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Evaluation and Comparative Analysis of Semantic Web-Based Strategies for Enhancing Educational System Development

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ABSTRACT

Educators have been calling for reform for a decade. Recent technical breakthroughs have led to various improvements in the semantic web-based education system. After last year's COVID-19 outbreak, development quickened. Many countries and educational systems now concentrate on providing students with online education, which differs greatly from traditional classroom education. Online education allows students to learn at their own pace. As a consequence, education has become more dynamic. In the educational system, this changing nature makes user demands difficult to identify. Many instructors suggest using machine learning, artificial intelligence, or ontology to improve traditional teaching methods. Due to the lack of survey studies examining and comparing all of the researcher's semantic web-based teaching methodologies, the authors decided to conduct this survey. This paper's goal is to analyse all available possibilities for semantic web-based education systems that enable new researchers to develop their knowledge.

KEYWORDS

Artificial Intelligence, Big Data, E-Learning, Machine Learning, Ontology

1. INTRODUCTION

The Semantic Web is an extension of the World Wide Web in which data is given well-defined meaning and better ways to share and integrate information. This type of web will allow computers and humans to more easily work together and share data and understand it much better than any previous system. A semantic web is made up of data that nodes are connected to each other in meaningful ways human (Choi et al., 2021; Luo et al., 2017). This means that when you are browsing the web, you can query for different types of information.

The web system is developed as a shared space where the users can interact with each other. However, this function of the web has become its most significant limitation. As most of the information is used by humans, that information is stored in the machine format(Zhang et al., 2019). To

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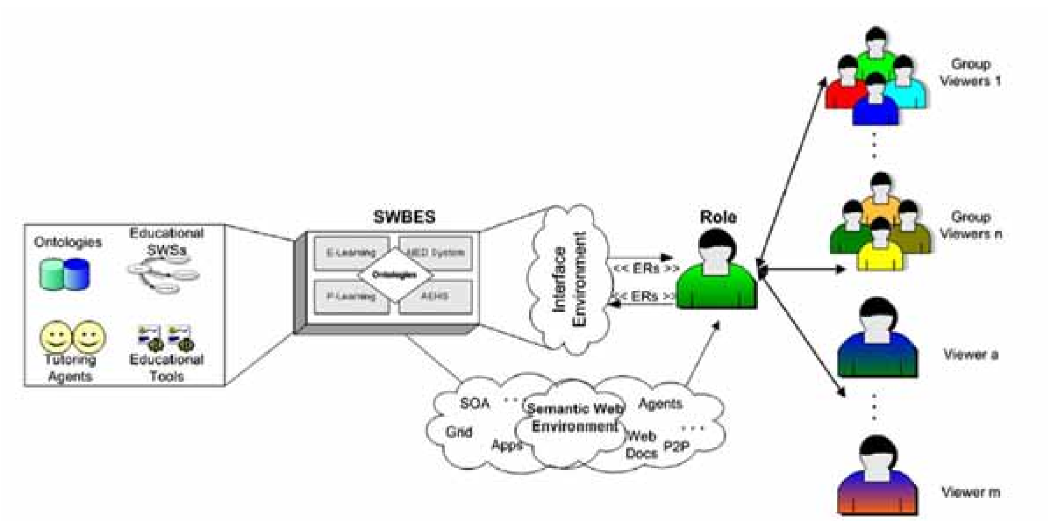
work in this scenario, researchers developed Symantec web, an improvised version of the classical web system. In the semantic web, computers store and analyze the information in an easily understandable form(X. Chang et al., 2015). The semantic web is a very complex topic it is developed by many different languages like XML (Bray et al., 2000, p. 0), RDF (Lassila & Swick, 1999), OIL (Fensel et al., 2000), DAML+OIL (Corcho et al., 2006), XOL (Karp et al., 1999), SHOE (Luke & Heflin, 2000), and OWL (Horrocks et al., 2003). all these languages are together tries to make information more understandable by the computers. Like any other information system Semantic web also has different layers. One of the most popular architectures of semantic page proposed by Berners-Lee. Till now Berners-Lee proposed for different architectures for Symantec web. How about some of those researchers argue that semantic web architecture can be represented as stack because different markup languages form it.

