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DEVELOPING AN ONTOLOGY FOR RETRIEVING MASSIVE OPEN ONLINE COURSES (MOOCS) INFORMATION IN COURSERA PLATFORM

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ABSTRACT

With the exponential proliferation of Massive Open Online Courses (MOOCs), online learners face difficulties in finding and highlighting relevant course contents. This makes learners to lose their motivation and surrender the learning process. For solving the issue and enhancing MOOCs resource utilization, Semantic web technology has the potential to play an important role by adding semantic annotation to the MOOCs resources for helping learners to access appropriate MOOCs pretty quickly according to their wishes. Furthermore, Ontology helps to shares a common understanding of the structure about any domain of interest amongst people and software agents. This paper presents Ontology for MOOCs Courses domain in the Coursera platform to retrieve the educational resources pretty quickly based on learners' request.

KEYWORDS: Semantic web, Ontology, MOOCs courses, Coursera platform.
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1. INTRODUCTION

In recent years, Massive Open Online Courses (MOOCs) have become the most prominent feature of higher education in several developed countries. It has offered a wide range of high-quality online courses to the maximum number of students and teachers who lives around the world at any time and without obstacles (Christensen et al., 2013).

These online courses generated an important revolution in the teaching and the learning process by supporting different essential activities such as Interaction and cooperation among learners. With the rapid growth of MOOCs, an enormous collection of courses on various subjects can be available in the form of video on website. So these courses exposed various challenges to the online learners, especially the issue that related to find relevant MOOCs course. Besides, the process of retrieving or gathering information from a large number of courses has become a cumbersome task. This may affect on motivation of learners and surrender the online learning process in the coming days.

Thereby, for addressing challenges, it seems that a Semantic Web technology has the potential to play an important role in overcoming the huge amount of online courses with high scalability and availability. Semantic Web is an extension of the current Web which provides metadata to web content and make it understandable to both humans and machines (Berners-lee, Hendler, & Lassila, 2002). Furthermore, Ontologies are core components of the semantic web and considered as the backbone of the semantic web. Ontology is used to capture knowledge of specific domain along with the aim of sharing common understanding of the structure of information among people or software agents (Gruber, 1993).

This paper presents ontology based MOOCs in Coursera platform that enables learners to find appropriate courses and navigate through the learning contents smoothly. It also shows the steps of the Ontology development process of MOOCs courses by defining the class and subclasses of the domain and then arrange them in a taxonomic hierarchy. Then, it creates properties for each class including the relationships among them. After that, it defines some individuals (instances) in order to make queries. Finally, when The Ontology has been completed, it is sent to the Reasoner to check the consistency of the whole ontology and inferred the classes hierarchy.

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The remainder of this paper is organized as follows. Section II describes the related work. Section III shows the process of Development of MOOCs courses in Coursera Platform. Finally, conclusions and future work are provided in Section IV.

2. RELATED WORK

Semantic technologies premised on machine understandable format used for describing objects, sharing and interlinking of structured data on the web. Semantic technologies are widely used in various disciplines such as E-tourism(Ruiz-Martınez, J. M., Minarro-Giménez, J. A., Castellanos-Nieves, Garcıa-Sánchez, F., & Valencia-Garcia, 2011) , E-Commerce (La Paz, Ramaprasad, Syn, & Vasquez, 2015),Crisis response situations (Bannour, Maalel, & Ghezala, 2019) and so on. Besides, Semantic technologies has the potential to play a significant role in enhancing teaching process and learning experience in Higher Education (HE). This ability can be done based on the prospective of semantic technologies to provide explicit meaning and give semantic annotations for learning and teaching resources, as well as learning objectives. So, with the help of ontologies and annotation, learners and teachers can discover learning and teaching resources, beside their objectives in an efficient way. Today, Ontologies have become an essential part of many large applications. One of the most common goals in developing the ontologies is to share common understanding of the structure of information among people or software agents. Despite the fact that ontologies exist for many subject domains, yet their quality for the educational aspect might be ambiguous.

This section presents briefly the most relevant works to our proposed ontology. For example, many ontology developers have created ontology for their own university by describing their university structures such as (Naser, Atallah, & Hamo, 2015) and (Jacksi, 2019). Furthermore, the research of (El-ghalayini, 2011) and (Tulasi, Rao, & Gouda, 2013) have created ontology for e-learning concept. It discusses the e- learning concepts in general and determines how classes are correlated to each other.

