American Journal of Information Science and Technology
2022; 6(2): 24-29
http://www.sciencepublishinggroup.com/j/ajist
doi: 10.11648/j.ajist.20220602.12
ISSN: 2640-057X (Print); ISSN: 2640-0588 (Online)

Enhanced E-learning Platform Using Semantic Web Ontology Technique

Oluchukwu Uzoamaka Ekwealor[1, *], Sylvanus Okwudili Anigbogu[1], Ifeoma Mary Ann Orji[1], Chidi Ukamaka Betrand[2]

[1]Department of Computer Science, Nnamdi Azikiwe University, Awka, Nigeria

[2]Department of Computer Science, School of Information and Communication Technology, Federal University of Technology, Owerri, Nigeria

Email address:

ou.ekwealor@unizik.edu.ng (O. U. Ekwealor), so.anigbogu@unizik.edu.ng (S. O. Anigbogu), oma4goodness@gmail.com (I. M. A. Orji), chidi.betrand@futo.edu.ng (C. U. Betrand)

[*]Corresponding author

To cite this article:

Oluchukwu Uzoamaka Ekwealor, Sylvanus Okwudili Anigbogu, Ifeoma Mary Ann Orji, Chidi Ukamaka Betrand. Enhanced E-learning Platform Using Semantic Web Ontology Technique. *American Journal of Information Science and Technology*. Vol. 6, No. 2, 2022, pp. 24-29. doi: 10.11648/j.ajist.20220602.12

Received: January 27, 2022; **Accepted**: February 14, 2022; **Published**: April 14, 2022

Abstract: This paper aims at improving the current electronic learning system by integrating ontology based semantic web into the online learning platform. The system applies semantic web and ontology technology to e-learning environment, thereby providing customized learning based on learners' need. With this system, learners can access the system anytime, anyplace, thus, they can study at their own pace using learning resources uploaded by instructors. The system also provides facilities such as semantic web search engine and ontology repository which houses knowledge data and their meta data through which students can engage on personalized learning. Through the search engine provided, the learner semantically searches the repository for the required learning resources. The results obtained from the search is filtered according to the learner's predefined preference by matching them with the learner's profile. After the filtering, the results that most appropriately satisfy the user's academic need is presented to the learner. This work will help to encourage self-directed learning as well as saves the students, the time wasted in surfing the network for learning resources, as it narrows the search to specified learner's preferences. The system will be beneficial to schools and other learning institutions.

Keywords: Electronic-learning, Ontology, Repository, Semantic Web, Extensible Markup Language (XML), Uniform Resource Identifier (URI)

1. Introduction

Electronic Learning appears to be the most frequently used technique for imparting knowledge in the recent years. The phrase "Electronic learning" was first coined out in 1999 during a Computer Based Training (CBT) seminar. It involves the process of acquiring and utilizing dispersed knowledge through the use electronic means. Electronic earning can be used synonymously as online learning or virtual learning.

Earlier 2000s, electronic learning was seen as huge landmark in the field of learning as it went a long way to eradicate the challenges posed by traditional class room earning by providing a more soothing learning platform that promotes anyone, anytime and anywhere learning.

Hisham et al [10], described electronic learning as a system of learning that involves the use telecommunication technology. They equally adduced substitute terms for e-learning which include technology-enhanced learning, computer-based training, online education etc. This explanation broadly illustrated the purpose of e-learning, which is of paramount importance, as the technique of building an electronic learning system is heterogeneous.

Semantic web learning Systems is a new educational technique that applies semantic web technologies into learning system thus creating a more customized, flexible

and intelligent learning platform. The major aim of this semantic web is to utilize available resources on the web to actualize learning at comfort zone.

Semantic web is an evolution of world wide web whereby contents of the web are represented in in the format that can be understood and utilized by both man and machines, such that software agents (bots, spiders) can be used to search, retrieve, share and integrate resources from the web.

The Semantic web refines the current web by including a layer that provides improved automated web content processing, making it possible for data to be shared and handled by both human being and software. succinctly put, it assists the computer in understanding the content of the web, in order to provide the users with pertinent information, facilitate deductions and calculations from the provided facts as well as combining information in new forms to aid knowledge based assignments which include authoring, planning, navigation, and research.

The Semantic web presents an era where machines will be able to independently read, understand and use the world wide web content, such that agents can perform intelligent functions for users unassisted. For instance, users can engage agents to search for learning materials from the net. However, with semantic web, machines can only understand the connotation of the semantic documents and data, rather than human speech and writing ups.