There is a need to develop an education system according to the user's need, and semantic web showing an opportunity in this direction. Therefore, the researchers propose using the semantic web in the east learning and the education system. In this context the basic reference model for semantic web based education system is represented in Figure 1 (I. I. Bittencourt et al., 2008). The semantic based web education system has three main in requirements: 1) Easy accessibility of storage; 2) The nodes or the agents in the reference models can understand the problems and issues of user; 3) The network capacity is high so that the user can extract the information on the semantic web (T. Anderson & Whitelock, 2004).

Figure 1. Semantic web-based Education system (I. I. Bittencourt et al., 2008)



Some researchers proposed ontology-based techniques to improve the semantic web based education system. In the ontology-based approach the user personal data and requirements I stored in the form of ontologies. ontology is not a new term it is first explained by Studer (Staab et al., 2001) in 1998. After this ontology-based techniques are used to store the real world data computer understandable form. Due to this nature of ontology techniques Richards are proposing it to formulate the next generation education system, biology-based techniques it is easy to represent the knowledge in the computer readable form that will increase the interoperability of the education systems. In the next generation education systems, many different ontology based techniques are used; some of them are explained as follows (Rani et al., 2015):

- Top-level ontology is used to store general concepts like time and space.
- Midlevel ontology: This is analogous to the software libraries in OOP
- Task ontology: This is used to improve storage efficiency.
- Domain ontology: This analysis the interrelationship between different user requirements.
- Application ontology: This is create with the help of domain and task ontologies and their purpose is to provide different applications.

The semantic web-based education system is a relatively new topic, so there are not many survey papers available in this area. Author (Katagall et al., 2015) analysis concept mapping method for semantic web-based education system improvement. Concept mapping is a method in which time information of semantic web page education is painted in the form of a graph to be better understood by the computer system. The concept map technique is developed by Joseph D. Novak of Cornell University in 1970. The concept map represents the information in a more organized manner and presents knowledge efficiently. There are many advantages of using a semantical map and an instrumental web page education system, like improved thinking, easily discoverable themes, and more improved concepts based on the discussion. Apart from education systems (Chiou, 2008; Davies, 2011; Lammers & Brown, 2012; Tokdemir & Cagiltay, 2010), concept maps can be used in science subjects management courses (da Silva & de Castro, 2012; Kavitha et al., 2012; Kneissl & Bry, 2013), medical (Hanson et al., 2013; Mehdipanah et al., 2013; van Bon-Martens et al., 2014). In another survey paper author (J. Lin & Sekiguchi, 2020) examined the scientific techniques for e-learning and intrapreneurship education system. For the survey paper author examines 41 top most journal articles. However, the semantic web-based education system area has not been explored in depth. Therefore, in the survey we cover all the latest research areas and challenges for the semantic web-based education system.

2. ENHANCING SEMANTIC WEB-BASED EDUCATION SYSTEM

Prior to the introduction of digital technology, education systems relied on abstract methods of teaching and analysing student data; however, the way data is represented has been completely transformed in the last decade. Many scholars have proposed many models for classroom teaching, including any learning models that may be used to comprehend and learn from students' actions and reactions (Erduran & Duschl, 2004; Gilbert et al., 2000; Khine & Saleh, 2011). In this context, the author (Adúriz-Bravo, 2013) considers that data from semantic analytics or a symmetric perspective may be utilised for scientific teaching in the classroom or at any other level. A computational model for developing semantic web-based educational systems

This article (I. I. Bittencourt et al., 2009) discusses a semantic web-based education system in which artificial intelligence-based approaches are utilised to enhance the educational system. The primary goal of this system is to assist writers and programmers in developing an existing system that benefits both of them. According to the authors (I. I. Bittencourt et al., 2008; Brooks et al., 2006), with the advancement of machine learning and artificial intelligence methods, researchers are attempting to use them in the field of education (Ren et al., 2021)cloud. There are numerous areas in which this artificial intelligence technology may be applied (Do et al., 2021), but there are primarily two areas in which it cannot.

