are some studies on the development of Intelligence LMS (Alami et al., 2008; Rossi, 2009; Schaverien, 2003; Olševičová & Mikulecký, 2008; Tu et al., 2002). In the (Alami et al., 2008), authors introduce a computational intelligence base system intended to offer a virtual educational and training environment. The paper (Rossi, 2009) illustrates the characteristics of an Intelligence Learning Management System. An approach to implement, on existing LMS platforms and e-learning functionalities based on artificial intelligence is described. The investigated proactive system supports the "Intelligent Adaptive Learning Environment". This system includes Artificial Intelligence based on e-Tutor subsystem.

The system, described in (Pedrazzoli & Dall'acqua 2009), allows a personalized learning approach based on the learning curricula of the student. The authors propose a concept for an Intelligent Adaptive Learning Environment. In the (Christos et al., 2006) authors present an agent platform, which supports various intelligent agents that provide assessment services based on computational intelligence techniques.

The paper (Muñoz & Oliveira, 2004) describes the main steps taken in developing an Adaptive Web Training Environment, consisting of an application profile of the LOM standard, Domain and Student Knowledge Models and Web ontologies. Web-based Intelligent Tutoring System, which allows students to dynamically generate suitable courseware and provides adaptive feedback (Kosba et al., 2003). Tu et al. (2002) proposed an ontological approach to the design of the student model for a tutorial agent system. The model emphasizes the classification and detection of error types.

IDENTIFICATION OF THE USER-DEFINED METADATA DESCRIPTORS

As mentioned above, the use of user-defined metadata descriptors to enhance the effectiveness of learning systems is recommended. There are some descriptors taking some aspects of a user's profile into account in the LOM standards. These descriptors are: (IEEE LTSC, 2002)

5.1 Interactivity Type

5.3 Interactivity Level

5.4 Semantic Density
5.6 Context
5.7 Typical Age Range
5.8 Difficulty

These metadata descriptors, in a certain sense, are useful in selecting suitable learning materials. However, as the values of these descriptors are defined by the authors of learning objects, they are not sufficient. In this regard, in the use of the metadata descriptors the values of which are specified by the users may improve the effectiveness of learning. The proposed two types of user-defined metadata descriptors are as in the following.

Knowledge level- This metadata descriptor defines the learners' knowledge level on the topic, which he/she wants to learn. The descriptor may receive following linguistic values: {low, medium, high, very high}.

It can be emphasized that the "knowledge level" and the "difficulty" carry different meanings. The "difficulty" determines the difficulty level of studying related learning object, but "knowledge level" determines the particular student's knowledge level and its value which do not depend on learning objects.

Relevance- This descriptor defines how the selected material meets the user demands. The descriptor may receive following linguistic values: {low relevance, medium relevance, high relevance, very high relevance}. These values are necessary to facilitate the improvement of the following stages of learning. The degree of relevance is used to update the learner's profile knowledge and to create the inference rules. These metadata descriptors together with other metadata are basic elements of Intelligent LOM System.

The overall structure of the Intelligent LOM System

The overall structure of the proposed Intelligent LOM System is given in Fig.2

Only the components of the Intelligent LOM System associated with the user-defined metadata descriptors are described in this study. Other details of the system can be found in Salahli et al. (2010) and Salahli & Yaşar (2010).

User-Profile database keeps information about the user's profile. The database consists of following tables:

Knowledge_level_table (learner, course, knowledge_level)
Relevance_table (learner, learning_object, relevance_degree)
Learning_style_table (learner, learning_style)

By using these tables, it is possible to determine the learning objects that are most appropriate to the user's knowledge level. What makes this

possible is the **Learning Module.** The module generates the learning rules based on information from the **user_profile database** and **metadata database**. These rules are kept in the **knowledge rules base**. The knowledge rules are expressed in the form as "*IF conditions THEN conclusion*".

Below, an example for a knowledge rule which expresses what the most relevant learning material is according to the values of the user-defined descriptors is given.

IF Knowledge Level is "medium" AND
(IF difficulty is "medium" AND semantic density is "medium" OR
(IF difficulty is "medium" AND semantic l density is "low" OR
(IF difficulty is "low" AND semantic density is "medium" THEN
"relevance is "very relevance"

Ontology module contains ontological relationships between the domain concepts for every course.

Fuzzy operation module performs fuzzy logic operations on the metadata descriptors. These operations, in particular, are used in the search of learning materials. Data and control flow between the modules are achived through the **mediator**.