Semantic web system applies the concept of ontology in searching information by notional meaning rather than by key-matching. Ontology can be referred to as a set of descriptive rudiments used to build a knowledge domain. These descriptive rudiments are generally classes or concepts, attributes and relationships existing among class members.

Ontology has attracted the interest of many researchers over the years because of its support towards the growth of computing systems [7]. It describes the fundamental ideas in a knowledge domain and explains the relation among them.

Furthermore, the use of ontologies has been hyped recently in the domain of Artificial Intelligence, computer and information technology, most especially in the following areas: Cooperative Information Systems, Intelligent Information Integration, Information Retrieval and Extraction, Knowledge Representation, and Database Management Systems [7].

Ontology as related to semantic web refers to definition of ideas and equivalent lexicon for describing a domain [6]. All the semantics present on the web are built on strictly defined ontology, therefore different semantic web applications can communicate through exchange of the content of their ontologies.

In online learning, Ontology can be constructed in many ways, however it should include a dictionary with definition of the terms and explanation of how each term is related to others. This will provide a valuable tool to facilitate the learning process [2]. Most educational semantic web [13] possess three a basic important features of effective information storage and retrieval capability, ability of independent software agents to enhance the learning, information retrieval and processing power of humans as well as ability of internet to aid, promote and improve communication skills of humans in various formats [3].

2. Review of Related Literature

Our proposed system, a semantic web ontology e-learning platform is focused on delivering e-learning environment that guarantees flexible and customized learning style. The present online learning platform with web 2.0 is posed with so many challenges that it could not meet the requirements of semantic web. Some of the issues with these current systems are inability to handle large educational content on the web, difficulty in searching appropriate learning content per learner's requirement, inability to present knowledge in machine-readable form with ability to reason and lack of provision for reuse of learning resources. All these problems are tackled by the use of ontologies in storing knowledge contents and developing a semantic web e-learning platform. The main purpose of ontology is to present the subject classifications in a very simple format and its machine readability and parsing abilities enable it achieve this purpose. In our proposed e-learning system, the leaners' personalization details are properly stored in the ontology, according to Felder-Silverman model [1] and any changes is reported by JADE agents.

2.1. E-learning

Learning is life-long activity, that can be accessible at any point and time in order to satisfy learner's specific need. According to Hall and Snider [9], electronic learning involves the act of acquiring knowledge through computers across the internet. They further explained that electronic learning encompasses web-based training, training online, technology-based learning and distributed learning.

Karon [15] described the comfort benefit a well-structured technology-based learning when he stated that a properly constructed electronic learning platform provides more convenient learning atmosphere than conventional instructor-centric method of learning. To buttress his fact, Karon explained that, in electronic learning system, courses are available for learners to access whenever they are ready to study, thus students' academic activities are not limited to a particular time scheduled by the instructor.

Hall [8] and Karon [12] described electronic learning as any form of knowledge impactation using computer system, either by use of CD-ROM or via the web. Compute-based training is similar to online training which embraces all the learning activities carried out with computer across a network including intranet, local area network, and the internet [5].

Urdan and Weggen [17], pointed out that online learning spans from a basic online learning program that utilizes text and graphics to render knowledge to a more sophisticated online learning platform that promotes learning through the use of animations, simulations, audio, video, links to materials on the web etc.

Electronic learning differs greatly from traditional learning method were the instructor acts as the intermediary between the students and the knowledge materials. With the emergence of e-learning, delivery of learning material ceased to be under the control of instructors, thereby granting the learners the privilege of combining learning material on their own. Succinctly put, electronic learning focuses on replacing the traditional static learning style with a more dynamic and customized learning system that satisfies user's personalized leaning needs as well as anytime, anywhere learners' requirement [16].

2.2. Semantic Web

Semantic web attempts to create an advanced world wide web framework that contains contents with formal semantics, i.e. web material that is understandable by both machines and human rather than materials understandable by human only. This enables software agents to reason and respond intelligently to unanticipated situations based on available web content.

The principle concern of Semantic web is declaration of meaning. To put this in place, different layers are required as follows: the extensible Markup Language (XML) layer, which is responsible for representing data; the Resource Description Framework (RDF) layer, responsible for representing the data meaning, the Ontology layer, whose major concern is to show the proper common agreement of the meaning of data; Uniform Resource Identifier (URI) which is a global naming convention, the Logic layer, that assists in reasoning intelligently with meaningful data. The topmost layers, Logic, Proof and Trust, are presently undergoing research with basic application demo constructed. The Logic layer helps to put down rules while the Proof layer implements the rules and combines with the Trust layer technique to assess for a given application whether to trust a particular proof or not.

