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Multi Criteria Decision Making System for Learning Object Repository

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Abstract

Sustainability and reusability of learning objects are important. In addition, reusability and effective use of learning object are provided by metadata. There are massive multimedia materials in learning object repository (LOR). Therefore, selection difficulty of appropriate learning object (LO) issue is emerged. In this context, effective and reliable method has to be found to select reliable and suitable LO. In addition, searching and using a learning object in learning object repository (LOR) may take too much time. Generally, this searching process is done through metadata from LOR. If the selection criteria do not exactly match metadata values, it may not possible to obtain the appropriate LO. Analytic Hierarchy Process (AHP) which is a multi-criteria decision making (MCDM) method for addressing complicated problems reduces the waste of time and improves the accuracy of decision making. For these reason, AHP can meet the requirements of LO selection. In this study, the SDUNESA LOR software has been developed for selection of suitable LO by using AHP. This web-based software stores, shares and also selects most appropriate LO in the SDUNESA LOR. AJAX, XML and SOA Web Services are used in this software which is especially developed for computer engineering education. Criteria of AHP are defined according to the computer education priorities. Obtained results show that AHP supported SDUNESA LOR software selects the most reliable and appropriate LO that meets defined criteria.

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Keywords: Learning object selection software, web-based learning, analytic hierarchy process

1. Introduction

Web-based education and distance learning systems are used widely in educational institutes. Web-based educational systems are useful and effective for individual learning [1]. Web-based educational systems provide a great deal of benefits for institutions and organizations. Moreover, increase in distance education programs in universities causes the need for e-content. Preparing e-content has difficulties in terms of economic costs and loss of time. To overcome these difficulties, LO is widely used in e-content.

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1.1. Learning Objects and Reusability

LO is described as any entity, digital or non-digital that can be used for learning, education or training [2]. LOs have fundamental features such as reusability, accessibility, interoperability, adaptability, durability, affordability, assessability, discoverability, interchangeability, manageability and reliability [3]. LOs also include metadata about them. Metadata is complementary and descriptive component to any data. Creating and using metadata for LOs increase reusability of LOs [4]. In addition, LOs can be searched simply, reached very fast and used effectively. LO and metadata are used together for preparing e-content. For this purpose, they must be stored and managed by LOR which consist LOs and metadata. In addition, interoperability and compatibility between LORs are provided by using LO metadata.

1.2. *Learning Object Repository and SDUNESA*

LORs are described as systems to store, search and facilitate the use of LOs [5]. They include LOs that can be stored, searched by keywords and reused according to the content of the course [6]. The SDUNESA software is developed which is used as web-based LOR software to store, search and share LOs and also select suitable LOs for computer engineering education. The developed SDUNESA software is based on IEEE LTSC LOM standard. Moreover, it supports Dublin Core Metadata standard as well as other metadata standards. Metadata conversion engine module in the SDUNESA converts different metadata standards. For example, the most widely used DC and LOM metadata can be converted into each other. In order to meet these features, MS SQL Server 2008 database management system, AJAX, XML, SOA Web Services and C# .NET technologies are used. The SDUNESA has n-tier software architecture (presentation layer, business layer and data layer) and object-oriented programming logic. Thus, expansion of the system is provided an easy and fast way, see Fig 1.

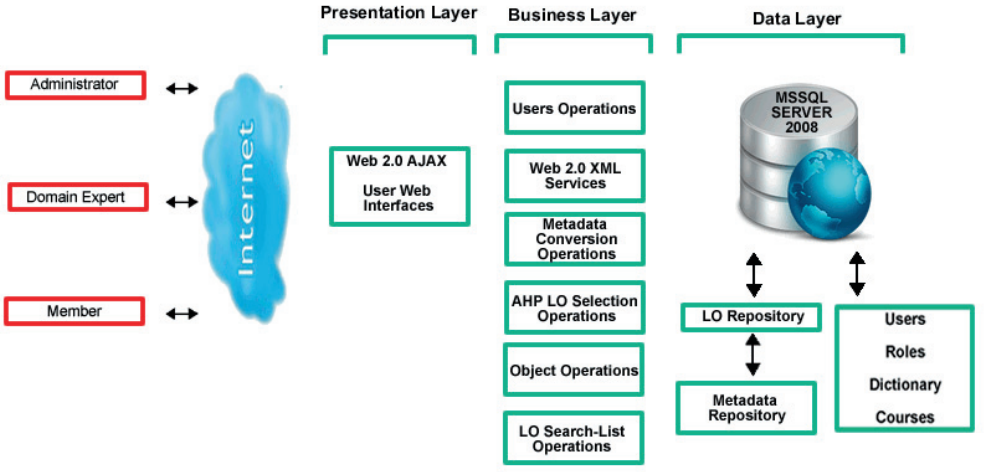

Fig. 1. SDUNESA software architecture

2. Materials and Methods

There are a lot of multi-criteria decision making methods to select LO from LORs. ELECTRE, TOPSIS, Multiplicative Exponential Weighting (MEW), Simple Additive Weighting (SAW) and AHP methods are some MCDM methods [7]. If they are implemented properly, they evaluate like human's judgments. These MCDM methods can be compared according to trust worthiness, perceived simplicity, quality and robustness. SAW method has simplicity rather than other methods. MEW method is unattractive to users due to difficult mathematical concept and scale invariant property that depends on only ratio of ratings about alternatives. Similarly, TOPSIS is mathematical and is not widely used. ELECTRE uses outranking of alternatives and it is more suitable for practical situations than restrictive dominance concept [7]. ELECTRE, AHP and SAW rankings do not differ significantly in