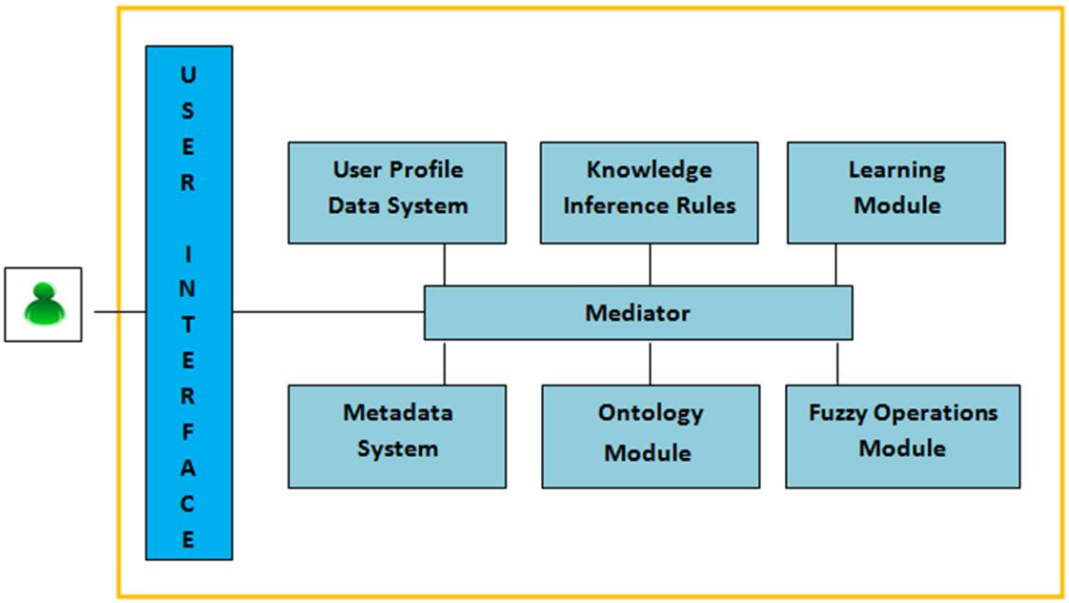


Figure 2. The Overall Structure of the Intelligent LOM System

EVALUATION OF THE USER-DEFINED METADATA AND TEST RESULTS

In this study, to determine the rate of understanding of the learning objects by the students with different knowledge levels, a following method has been investigated:

1. Selection of learning objects to be evaluated. For this purpose, learning materials of three courses taught over a period by the authors are used.

2. Evaluation of the metadata descriptors "difficulty" and "semantic density" according to LOM Standard.

3. Determination of knowledge levels of the students as "low", "medium" and "high" and "very high". The knowledge level has been determined by taking the average grade point, exam grade, and other success factors into account.

4. Determining student's knowledge level on appropriate objects with linguistic values of "high relevance", "relevance", "low relevance" and "not relevance" on the basis of students' scores got from the selected courses.

5. As a result of steps 2- 4, determining the dependence between the "relevance degree" of learning objects and the metadata descriptors (namely, "difficulty", "semantic density", and "knowledge level"). The dependence is expressed as a production rule:

If KWL=*kwl* Θ D=*d* Θ SD=*sd* THEN R=*r*

Here KWL, D, SD, and R refer to Knowledge Level, Difficulty, Semantic Density, and Relevance, respectively. *kwl*, *d*, *sd*, and *r* are the linguistic values of the appropriate metadata descriptors. Θ is a logical operation as AND or OR.

The evaluation process is shown in Fig.3.