2.3. Semantic Web Technologies

The Semantic Web illustrates a web of data instead of documents. As common structure and standard is required to retrieve documents from computer systems around the world, there is need also for common standard to be used to represent and integrate data. There is also need for languages that will help us describe how this data are related to real world entities and to create reasoning about the data.

The important attribute of semantic web are the Languages Resource Description Framework and Resource Description Framework Schema, which are followed by a higher layer that is concerned mainly with the core concept of semantic web technology, known as ontology and then evaluation of the flows and directions of the technology.

1) Resource Description Framework and Resource Description Framework Schema: Resource Description Framework (RDF) is data, what Hypertext Markup Language is to documents. It is referred to as a W3C standard2 based on Extensible Markup Language that enables us create statements about a thing. It is seen as a data model rather than as language, e.g one can state that a particular object has a peculiar property, or that exist a relationship between the object and another. Resource Description Frameworks can be stated in triples format as follows: subject, predicate and object and have a uniform structure. Web contents are identified using a Universal Resource Identifier (URI) that enables us to create statements on the same concept in different applications.
2) Ontologies and Reasoning: According to Tom Gruber [6], an ontology is defined as a formal and detailed description of ideas. It gives a common perception of a field of interest. Formal description as indicated above implies that computers can reason about it, thereby enhancing the correctness of searches, as search engine will be able to retrieve data concerning a specific concept, rather than a huge collection of web contents retrieved through keyword matching.

In connection to the Semantic Web, in order to facilitate sharing, reusing and reasoning about data, we need to give a specific description of ontology, and portray it in a format that is compliant to machine processing. Web Ontology Language (OWL) is the most commonly used ontology language.

To add an inference/reasoning ability to an ontology language is a delicate one, as there will be a commutation between effectiveness and expressivity. Basically, it rests on the type and prerequisite of the end application, and as a result of this, web ontology language provides three sub languages:

1) OWL Lite which supports only a few subsets of OWL constitute and is operationally efficacious.
2) OWL DL which is rooted on first order logic called description logic,
3) OWL Full which provides full affinity with resource description framework schema but at the price of operational tractability.

The upper layers of the semantic web structure have attracted amazing awareness following their contribution to the successful implementation of Semantic Web technology. The proof layer consists of the actual reasoning process, proofs representation and validation of proof. It helps applications to inquire the reason for arriving at a specific conclusion. For instance, they can provide proof of their deductions. The trust layer offers confirmation of identity and proof of the trusty of data and services. It is achieved by employing digital signatures, endorsement by credible agents, certification agencies rating, etc.

2.4. Ontology

Ontology serves as the back bone of semantic web technology. The term ontology is commonly used presently in the area of web application and information science, principally in areas such as cooperative information systems, integration of intelligent information, retrieval and extraction of information, representation of knowledge, database management system, and e-learning system.

Ontology is a detailed specification of a concept [15]. It supports description of learning materials, thereby allowing static interoperation through common domain concepts, as well as dynamic interoperation through detailed publishing of proficient specifications, that can be inferred about to inquire if a specific semantic web service is suitable for a given task.

Again, Ontologies is applicable in mixed electronic learning as a way of describing the organization of universities and courses, as well as defining services. An electronic learning Furthermore, ontology consists of specifications of course providers, courses, instructors and learners. The structure of ontology depends on a taxonomy which helps in building a system based on specific operational specifications [14].

The ontology represents learning domain by describing all its concepts, the relationships between them and other attribute and domain regulations. Its development is equivalent to defining a group of data and their format and as such, the ontology can be said to be a knowledge base from which useful knowledge can be extracted, in other to produce customized views of electronic learning system.

2.5. Semantic Web Ontology

Ontology provides an extendible and shared platform to express common lexicon in a knowledge domain. It contains machine understandable descriptions of fundamental concepts in a knowledge field and the relationships existing among them [4]. Currently, ontology is among the common techniques used for representing knowledge in the web.