1) First and foremost, it is utilised to improve the amount of contact between students and teachers during an e-learning situation.
2) Second, it will be utilised to present the user with a personalised suggestion based on their specific requirements.

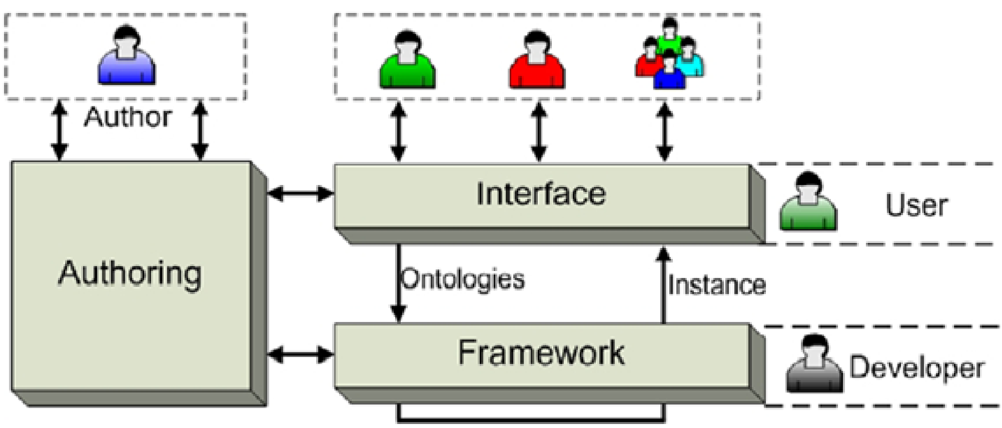
This kind of system is not difficult to design; yet, it has significant constraints, including interpretability and extendibility. As a result, academics are continuing their efforts to create a semantic web-based education system. The application of artificial intelligence and machine learning in education is a much better system that allows the user to choose a subject and converse about it on the fly (Norvig & Intelligence, 2002). In this context, the First AI base tuition system is developed by the author (Wenger, 2014), and it is very much improved from the traditional tuitions system; it will provide an expert domain model learning model and logical video models

1) The first module is the export module. It is AI base model which provides an expert solution to the problems of the user
2) The second module is the learner's module that helps the user to learn the new things
3) The third model is a petty add log ideological motor that helps to learn the next thing that it will collect the doc the steps in pedagogical order so the user can move to the next step very easily
4) and the final model is the communication model, it will help to maintain the interaction between different learners and different users

But all these features make the educational system very complex (de Barros Costa et al., 1998)

The author (Vouk et al., 1999) proposed a adaptive web-based educational system (AWBES). The suggested system is constantly evolving in response to the needs of the students, and it is primarily based on artificial intelligence and machine learning techniques. However, this system also addresses a number of issues and limitations (Brooks et al., 2006; Mizoguchi & Bourdeau, 2000; Rodrigues et al., 2005), including complexity, high development costs, difficulty integrating with the most recent tool, scalability, a lack of suitable metadata, and interoperability, among others. Recently, researchers proposed a Symantec web based education called "e-Mathema" system that is used to develop many e-learning platforms (I. Bittencourt et al., 2006, 2007; I. I. Bittencourt et al., 2009, 2009). This model has three layers (I. Bittencourt et al., 2008) as represented in Figure 2; each layer is explained below:

Figure 2. e-Mathema framework (I. I. Bittencourt et al., 2009)



