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Research Article

Development of a Semantic Web-Ontology E-Learning Platform

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Abstract

This paper is focused on developing A Semantic Web-Ontology E-Learning Platform, which is a system that combines semantic web and ontology technology to guarantees a sophisticated learning environment that provides the learners with adaptable and customized learning resources based on learners' knowledge requirement. With this system, learners can log in from their comfort zone anytime, to receive their online lesson as provided by their tutor. The system has an added advantage of providing a personalized learning to students through creation of intelligent search engine and ontology backbone consisting of learning data and their meta data. The learner, through this search engine, searches the ontology semantically for the learning materials that suits his/her profile. The system also has the capability of filtering the search results by matching them with the profile of a particular learner using inference engine, such that the result best suited for the user's academic need is presented. This work will not only promote self-directed learning but will also facilitate quick search of learning materials, by narrowing the search based on specified learner's interest. The methodology adopted for this work is Object-Oriented Analysis and Design Methodology (OOADM) and programing languages used are Php-Mysql and Java Script. The system will be of great benefit to schools, other learning institutions and organization seeking to educate their manpower.

Keywords

E-Learning, Extensible Markup Language, Ontology, Ontology Web Language, Semantic Web, Repository

1. Introduction

E-learning involves the use of information and communication technology for the purpose of promoting learning [15]. It involves acquisition and use of knowledge through electronic channel. It was one of the huge developments recorded

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in digital revolutions in early 2000s and has removed the barriers of place and time associated with traditional learning system as well as socioeconomic barriers. Hisham et al, (2014) described e-learning as a learning system involving the use of electronic media and information and communication technologies (ICT) [8]. it can also be referred to as technology enhanced education, computer-based training, online learning etc.

Learning was initially dependent on only computers and networks. However, with current technological innovations, it can make use of different channels such as wireless network, satellite network, cellular phones and personal digital assistant (PDA).

Presently, different domains and organizations are leveraging on semantic wed technology for improved productivity and e-learning is one of the domains that is immensely benefitting from semantic web technology. Semantic web makes e-learning platforms more flexible by using enhanced semantic web techniques like collaboration and annotations tools [16].

The Semantic Web is not a separate entity from the usual web, rather it is an enhanced version of the existing web that facilitates exchange and reuse of information. It is centered on making the web more understandable to both human and machines by creating a suitable framework that enables intelligent software agents access the web and carry out complex tasks for their users.

Semantic web technology creates room for computers to communicate with each other through sharing correct information to meet users' needs. It achieves this with the help of tools such as eXtensible Markup Language (XML), Resource Description Framework (RDF) and SPARQL [13]. The Semantic Web is seen as very powerful and suitable framework for e-learning due to its ability to provide diverse means for e-learning such as ontology development, ontology-based annotation of learning materials, their composition in learning courses and proactive delivery of learning resources through e-learning portals [9].

The most important part of the Semantic web in e-learning is the term ontology. it is seen as the back born of every semantic web system. It is defined as a set of representational primitives such as classes, attributes and relationships used in modelling a domain of knowledge or discourse. it searches out results using the conceptual meaning of input query instead of key matching. it gives a clear description of the concept of shared domain [7].

This paper is motivated by the need to eradicate some of the challenges encountered in the existing e- learning platforms. The e-learning systems currently operational are mainly teachers oriented and provides little or no support for learners oriented learning or self-directed learning. These systems concentrate on displaying available educational resources to learners instead of presenting the users with knowledge links. This confines learners' knowledge as they are left at the mercy of the limited learning resources provided by their instructors. The semantic web ontology based e-learning system will solve this problem by providing knowledge link through which learners can acquire more knowledge. This can be achieved by inculcating semantic web and ontology into e-learning platform in such a way that learners can independently search for learning materials of interest thus promoting self-directed learning.

Another issue is the inability of the current e-learning systems to provide links to related learning resources in a specific domain. For instance, when a learner searches resources on "Artificial Intelligence", the systems would only respond with the resources bearing the keyword "Artificial Intelligence", any other relevant resources related to it but without the keyword will not be displayed. With semantic web ontology system, ontology searches out result conceptually rather than focusing on key words.

Furthermore, with the overwhelming number of learning materials on the web, it is often very time-consuming to find the required learning materials in existing e-learning systems. hence, it becomes necessary to develop a system with quicker response time. Semantic web ontology based system provides an intelligent search engine and inference engine which help to reduce the time spent in searching for resources.