Basically, ontology comprises of objects, relations, attributes, instances, functions, constraints, rules, and other inference procedures. The strength of ontologies depends on its capability to represent knowledge in detail, ie. concepts, properties, and constraints, its semantics encoding ability, ie. meta-data, rules, and other reasoning procedures) and its capability to support common understanding of the represented knowledge within as well as between humans and software agent.

Present increase in semantic web research, has contributed to the evolution of W3C Standard-Ontology Web Language (OWL). We have different types of ontologies as follows:

1) Domain Ontologies: these expresses the knowledge concerning a specific domain.
2) Upper Ontologies: these consists of various types of domain and not just a specific one.
3) Application Ontologies: this type of ontology contains all the knowledge required to model a given application within or across domain.
4) Structural Ontologies: These refer to any given domain.

2.6. Semantic Web Ontology Based E-learning Platform

E-learning is one of the fields of study, that has benefitted greatly from Semantic web technologies. In the existing electronic learning systems, knowledge is only imparted to students through the learning materials uploaded by the instructors, hence no room for improved student-centric personalized learning.

Having observed these lapses, it is pertinent that we coopt semantic web and ontology technology into electronic-learning platforms for a more efficient result. The semantic web provides a more flexible learning environment by incorporating semantic web technologies such as participatory and annotation instruments [16].

The major feature of the Semantic Web technology i.e. common shareable meaning and machine understandable data, enabled by software agents, provides a strong method for satisfying the electronic learning needs of productive, timely and convenient learning. Learning contents are elucidated semantically such that users can find and combine necessary learning resources as easy as possible based to his/her learning needs. This can be achieved through querying semantically and navigating through knowledge contents, made possible by the ontology backbone [11]. The e-learning sphere of influence promising some new rules which would describe the learning resources, including learning objects metadata.

The biggest and major aspect of the Semantic Web applicable in electronic learning is ontology, which offers an appropriate description of the idea of shared domain [6]. The Semantic Web can be used as an acceptable platform for developing an electronic learning system, since it satisfies requirements for online learning, implementation of ontology, ontology-based elucidation of knowledge contents, their composition in learning courses and active delivery of the learning resources through electronic learning gateway [11].

Ontology plays a very crucial role in electronic learning systems by specifying a common meaning of vocabulary and symbols by feasibly mapping between symbols and their meanings. In electronic learning systems, the shared understanding issue arises in different levels of ontology, such that the specification of contents can be mapped in several ways. The most imperative things to be put into consideration while searching for knowledge materials include:

1) Learning contents
2) Pedagogical issues ie. the context of the knowledge materials
3) Learning content structure

Following these considerations: learning content, context, and structure, ontologies are grouped into three levels, viz:

Content Ontologies: these specify the fundamental concepts of the field of learning e.g., mathematics or literature. It also involves the relationship between these concepts and some basic attributes. Example, the study supervised learning is part of machine learning, which in turn is part of Artificial intelligence. The ontology has to involve the relationship “is part of” and the point that it is an active attribute of the object. By so doing, a computerized learning software agent can deduce that knowledge on supervised learning can be found under Artificial intelligence. The content ontology can also show synonyms e.g, ‘enable’ and ‘allow’ and abbreviations such as ‘HTML’ as Hypertext

Markup Language.

Context Ontologies: these can be handled in a pedagogical ontology. knowledge materials are issued in several contexts of learning such as lecturing, teaching, illustrations, images, assignments, etc. It assists in relevant context searching of learning resources according to user requirements. For instance, to search for specific definition of a topic of interest, definitely there would be a learning material with more details and examples.

Structure ontologies: these are used to describe the logical components of the learning materials. Electronic learning is usually done at learner's pace, therefore, we need to break down the teaching into small modules of information, which can be customized to satisfy personal learning needs. However, these learning materials has to be well linked to build all the courses and as such huge attention should be paid during the design of the structure electronic learning materials. Such knowledge structure will have to includes different hierarchical and navigational links as "next", "previous", "Part of", "required", "based on", etc. Relationships existing between these relations can as we be stated, e.g "next" and "previous" are inversely related.