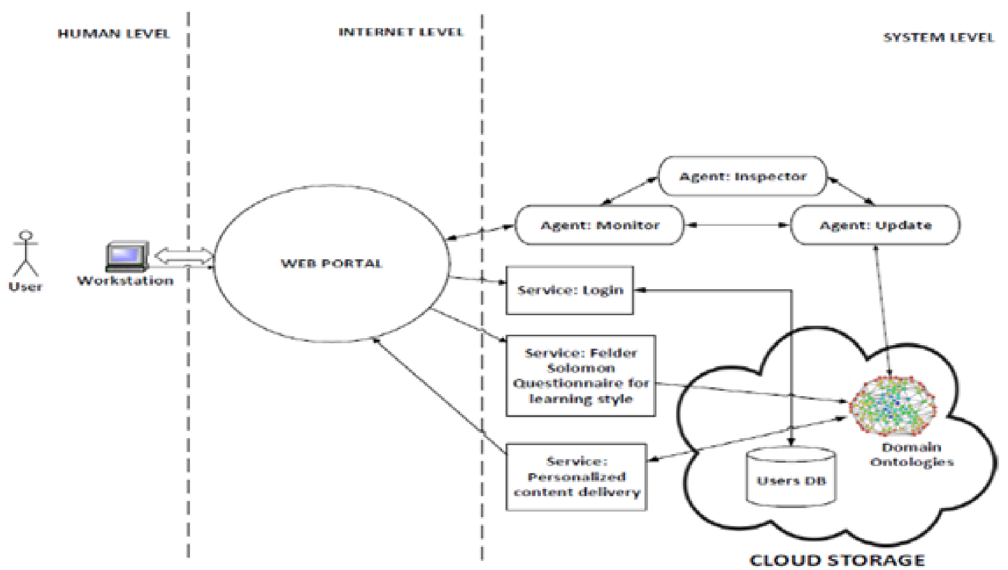
- Framework: it is a technical layer of the system that a developer controls. This layer is a special feature in the proposed system; it is controlled by different ontologies like mathema ontology, inference ontology, and interaction ontology.

- Interface: this is the second and most important layer of the system. in this layer user provides input in the form of his requirements in the form of personalized data.
- Authoring: this is the 3rd layer that uses ontology-based techniques to provide a user-friendly environment for the authors. The author input their requirement in this layer and the output is in the form of different ontologies through which system easily understand this requirements

In another paper (F. Lin et al., 2004), the author proposed a multi-agent base education system. Still, this approach has a limitation as there is no way to add new agents and their interpretability is limited. In this context, author in (Dietze et al., 2007) proposes a semantic adaptive education model. This education model is reusable and dynamic in learning; however, this system also has interpretability issues.

All the previous approaches used advanced techniques to improve the semantic web based education system. However, the author in (Rani et al., 2015) proposed ontology-based method for improving semantic web page education system, the proposed system is based on Felder-Silverman learning style (Graf et al., 2007) and finally ontology data is stored at the cloud server, as represented in Figure 3. Author uses digital ocean's remote cloud server to store the ontology based data, also the MySQL server for the query application is also running on the cloud server (Al-Qerem et al., 2020; Nguyen et al., 2021). Pause system WhatsApp efficiently without any 3rd party agent. A proper log file in maintain to analyse the use users personalise requirements (Felder & Spurlin, 2005).

Figure 3. Cloud based semantic web-based education system (Rani et al., 2015)



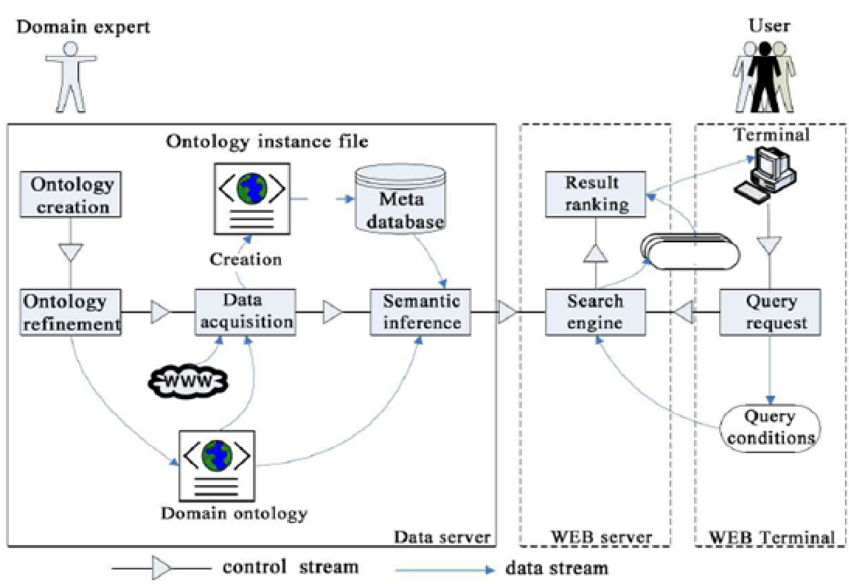
In the present cementing web based education system main requirement is that the user gets that material as per his requirement. the e learning system should be improved and learn according to the user preferences. By using ontology weather this problem can easily be solved. Using the ontology method, user data can be directly converted into machine readable format and the data prepared by the on tool on ontology based method can easily be shared. In the proposed approach, Felder-Silverman model and JADE agents collaborate to provide an ontology-based learning method that can improve and learn from the user.