three examples [8]. Moreover, AHP and ELECTRE are close to each other [9]. "Which MCDM method is perfect?" question is hard to answer because searching for the perfect and best MCDM method is critical and valuable. AHP, ELECTRE, Weighted Sum Model (WSM) and Weighted Product Model (WPM) methods are compared in Triantaphyllou and his colleagues' study [10]. AHP method is used for complex MCDM problems with both single and multi-dimensional MCDM problems with relative values. ELECTRE method eliminates less favourable alternatives when used for with few criteria and large number of alternatives. WSM is most commonly used approach in single dimensional problems. However, multi-dimensional decision making problems are not suitable with this method. WPM method is similar to WSM but it is can be used for multi-dimensional decision making problems with actual values instead of relative values. Unfortunately, different MCDM methods give different results. Thus, if MCDM method reflects decision maker's real values in an appropriate way, it can be chosen [11].

AHP method is used in the SDUNESA LOR software because it is based on priority theory and complex problems. The selection hierarchy of this study comprises of three main steps, see Fig 2. AHP method is simple, flexible and usable with both quantitative and qualitative criteria. AHP does not use difficult mathematical expression. It is transparent for decision maker experts for rankings. In addition, it allows sensitivity analysis with relative priorities by changing ranking values, see Fig 3. For these reasons, some professional commercial software use AHP method [12]. The SDUNESA software is tested with different number of criteria. In first three experiments, consistency ratio of the criteria is found greater than 0.1 that indicates criteria are not consistent for the selection of the LOs. At fourth experiment, consistency ratio of the criteria is found 0.095850 that is less than 0.1, thus given criteria and points are consistent. Finally, we select most appropriate LO with AHP method. According to the defined criteria on the SDUNESA LOR software, AHP MCDM method is used effectively in best LO selection from LOR issue.

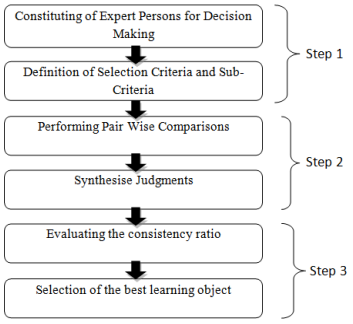

Fig. 2. Steps of LO selection with AHP

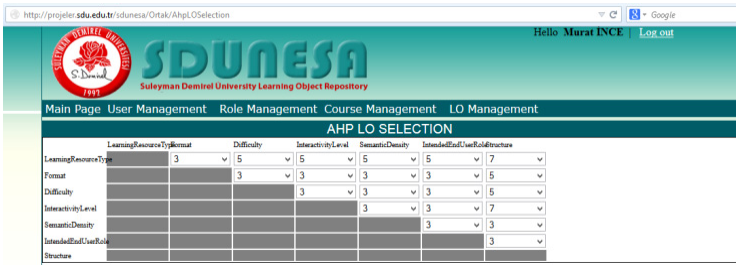

Fig. 3. Defining of LO selection criteria

Table 1. Weights and consistency ratio of criteria

No	Learning Resource Type	Format	Difficulty	Interactivity Level	Semantic Density	Intended End User Role	Structure	Consistency Ratio
1	0.729745	0.171617	0.098637					0.301360
2	0.348919	0.211742	0.197567	0.092736	0.149034			1.135021
3	0.346944	0.254862	0.182676	0.102099	0.061024	0.032315	0.020075	0.154603
4	0.382816	0.195985	0.142394	0.119969	0.075864	0.054200	0.028768	0.095850

3. Conclusion and Discussion

Innovative approaches enhanced and increased the importance of distance education and web-based learning systems. Therefore, the need for the e-content which are used in these systems is increased. LOs and LORs are used to prepare these e-contents. For these purposes, a lot of educational LO is designed in the World Wide Web. Therefore, selection of the best and suitable LO problem within the huge LOR is occurred. By using the LOM

metadata, the SDUNESA software is used to select the most appropriate LO from repository by using AHP method. SDUNESA software also provides reliable results in the occurrences of selection criteria that do not exactly match the metadata values. Obtained results show that this method finds the most reliable LO that meets our criteria. Using different multi criteria decision methods can extend this study. It is believed that this study enhances the usage field of AHP method and facilitates the selection of LO with defined criteria.

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