1.1. Aim and Objectives of the Study

The aim of this paper is to develop a semantic web-ontology e-learning platform and the objectives include developing a system, that should be able to:

1) Create a common platform where students, teachers, and administrators of schools can upload and access learning materials.
2) Provide an ontology (a repository of knowledge) containing the customized details of learners and taxonomy of the learning resources.
3) link the knowledge enclosed in different remote ontologies for improved learning.
4) Create an intelligent search engine to assist users search for learning materials semantically.
5) Filter the search results obtained from the search engine based on some semantics and the learner's preferences.
6) Rank the filtered results based on the pre-defined preferences and relevance so that the best-suited results are presented to the user.

2. Review of Related Work

The interest of researchers towards the development and use of ontologies has tremendous increased. This is evident in the great number of publications on semantic web ontology currently.

According to Dicheva (2008), learning systems applying semantic techniques like ontologies are the third generation of e-learning systems [3]. Stating that ontologies gives meaning to web information and portrays knowledge in such a way that

new ideas can be deduced and information processed automatically. We have different applications of ontologies and these have improved e-learning systems by creating simpler means to manage, share and retrieve learning materials. They create more flexible learning environment and enhances personalized learning by creating individual learning paths. They also facilitate the growth of social learning [10].

Dicheva, D. (2009) et al., in their work, grouped the applications of semantic web technologies in e-Learning into five categories: ontologies that enables technologies, ontologies used for authoring instructional systems, instructional support and adaptation, sematic web-based intelligent learning environments and social semantic web applications [4].

The Edutella venture created Resource Description Framework (RDF)-based peer-to-peer application for sharing educational object, making it possible for educational contents to be distributed easier to the system, thereby providing ample metadata to give more information about learning objects [6]. Here, one can search for resources or articles from the shared data repository based on their semantic comments. Today we have more than enough semantic representation dialects for educational objects such as the Educational Modelling Language (EML) [14], a proposed set of integrated procedures for online learning subjects by IMS Global Learning Consortium such as metadata specification and the learning object metadata, a standard specified by the Learning Technology Standardization Committee (LTSC) of Institute of Electrical and Electronics Engineers (IEEE) [17].

Instructional Management System (IMS) and SCORM defined Extensible Markup Language-based interoperable specifications to exchange and sequence educational contents. They are more concerned with standardizing learning and teaching techniques and modelling how the systems control interoperable learning objects suitable for the learning process [1].

Narayanasamy, S. K. 2022 et al, presented a domain-specific progress attained by semantic web technologies in the recent years and outlined different methodologies used in healthcare, virtual communities, and ontology-based information processing systems. In their paper, they pointed out that the use of semantic web is wide spreading over different fields especially in healthcare, virtual communities, e-learning platforms etc. [12].

Moussallem et al. 2018 stated that research has been going on over the past few decades on making machines understand human language until the inception of semantic web technologies which made it possible for machines to comprehend images and textual contents. In their paper, they offered a novel method of transforming textual documents into predefined machine-translated form [11].

Drury et al. 2019, in their opinion, stated that semantic web has contributed immensely in the domain of precision agriculture over the years, as it has proffered solutions to many retarding problems encountered in the agricultural sector [5].

Ahlem, R. et al 2020 also opined that semantic web technology is now being incorporated into the Internet of Thing. Their work provided insight on how semantic web has contributed meaningfully in the operations of Internet of Thing devices [2].

3. Components of the Semantic Web Ontology E-Learning Platform

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

1) Learning platform
2) Repository (web ontology)
3) Semantic Web search
4) Administrator's interface

Learning Platform: This encompasses most of the activities that take place in the system. For students to partake in the e-learning, they have to undergo the initial process of registration i.e. they will register with the required details and information in order to get access to the system. As soon as they are registered, they will be able to view every detail of the available courses in the system, which include all the necessary information and list of available courses from which the students can select their desired course. Apart from the learning materials uploaded by the tutors, external learning links are also provided to assist students further their learning from the internet.

Semantic web: This is major component of the system where the search takes place. It is made up extensible markup language files, different servers and metadata (metadata consists of data about data that is present in the system). It has built-in Semantic Web Search Engine, through which learners can search the web for available learning resources.

Repository (Web ontology): This serves as the database of the system. It houses all Ontology Web Language file and keeps details of the entire system. Every information needed by the instructors or learners are contained in this repository.

Administrator's interface: The administrators are responsible for controlling all the activities carried out in the system. They appoint people to perform functions such as evaluation, advising, teaching etc.