Author (Gurcan & Cagiltay, 2019) proposed big database software engineering techniques when analysing the semantic data available for online education system. Big data is a technique that can be used to analyse the large amount of data efficiently (Assunção et al., 2015; Do et al., 2020; Kantardzic, 2011; Metzger, 2014). Software based big data techniques helps to analyse the data and through this time side of data can be easily extracted (H. Chen et al., 2012; X.-W. Chen & Lin, 2014; Metzger, 2014). However, there are many limit limitations of big data software techniques that has to be resolved before using it completely for semantic web page education system (K. M. Anderson, 2015; Garousi et al., 2016; Madhavji et al., 2015). One limitation how using big database software engineering technique is that it required large amount of understanding and professional knowledge (Bosch, 2015; De Mauro et al., 2018; Gardiner et al., 2018; Hu et al., 2014; Metzger, 2014; Miller, 2014; Moreno et al., 2012; Wu et al., 2015)

3. DATA EXTRACTION TECHNIQUE IN SEMANTIC-WEB BASED EDUCATION SYSTEM

While there is an abundance of data and information available on the Internet in this digital era (Tewari & Gupta, 2020), it is challenging to add and extract that information according to our requirements because the traditional methods for extracting information based on keywords and end title titles do not apply to online sources. As a result, the development of data extraction methods for semantic web-based education is necessary. In this context, author (Jiang, 2019) proposed the method for the improvement of the performance of the network education. In the proposed approach authors of this article attempt to design a seven-step ontology-based data extraction approach for a semantic education system, as represented in Figure 4.

Figure 4. Semantic data extraction method (Jiang, 2019)