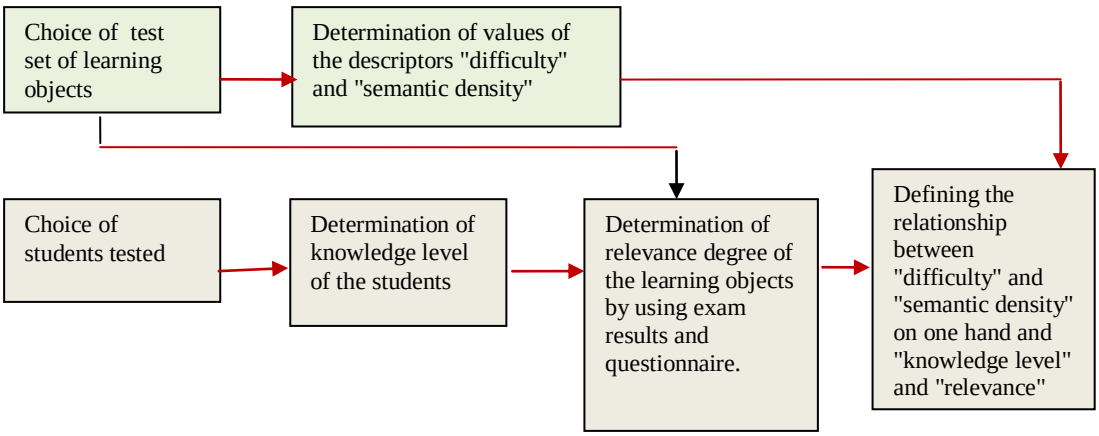


Figure 3. The Evaluation Process of the User-Defined Metadata

In the Table 1, 2 the understanding rates with the different knowledge levels of students have been given. The values of understanding rates will be used as a value of the "relevance". While Table 1. expresses the case when "difficulty level" is "medium", Table 2 represents the data for case "difficulty level" is "difficult". For example, for the student with knowledge level "medium", a learning object with the difficulty level "medium", is "low relevance" in 0.2 degree (the understanding rate), is "medium relevance" in 0.7 degree, and is "high relevance" in 0.2 degree.

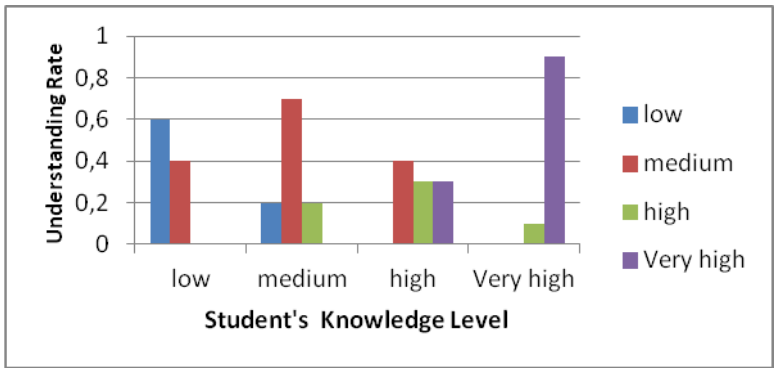
The graphical depictions of the tables are shown in Fig. 4.a and 4.b, respectively.

Table 1. Understanding Rate with Different Knowledge Levels (The Value of the Metadata "Difficulty" is "Medium")

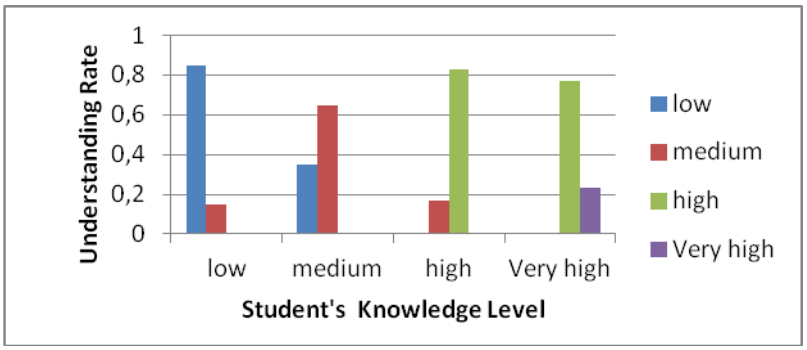
Knowledge level	Understanding rate			
	Low	**Medium**	**High**	**Very high**
Low	0,6	0,4		
Medium	0,2	0,7	0,2	
High		0,4	0,3	0,3
Very high			0,1	0,9

Table 2. Understanding Rate with Different Knowledge Levels (The Value of the Metadata "Difficulty" is "Mifficult")

Knowledge level	Understanding rate			
	Low	**Medium**	**High**	**Very high**
Low	0,85	0,15		
Medium	0,35	0,65		
High		0,17	0,83	
Very high			0,77	0,23



a) **The Value of the Metadata Difficulty is "Medium"**



b) The Value of the Metadata Difficulty is "Difficult"

Figure 4. Understanding Rate with Different Knowledge Levels

CONCLUSION

In this paper, the structure of the Intelligent Learning Object Management System with learning properties has been proposed. Being the basic elements of the LOM system, the values of the two metadata descriptors which are defined by leaners have been provided. As the values of these metadata descriptors are defined by leaners themselves, the effectiveness of learning is improved. Namely, the use of this metadata for the improvement of learning process is described. Also, some test results obtained from the development phase of the proposed system are given.