Moreover, According to (Elfadiel & Ibrahim, 2015) ontology has been developed for open online learning in Moodle domain which is a free open-source learning management system(Brandl, 2005). Another example of using semantics is SlideWiki system (Khalili, Auer, Tarasowa, & Ermilov, 2012) which is an educational platform works with presentations and assessment tests. Besides, The ECOLE system deals with sharing and exchanging educational content among different universities and institutions (Mouromtsev, Kozlov, Kovriguina, & Parkhimovich, 2015).

Lately, the phenomenon of Massive Open Online Courses (MOOCs) is growing rapidly due to having a large number of online learning resources on various subjects and the growing number of learners to access collaboration tools, educational resources and online repositories in 24/7 at the top universities of the world. For this reason, a group of ontology developer have created ontology for open online learning. According to research of (Volchek, Romanov, & Mouromtsev, 2017) have developed ontology for open edx platform . Since different groups of developers create ontology for open online learning. However, there are always some concepts missing and relationship of even classes are different. In this paper, we create ontology for retrieving data in open online learning (MOOCS) in Coursera Platform domain which provides semantic annotations for learning and teaching resources, as well as learning objectives. This will help learner to access, share and exchange learning tools and objectives in an efficient and flexible way. Moreover, with help of these technologies Information contained in such courses can be better structured and linked.

Due to the following facts the Coursera platform is chosen as a case study of our ontology such as (Coursera, 2019):

- It is open.
- The number of participants enrolling in Coursera Platform has been increased. Coursera platform that has been launched in 2012 exceeded 10 million users in 2014 and it has reached approximately 40 million users in 2019.
- On Coursera platform you can find a massive collection of online courses, specializations, certificates and degrees from top universities and institutions.

3. ONTOLOGY DEVELOPMENT PROCESS FOR MASSIVE OPEN ONLINE COURSES (MOOCS) IN COURSERA PLATFORM

Constructing the ontology structure for e-learning MOOCs covers the following main steps. First, it is a data collection. Next, it determines tools and techniques for building ontology. Then, constructing ontology structure phases have to be defined. Later, the visualization of ontology will be displayed in a graphical manner. Finally, results and discussions of the ontology development process will be presented.

3.1 Data Collection

The data for e-learning ontology structure have been collected from Open Online Courses (MOOCs) in Coursera Platforms. This is done by registering to Coursera Platforms website and make an account to become participant. Then, I search for all their courses contents and find out the needed information for MOOCs ontology. Moreover, all activities inside this platform can be considered as a class for ontology structure such as student, teacher, subject, course materials and so on.

3.2 Tools and Techniques

Several tools and techniques have been used for developing the ontology structure of MOOC. Protégé (version 5.5.0) editor is free and open source ontology editor developed at Stanford University. It is considered the most common building tool used for implementing the ontology today. This editor can allow users to visually create, edit and save ontology in different formats (Protégé, 2019). Then, the Web Ontology Language (OWL) is recognized as the most popular languages for defining and describing classes, subclasses and object properties and datatype properties. Moreover, it provides further characteristics such as cardinality, equivalent, disjoint classes and object property characteristics like transitive, functional and symmetric and so on (McGuinness & Van Harmelen, 2004). Next, to ensure that the ontology used in this work is consistent, Hermit(Glimm, Horrocks, Motik, Stoilos, & Wang, 2014) and Pallet(Sirin, Parsia, Grau, Kalyanpur, & Katz, 2007) Resoner have been used, and are plugin in Protégé editor. In the last stage, SPARQL query is used to query meaningful information over the ontology (Kollia, Glimm, & Horrocks, 2011).

3.3 Building MOOCs Ontology Structure

This section represents the main stages that contribute to develop MOOCs Courses ontology process (Noy & McGuinness, 2001), as listed in figure 1:

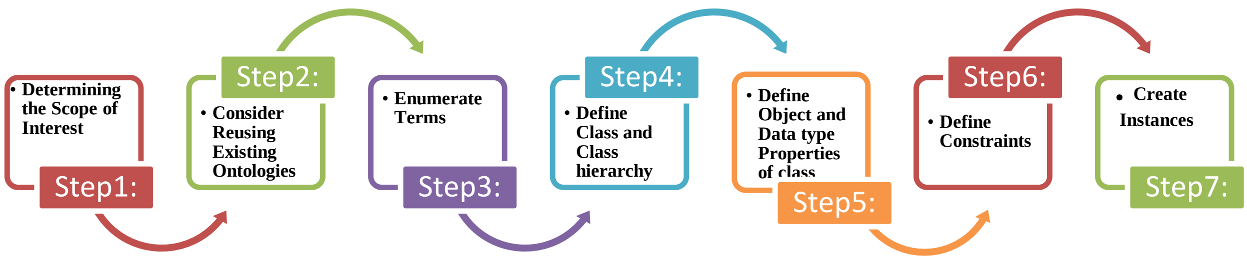

Fig. (1): Ontology Development Process**.**

Step1: Determine Ontology's scope and domain

In this study, the scope of ontology is a MOOC's Courses in courser platform domain, and the learner and educator can be considered as the main users of ontology. Therefore, the objectives of the proposed ontology are overcoming semantic interoperability problem and improving interaction and communication between several open online MOOC courses platforms. In addition to that, this ontology is used as a mechanism for sharing a common understanding of the specific domain amongst people and software agents. For specifying the scope of the ontology, it necessary to list a set of competency questions and the information in the ontology should provide answers.

Hence, the following competency questions are:

- Who are the MOOC users?
- Who is responsible for accepting and publishing the courses online?
- Who has a right to create and manage the courses?
- How many Students are talking Java Course?
- Who is teaching **Web of Data** Subject?
- What types of collaboration can MOOC Courses offer to the student?
- What types of Assessments are available in MOOCs Courses?

Step2: Consider reusing existing ontologies

In this step of ontology development process, checking for existing ontologies is necessary in order to know if someone else has already done it in this particular domain or not. If yes, then it is possible to extend and enhance it. Anyway, this step will be required when a system needs to interact with other applications (Noy & McGuinness, 2001). As a result, the ontology will be built from scratch in this work.

Step3: Enumerate important terms in the ontology

It is important to capture the relevant concepts that are related to the domain of interest and define: 'what are relationships exiting?'' What would we like to say about those concepts?'.

The most important concepts of MOOC courses will be included several keys such as: MOOC Courses, Users, Collaboration, Course Materials, Course description, teaches, studies, and studied by and so forth.

Step4: Define the classes and the class hierarchy

A class is a concept in the domain. In this step, the ontology development process is included by defining the concepts in the ontology and then organizing these concepts in a taxonomic hierarchy (subclass–superclass), as shown in Figure 2.

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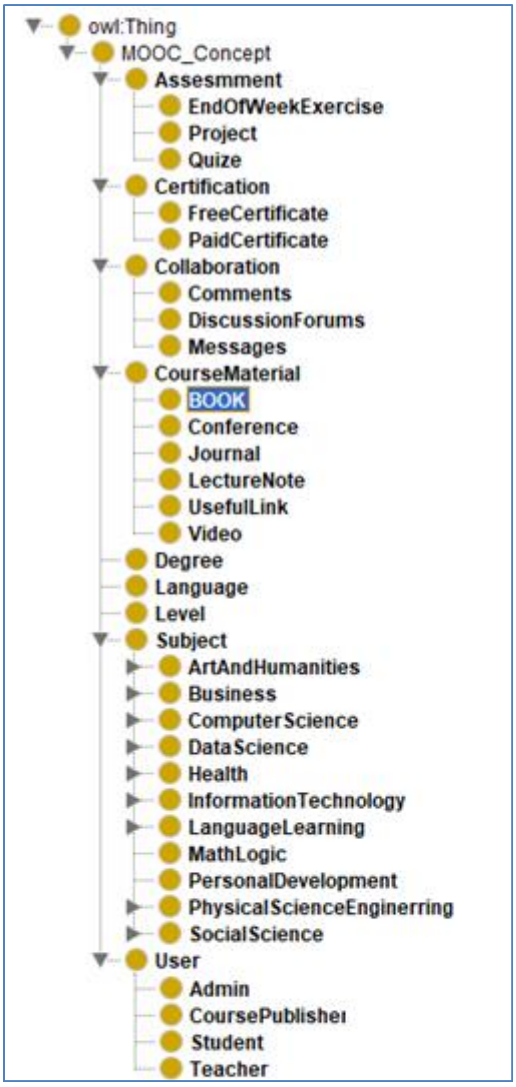

Fig. (2): Create class Hierarchy for MOOCs Courses ontology by using Protégé Editor

Step5: Define properties of the ontology

There are two types of properties: **Object properties** and **Data type properties**. Object properties define the relationship among classes, as illustrated in Figure 3. Meanwhile, Data type properties describe relationships between instances and data values such as string and integer, as illustrated in Figure 4.