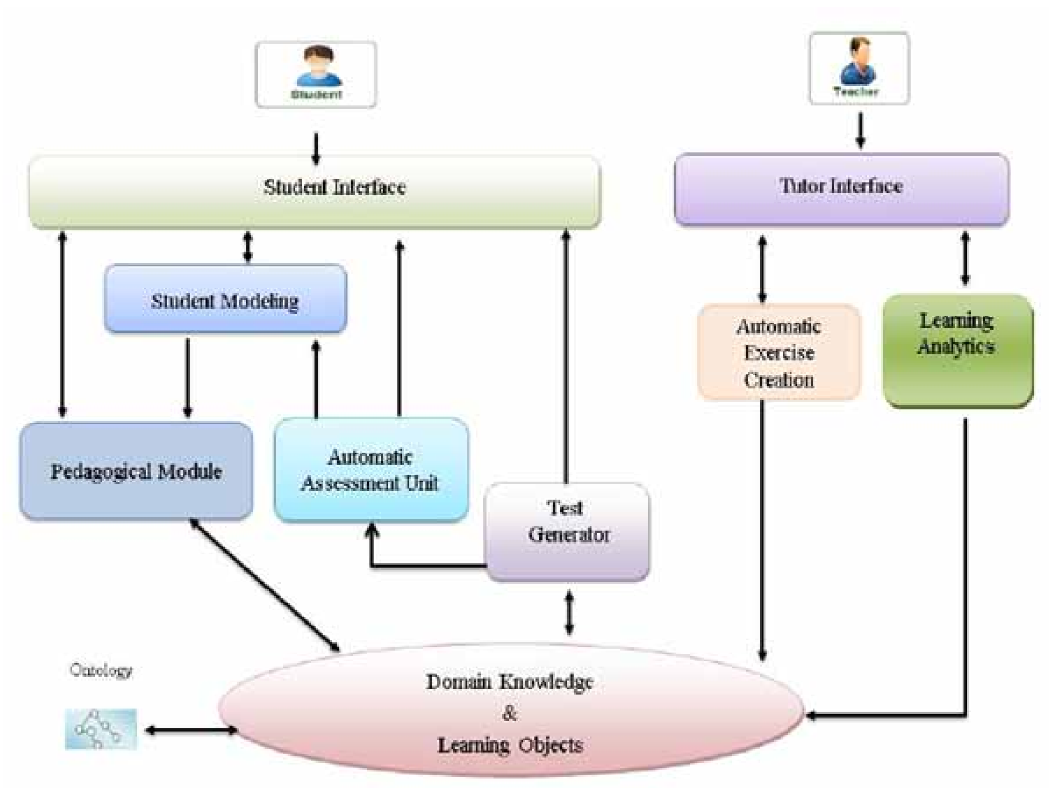


That additional ontology-based information detection system has many limitations like it cannot differentiate between the same similar queries. Overcome this issue author proposal latest framework that is based on reasoning ontology and semantic query processing.

3.1 Analysis of User Profiles in the Semantic Web-Based Education System

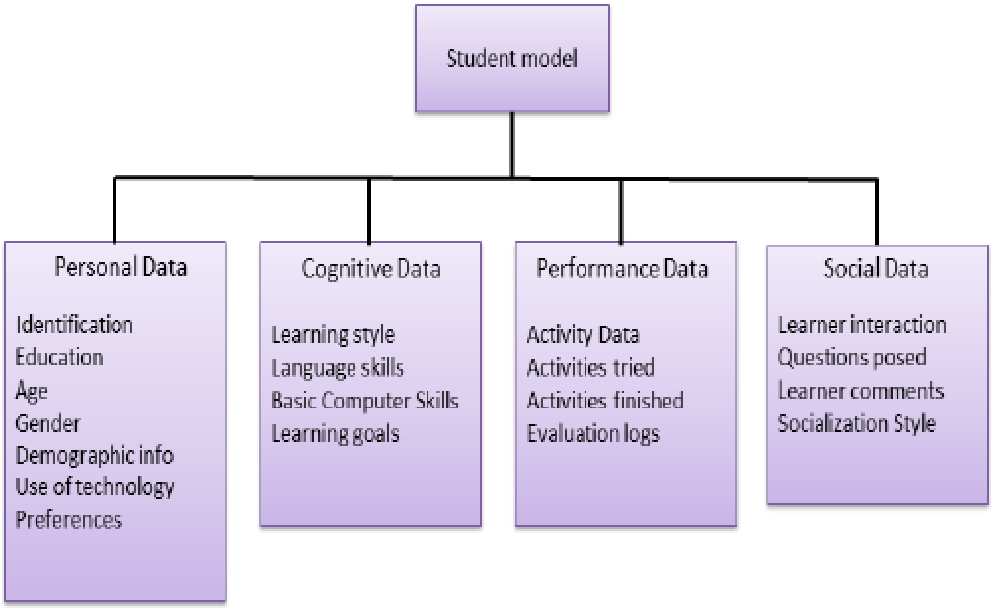
Intelligent e-learning services systems are essential for today's generation because, as a result of the pandemic, most schools have been closed, and students are now learning from computers through the use of e-learning systems. As a result, there is a pressing need for the development of an intelligent learning system that will analyse the user and provide the information according to the user's needs. Advance semantic models were suggested by the researchers, which aid in accepting the user into information and assisting in the development of a new curriculum tailored to the needs of users. In this context, the author (Grivokostopoulou et al., 2019) proposes an ontology-based method for selecting and analyzing the user profile in a web-based education system, as represented in Figure 5.