4. Operations of the System

This system exhibits all the functions of usual web-based e-learning management system with advance semantic web ontology capabilities. To access the system, the learner logs into the system with his details if he is already a registered member, otherwise he needs to register as a new user to be able to participate in the learning. From the learning platform, the learner can perform several task which include selecting the subjects and topics of interest, taking and viewing their marks, doing and submitting assignments, searching for more knowledge through intelligent search engine, etc. At the end of the learning, the student logs out to exit the system. The

instructors on their part are responsibilities for uploading the learning materials, adding new subjects, topics, quiz and exams. The admin controls all the activities going on in the system including monitoring the instructors and learners. It is also the work of the admin to keep the students' record in the database and edit them as the need arises.

Some of the important modules present in the learning platform include; teaching modules where the case studies, lecture materials and examples are uploaded in the form of presentation slides, Pdf and word files by instructors for students' accessibility; Curriculum module containing the objectives and contents of the courses, Evaluation module for tests, quizzes and assignments; Communication module which provides an avenue for interaction among students themselves and between their teachers. This is achieved through web boards and help modules through which student can get help for their frequently asked questions via email.

The system has a Semantic Ontology web interface, through which users can obtain personalized learning. To search for a topic, the user inputs the keyword through the interface. This user interface uses an ontology search engine to search ontology files for the mentioned keyword from database. The search engine performs an intelligent search through semantic querying of the ontology using the specified keyword in order to retrieve the required ontology files. The user interface also provides an avenue for users to type synonyms of the given keyword in case the keyword does not exactly match the terms in ontologies. The class extractor then processes the required ontologies and extracts the class names. This process continues until the required result is obtained.

The user accesses the system through the user interface on his system, his preferences and search terms are represented using the standard terms as represented in the vocabulary. These representations are then used to search. Matches that meets the pre-specified criteria are filtered and ranked, such that the best suited results are presented back to the user, along with extra information to guide his learning.

In this proposed system, we will take advantage of ontologies for the explication of expert knowledge as a possible approach to overcome the problem of semantic heterogeneity and the problem of structure heterogeneity will be solved by the use of XML based data integration together with data warehouse.

Web-Ontology Language (OWL) was chosen to describe ontology due to peculiar roles it plays in information integration and its reliability on extensible markup language (XML) schema data types.

The service–oriented integration (SOI) combines the traditional integration object with open and highly flexible web services, and provides an abstract interface through which information systems can interact with each other instead of by bottom protocol and user-defined programming interface specifying how the system communicates with other systems. The learning information is described in the form of services so that other services can discover and select to interact and bind with them when they are running or being designed.

5. System Design

This system presents modules for:

1) Online Learners Registration
2) Online Subject Registration
3) Electronic Learning
4) Uploading Learning Material
5) Online ontology repository to maintain learners' personal-ization details and taxonomy of the learning resources.
6) Intelligent Web Search
7) Filtering the search results returned by the search engine

5.1. Main Menu

The semantic web ontology e-learning platform as developed in this work has three access levels, which are Learners, Tutors and Admin. Figure 1 shows the various modules and sub-modules as designed in the application. The functionalities of each of the subsystems is unique and performs the assigned task when clicked on by the user.