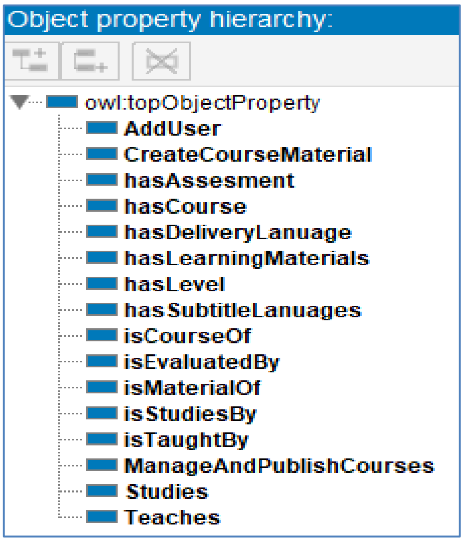

Fig. (3): Define the Object Properties

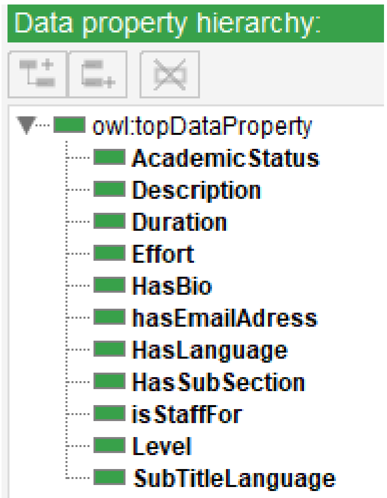

Fig. (4): Define the Data type Properties

Step6: Define constraints

Property constraints (facets) describe or limit the set of possible values for a property. For example: A student is equivalent to the class who has at least one Course. Turtle Syntax Style:

```
:Student rdf:type owl:Class ;
        owl:equivalentClass [ rdf:type owl:Restriction ;
                              owl:onProperty :hasCourse ;
                              owl:minQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
                              owl:onClass :Subject
                            ] ;
        rdfs:subClassOf :User .
```