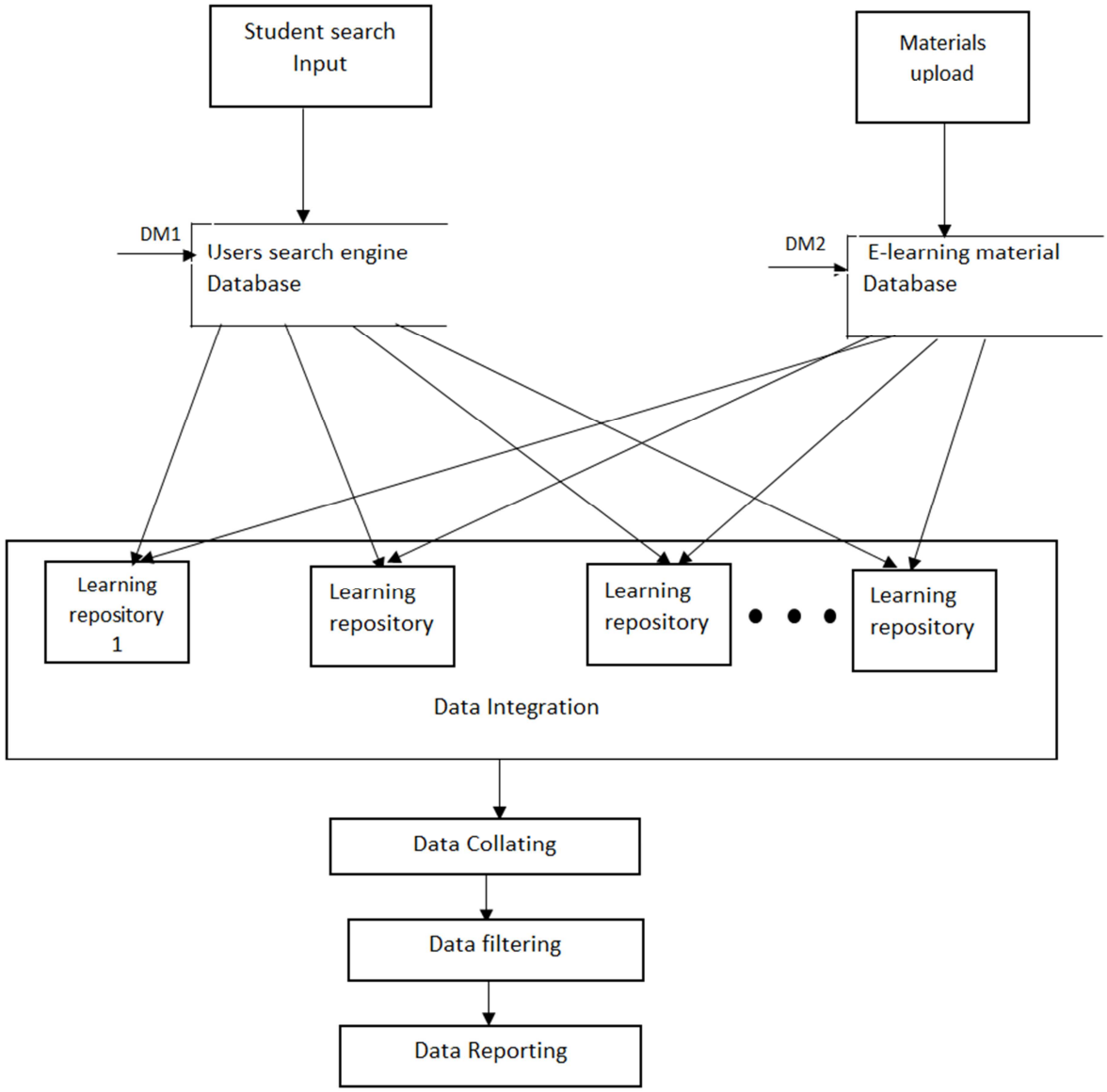

Figure 1. *Structure of Semantic Web Ontology E-Learning Platform.*

3. Operations of Ontology Based Semantic Web E-learning platform

The semantic web-ontology e-learning platform comprises of the following components:

1) Learning section
2) Ontology (Repository)
3) Semantic Web
4) Administration section

Learning Section: in learning environment, the eligible students initially undergo a registration process to upload required information about themselves, in order to gain

access into the system. This section contains list of all the available courses and their contents and students are allowed to choose their course of interest from the list. It provides an avenue for instructors to upload learning materials such that students can download and learn as well as external knowledge links to foster student's self-directed learning the internet.

Web ontology (Repository): This can be likened to the database that houses web ontology language (OWL) files in the system. It stores all the details concerning the entire system including information needed by both instructors and learners and all the details about the students. One the majors benefit of this ontology component is the specification and classification of concepts in different domains of knowledge.