The proposed System is in the development phase and is supported by Canakkale Onsekiz Mart University, Scientific Research Projects Fund (Project No: 2011/018). We hope that the results expected from the project will contribute in making learning management more effective through the application of intelligent learning methods, where one of these methods was the subject of this paper.

REFERENCES

Alami, M.E., Casel, N. & Zampunieris, D. (2008). An architecture for e-learning system with computational intelligence, *The Electronic Library*, 26 (3):318-28.

Brasher, A. & McAndrew, P. (2004). Human-generated learning object metadata. *Springer-Verlag Berlin Heidelberg 2004*.

Christos E. Alexakos, Konstantinos C. Giotopoulos, Eleni J. Thermogianni, Grigorios N. Beligiannis, Spiridon D. Likothanassis. (2006). Integrating e-learning environments with computational intelligence assessment agents, *International Conference on Computer Science (ICCS 2006), Budapest, Hungary, May 26-28, 2006*, 13: 233-238.

IEEE LTSC (2002). IEEE 1484.12.1-2002, Draft standard for learning object metadata, *IEEE Learning Technology Standards Committee (LTSC), 15 July 2002*. Retrieved April 9, 2010 from http://ltsc.ieee.org/wg12/files/LOM_1484_12_1_v1_Final_Draft.pdf

Kosba, E., Dimitrova, V. & Boyle, R. (2003). Fuzzy student modeling to advise teachers in web-based distance courses. *International Journal of Artificial Intelligence Tools, Special Issue on AI Techniques in Web-Based Educational Systems, World Scientific Net*, 13(2): 279-297.

Muñoz, L.S. & Oliveira, J.P.M. (2004). Adaptive web-based courseware development using metadata standards and ontologies, *International Conference On Advanced Information Systems Engineering (Caise 2004)*.

Mosby's Medical Dictionary (2009), Elsevier, 8th edition, retrived: http://www.thefreedictionary.com/Mosby%27s%20Medical%20Dictionary%208th%20edition%20%C2%A9%202009%20Elsevier

Olševičová, K. & Mikulecký, P. (2008). Learning management system as ambient ıntelligence playground. *International Journal of Web Based Communities (IJWBC)*, 4(3): 348-358.

Pedrazzoli, A. & Dall'acqua, L. (2009), OPUS One. An artificial intelligence - multi agent based intelligent adaptive learning environment (IALE), *Learning in the Synergy of Multiple Disciplines*, Vol.5794 Berlin/Heidelberg: Springer, Oct 2009 (ISBN: 978-3-642-04635-3)

Riley, S.A., Miller, L.D., Son, L.-K., Samal, A. & Nugent G. (2009). Intelligent learning object guide (iLOG): A Framework for Automatic Empirically-Based Metadata Generation , Retrieved January 10,2010, from http://cse.unl.edu/agents/ilog/downloads/ Rileyetal_ IntelligentLearningObjectGuide_final_4_4_09.pdf

Rossi, P.G. (2009). Learning environment with elements of artifi cial intelligence. *Journal of e-Learning and Knowledge Society*, 5(1): 191–199.

Salahli, M.A., Gasimzade, T. & Guliyev, A. (2010). The development of learning object metadata system: fuzzy representation of the metadata, ninth *International Conference on Application of Fuzzy Systems and Soft Computing*, Prague, Czech Republic, August 26-27, 2010

Salahli, M.A. & Yaşar, C. (2010). The development of learning object metadata system using ontology knowledge on computer education, *2nd International Congress Of Educational Researchs*, Antalya, 29 April- 02 May, 2010.

Schaverien, L. (2003). Re-conceiving "intelligence" in learning management systems: tuning learning to theory, *University of Sydney, Sydney, Australia.* Retrieved 20 June, 2010 from http://sydney.edu.au/engineering/it/~aied/vol4/vol4_Schaverien.pdf

Tu, L.Y., Hsu, W.L. & Wu, S.H. (2002). A cognitive student model – an ontological approach. *International Conference on Computers in Education*, December 3-6, 2002, Auckland, New Zealand.