Fig. (5): Define Min cardinality constraint in Turtle Syntax

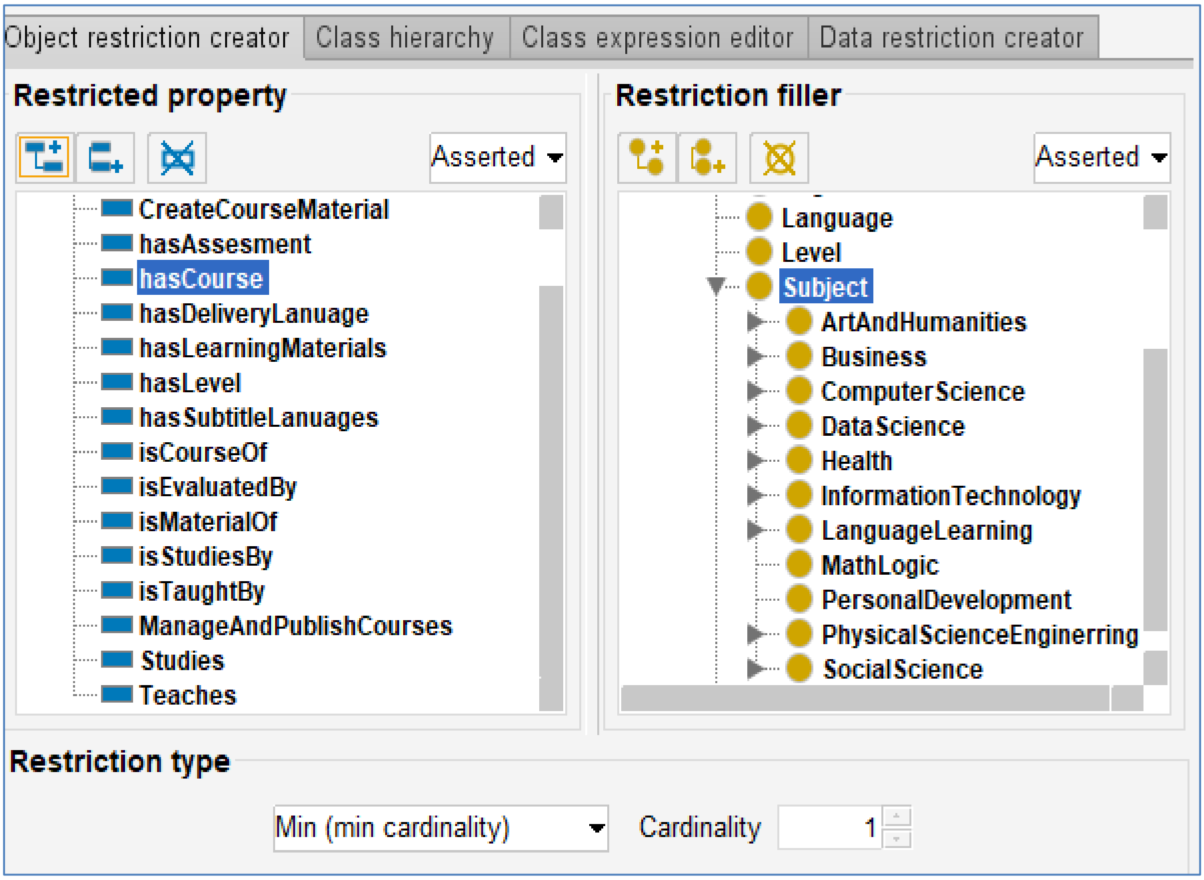

Fig. (6): Define Min cardinality constraint

Step7: Create individuals of ontology

The main goal of this step is to define an instance of the class. At the beginning, the right class should be selected, and then create its instances for the class. One instance can belong to many classes or many classes belong to the same individuals that have been defined. After that, Object properties and Data properties for each individuals should be defined, as described in Figure 7.

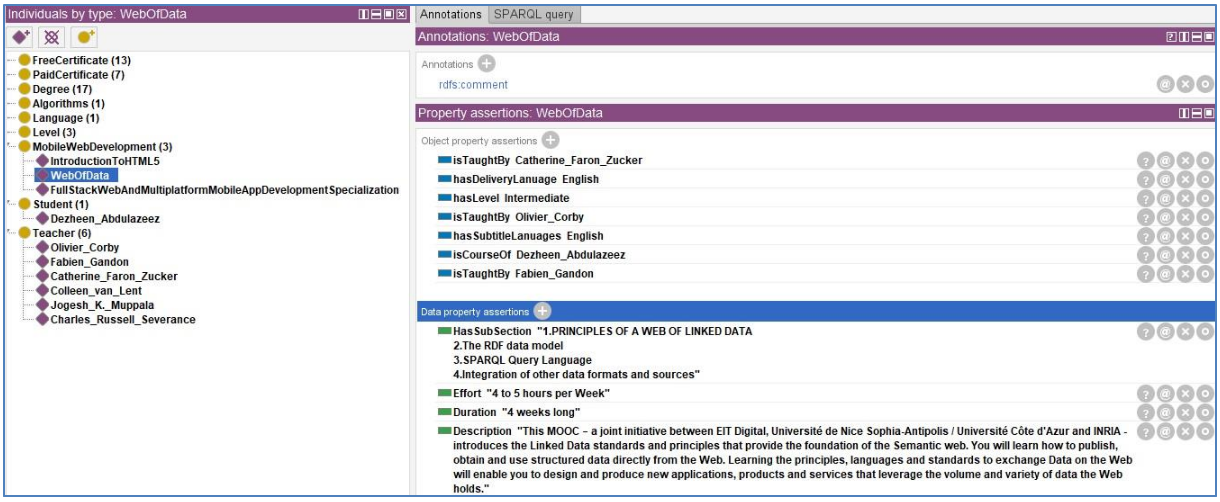

Fig. (7): Define individuals of the classes

3.4 Visualization View of the Ontology

In this section, a visualization result of MOOCs Ontology is viewed through OWLViz Protégé plugin. It declares "is-a" relationships among classes in a graphical manner (Horridge, 2019), as Figure 8,9,10 and 11.