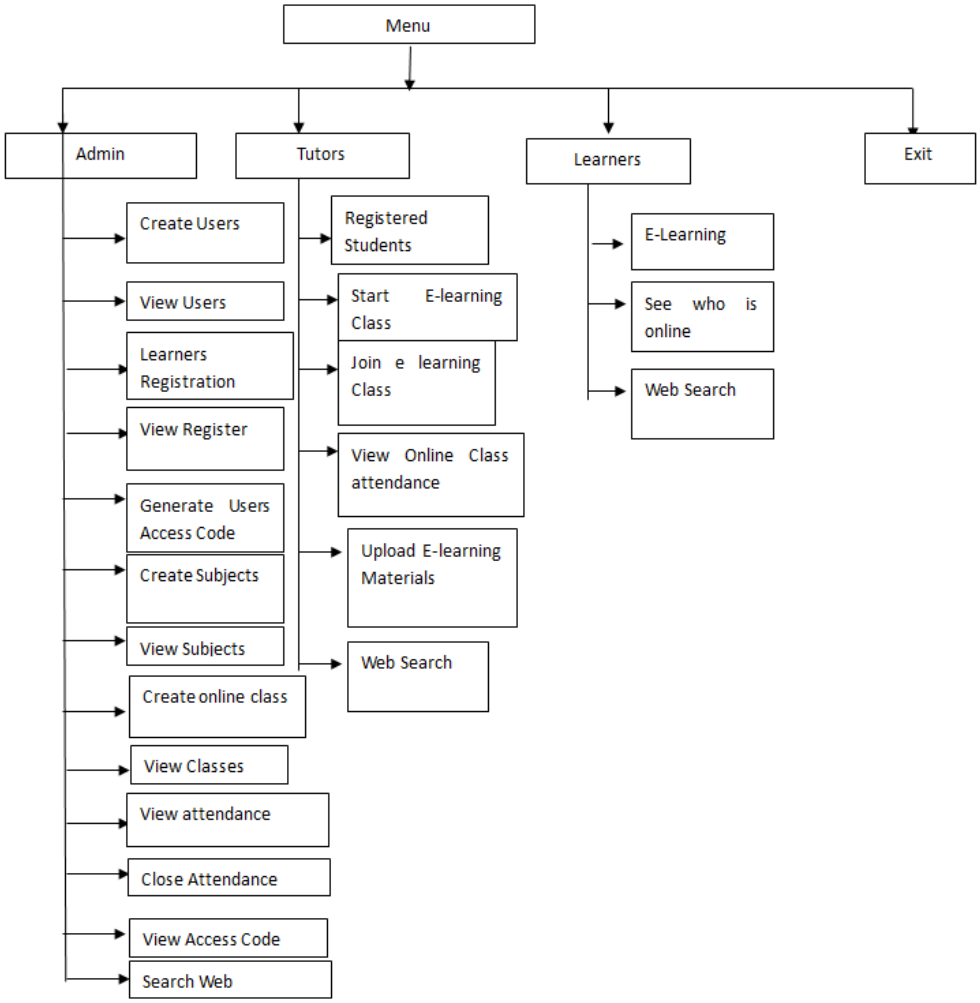

Figure 1. *Main menu.*

5.2. Sample Outputs of the System

Some of the sample outputs include:
Student Registration Form

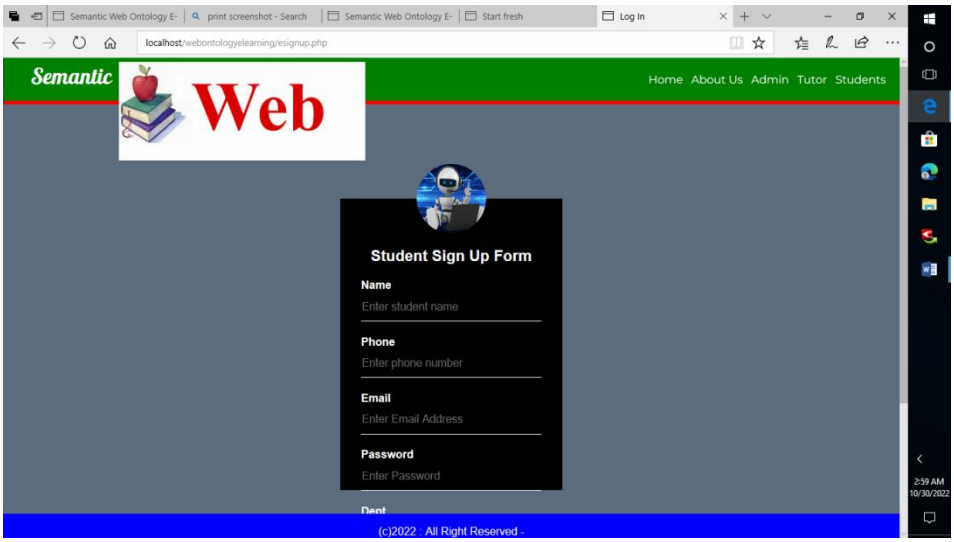

Figure 2. *Student Registration Form.*

Course Registration form

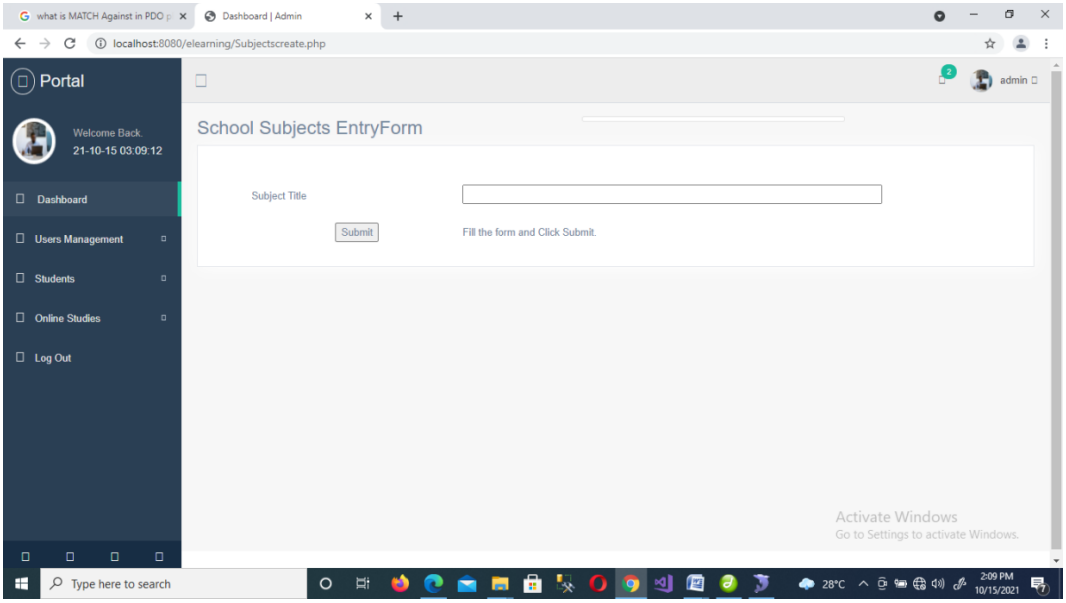

Figure 3. *Course Registration form.*

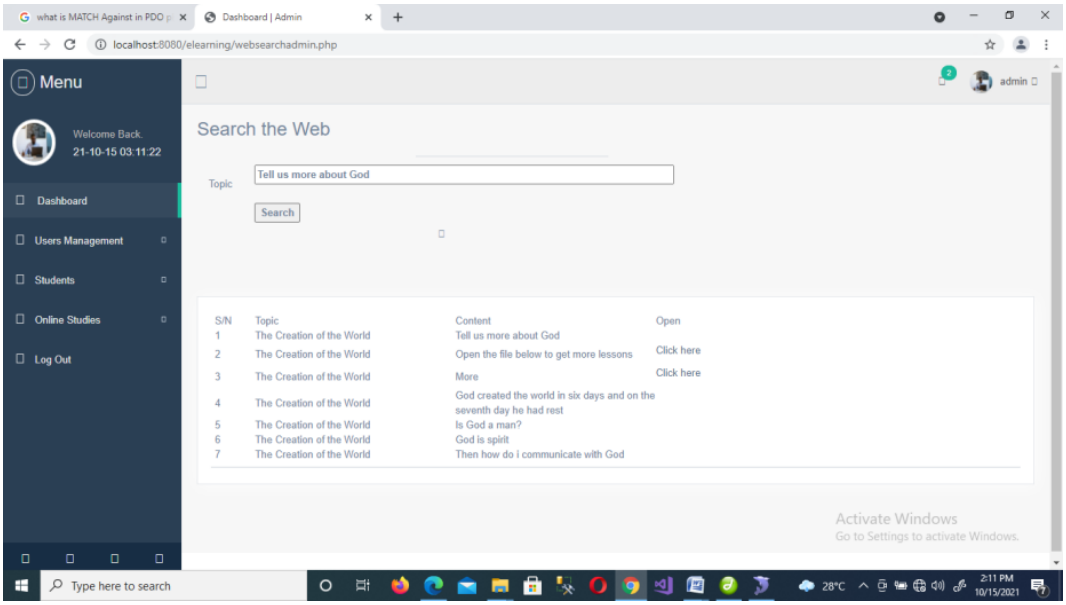

Figure 4. *Web Search Form.*

6. Conclusion

The semantic web ontology e-learning platform developed presents all the features of current e-learning systems with additional semantic ontology technology. It satisfied the learners' requirements of flexible and customized learning as learning resources obtained from the intelligent search engine are filtered based on the learners' academic profile. The customization of learning materials was achieved through the use of domain ontology that enables the system recommend appropriate resources to the learner. The system is very scalable and can handle courses from different knowledge domains simultaneously, as long as the courses are uploaded in the database, for the unification and standardization of ontology.

Abbreviations

ICT	Information and Communication Technology
PDA	Personal Digital Assistant

XML	Extensible Markup Language
RDF	Resource Description Framework
OWL	Web-Ontology Language
SOI	Service Oriented Integration
EML	Educational Modelling Language
LTSC	Learning Technology Standardization Committee
IEEE	Institute of Electrical and Electronics Engineers
IMS	Instructional Management System
SPARQL	SPARQL Protocol and RDF Query Language

Conflicts of Interest

The authors declare no conflicts of interest.

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