Figure 5. Proposed architecture of semantic web-based education system (Grivokostopoulou et al., 2019)



The student modeling approach is the basic building block of this approach, as represented in Figure 6. In the student modeling approach, the education system becomes adaptive and gain information about the students and change according to it(Folsom-Kovarik et al., 2010).

Figure 6. Student model system (Grivokostopoulou et al., 2019)



Boolean-based method is one of the types of student modeling system. in this system for every student experience, we get an answer in the form of yes or no (Chrysafiadi & Virvou, 2013). Another method is a studio type method that is based on clustering in this method users are grouped according to different cluster based on their characters and characteristics and requirement; each group is called a stereotype. every new user is assigned to a specific stereotype according to his needs. Some researchers propose a new method called Buggy model. in the buggy model the most frequent error and mistakes of the of the user is record and the system is improve according to that. Main aim of this model is to detect the bug in the semantic web based education system and improve it efficiently (Brusilovsky & Millán, 2007). The author proposed an ontology-based user experiment improvement in the web-based semantic education system. The proposed approach helps the education system to develop new curriculum and syllabus according to the user requirements. Due to the latest digital technology there is a rapid development in the learning technology also pro from e-learning 1.0 to e-learning 3.0 in in this time (Adil & Lahcen, 2017). E-learning 1.0 model all the study material is created and stored at the cloud services (Manasrah et al., 2019) server for the students. In e-learning 2.0 model students can interact with learning model and provide there feedback to it (Adil & Lahcen, 2017). In e-learning 3.0 model, users get the personalized learning in which thing as per their preference they get the study material.

Recently, lots of work has been done in the e-learning 3.0 model to provide better user interaction and performance for the students. Researchers provide different types of methods like ontology-based methods or AI-based methods for providing better experience to the students (Brusilovsky & Millán, 2007; Chrysafiadi & Virvou, 2013; Felder & Silverman, 1988). Researchers are trying to improve the classical instruction-based system to interact in a more effective way through the user. In this context, the author (Folsom-Kovarik et al., 2010; Maria et al., 2007) proposes an anthology-based method to improve the limitations of the intersection-based system. Some researchers are trying to develop an ontology based system based on the meta data (Gong, 2014; Grivokostopoulou et al., 2014). In the ontology basis system, a researcher is trying to improve the learning material and the course syllabus so that the interaction between the teachers and students will increase. However, classical methods for preparation of syllabus in the e-learning models are not effective in the present scenario (M. Chang et al., 2011; Grivokostopoulou et al., 2017).

3.2 Future Challenges for Semantic Web-based Education System

In this study, we discuss several applications of the semantic web in relation to the evolution of the educational system. However, it is challenging to employ semantic web in the construction of large-scale education systems since semantic web is still in its infancy and hence has several limits and obstacles when used for the development of web-based education systems. The requirement for a semantic web page education system is that anyone can learn from any location and that education systems become adaptive; however, this requires a significant amount of resources and bandwidth from the WWW. In a semantic web page education system, user and e-learning performance improves in accordance with the requirements. This educational system should include adaptable metadata representation and software that is capable of evolving in response to user needs. In today's world, users often acquire knowledge from several sources; hence, there is a need for the creation of universal standards that are relevant to all online resources and facilitate the learning experience of users (I. I. Bittencourt et al., 2008).

4. CONCLUSION

Recent years have seen increased interest in semantic web-based technologies from business and academia. We can employ semantic web-based strategies to make a system more intelligent and user-friendly. Richards is proposing to use semantic web approaches to construct next-generation education platforms as a result of their excellence. Due to the incorporation of semantic approaches, educational systems have grown more adaptable to user requirements and provide a more personalised experience to students. The storage and collaboration capacity of an e-learning platform are boosted as a result of semantic technology.

We analyse some of the semantic web-based education tools and strategies presented by scholars for strengthening the educational system in this survey article. Additionally, we discuss many research problems in the area of semantic web-based education. Finally, we may conclude that symmetric technology strengthens the educational system and can be utilised to create the future generation of educational systems.

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