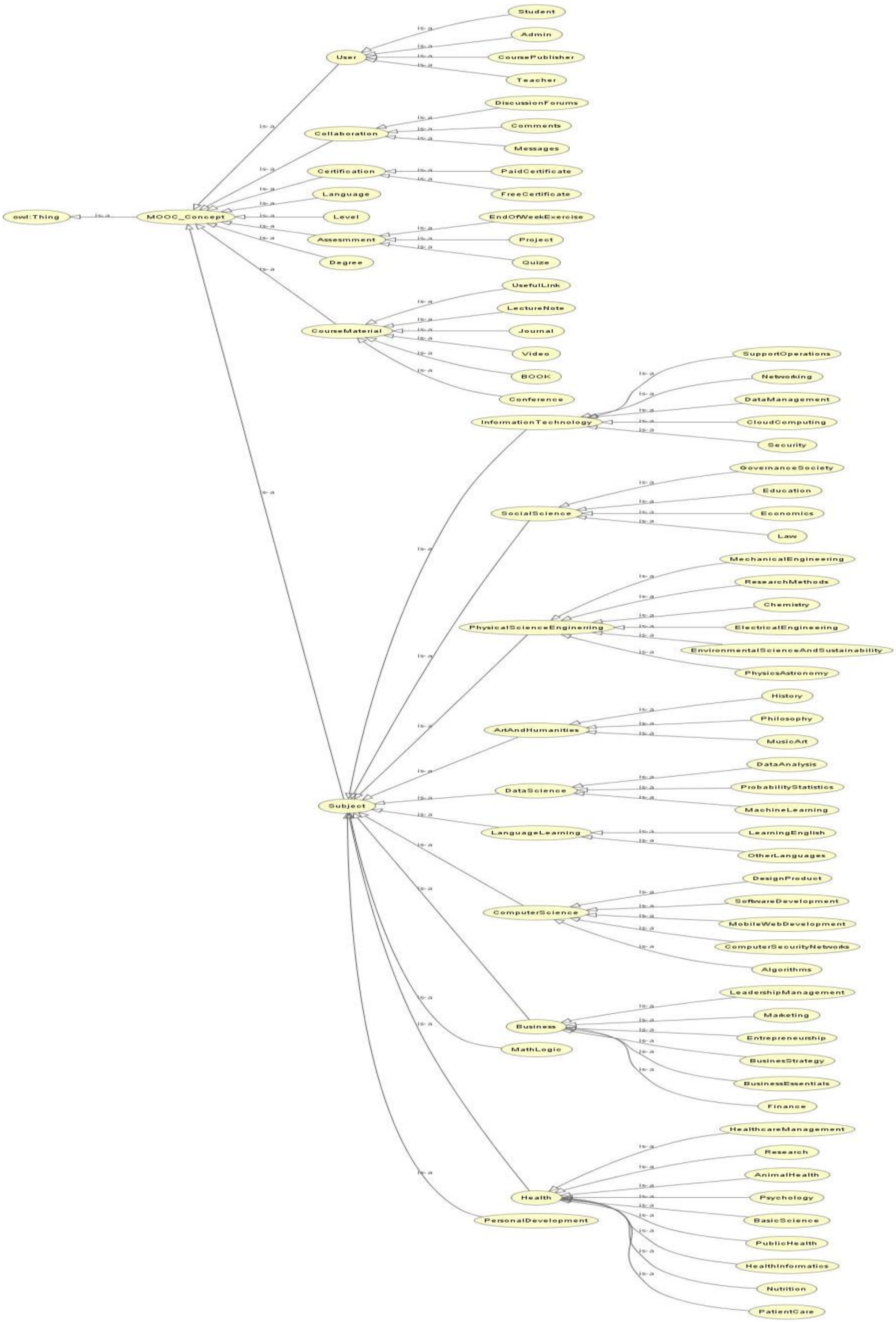

Fig. (8): Ontology Visualization using OWLViz

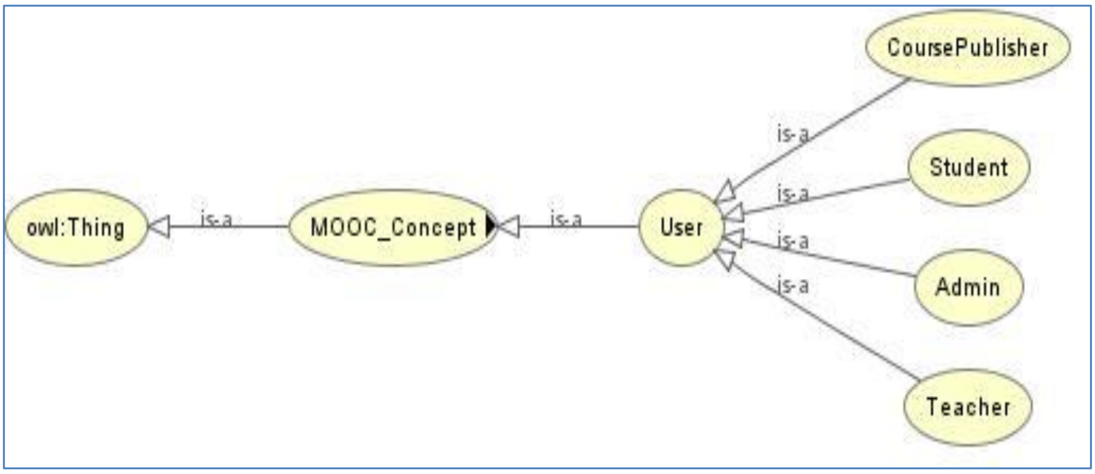

Fig. (9): Asserted Model for Users

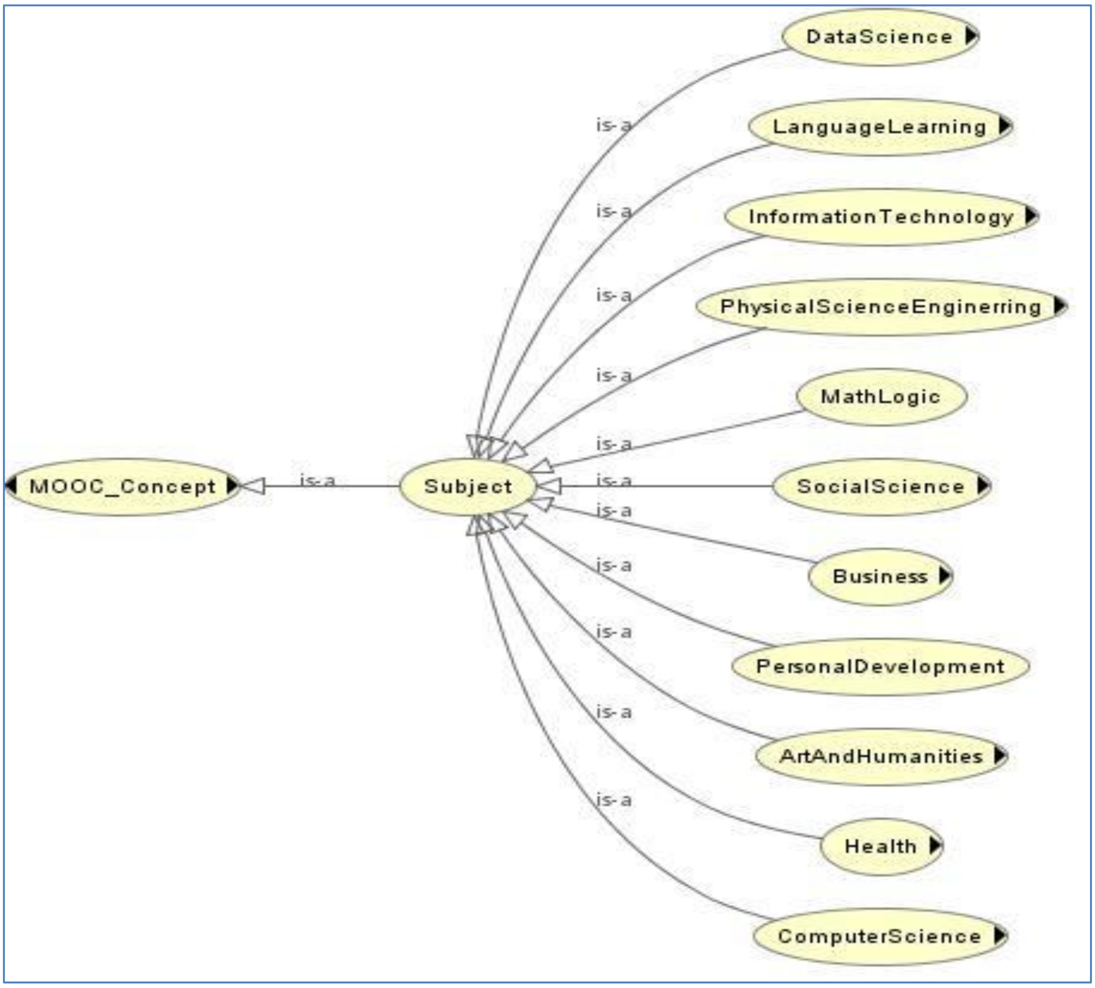

Fig. (10): Asserted Model for Subjects

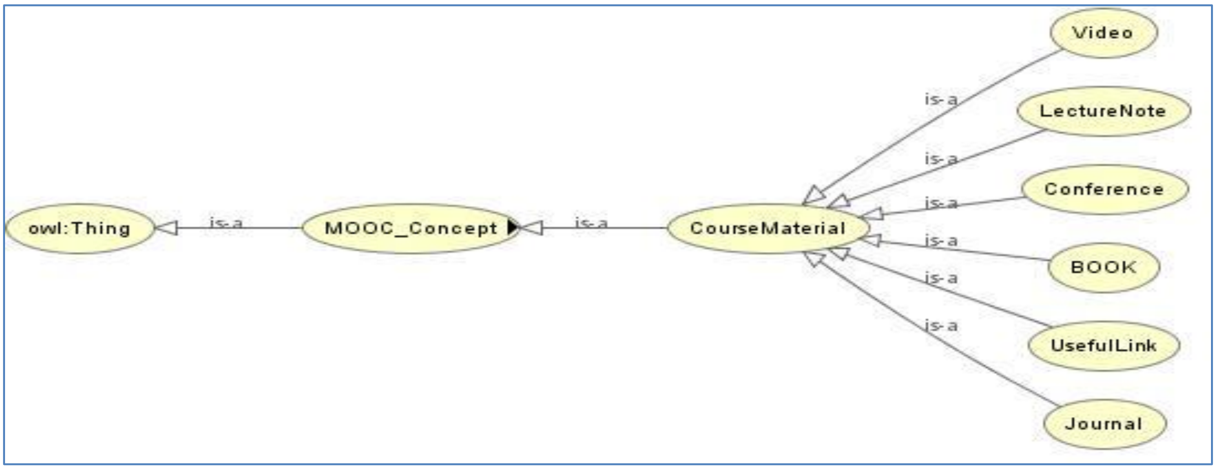

Fig. (11): Asserted Model for Couse Materials

3.5 Results and Discussions

After the ontology design is finished, it must be verified that the ontology has been built correctly. That is, all the classes are