Semantic web: this is the main component of the system where search is performed. It consists of a number of elements, such as extensible Markup Language files, servers and data about data (metadata) present in the system. With the help of semantic web search engine, learners can search the web ontology for required learning materials. At the end of the search, results obtained filtered according to user's priority and some semantics. Also, an inference engine will be employed in matching the returned learning materials and student's profile depending on the stipulated instruction, while a ranking algorithm would be used in prioritizing the filtered result based on their relevance. Such search engines already exist such as Swoogle and Watson, they can be adapted and their results further filtered to fit the intended use. Also the Reasoning/Inference Engine would be responsible for carrying out the matching of the returned resources and the learner's profile based on specified instructions. A Ranking Algorithm, this component of the system would also be implemented using a programming language; it would help to prioritize the filtered results based on pre-specified preferences and their weights or level of importance.

Administration section: this consist of Administrators in charge of the system functionalities. These administrators render varieties of services, such as students' evaluation, advisory services, instructing students and so on, in the system.

4. Conclusion

This work, enhanced e-learning platform using semantic web ontology, consists of all the attributes of existing e-learning systems as well as semantic ontology technology. It greatly enhanced the existing online learning platforms, as it satisfied the learners' need of adaptable and personalized learning by presenting search results based on learners' academic profile. The customization of learning materials is achieved by the use of domain ontology which makes the system capable of recommending appropriate resources to the learner. The system is highly scalable as it has the ability to handle the courses in different domains simultaneously, provided the courses are uploaded in the repository.

References

[1] Berners-Lee, T., Hendler, J., and Lassila, O. (2001), The Semantic Web. Scientific American Magazine. doi: 10.1038/scientificamerican0501-34.

[2] Convetini, N., Alanese, D., Marengo, A., Marengo, V., and Scalera, M. (2006), "The OSEL taxonomy for the classification of learning objects", Interdisciplinary Journal of Knowledge and Learning Objects, 2, 125-138.

[3] Corcho, O., Fernández-López, M. and Gómez-Pérez, A. (2007). Ontology engineering: what are Ontologies and how can we build them, in Cardoso, J. (Ed.). Semantic Web: Theory, Tools and Applications, Information Science Reference London 44-70.

[4] De Nicola, M. (2004), Towards an Ontological Support for e-Learning Courses, OTM Workshops, LNCS 3292, pp. 773–777, 2004. © Springer-Verlag Berlin Heidelberg.

[5] Gotschall, M. (2000), E-learning strategies for executive education and corporate training. Fortune, 141 (10) S5-S59.

[6] Gruber, T. (1998), A translation approaches to portable ontology specifications" Knowledge Acquisition, vol. 5.

[7] Guarino, N. (1998), "Formal ontology and information systems", In N. Guarino (Ed.), Proceedings FOIS"98 pp. 3-15, Amsterdam, IOS Press.

[8] Hall, B. (1997). Web-based training cookbook. New York: Wiley.

[9] Hall, B., & Snider, A. (2000) Glossary: The hottest buzz words in the industry.

[10] Hisham, M., Saud, M. and Kamin, Kamin, Y. (2018), "E-learning as Cooperative Problem Based Learning (CPBL) Support Elements in Engineering Education".

[11] Jovanovic, J., Gasevic, D., Torniai, C. and Devedzic, V. (2009), Using semantic web technologies to provide contextualized feedback to instructors. In: Dicheva, D., Mizoguchi, R.

[12] Karon, R. L. (2000). Bankers go online: Illinois banking company learns benefits of e-training 1 (1) 38-40.

[13] Koper R. (2004), Use of the Semantic Web to Solve Some Basic Problems in Education: Work-load. Journal of Interactive Media in Education.

[14] Markellou p., MousouroulI I., Spiros S, and Tsakalidis A. (2005), Using Semantic Web Mining Technologies for Personalized E-Learning Experiences, Proceedings of the Web-Based Education, Grindelwald.

[15] McIlraith, S., Son, T. and Zeng, H. (2001). Semantic web services. IEEE Intelligent Systems, technologies to provide contextualized feedback to instructors. In: Dicheva, D., Mizoguchi, R., technologies to provide contextualized feedback to instructors. In: Dicheva, D., Mizoguchi, R.,

[16] Stojanovic, L., Staab, S. and Studer, H. (2001). E-learning based on the Semantic Web",

[17] Urdan, T. A., & Weggen C. C. (2000). Corporate e-learning: Exploring a new frontier. WR Hambrecht + Co.