consistent and well defined as well. Therefore, it should be verified and validated the ontology in the matter of following different features:

• **Ontology consistency:** Checking the correctness of the MOOCs ontology. It should have been validated in terms of consistency and semantic correction by using standard reasoner tools such as Hermit [(Glimm et al., 2014)] or Pellet (Sirin et al., 2007) which are supported by Protégé editor (Protégé, 2019), as Figure 12 and 13.

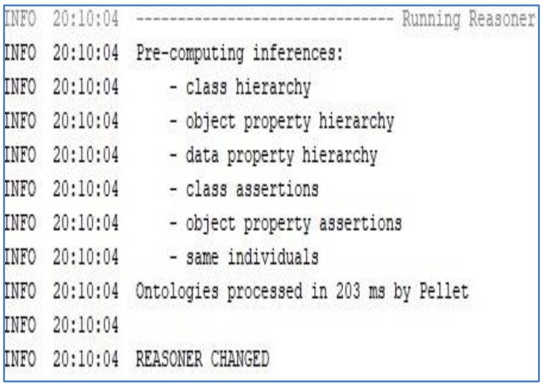

Fig. (12): Pallet Reasoner

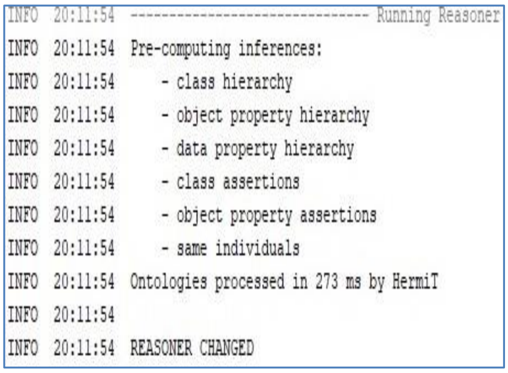

Fig. (13): Hermit Reasoner

• **Answering competency questions:** Verifying knowledge based on the ontology has to answer all the competency questions that we have defined and determine in the domain and scope of the ontology stage. This test is done by using SPARQL Query. SPARQL stands for SPARQL Protocol and RDF Query Language which is a query language designed to access meaningful information on the ontology (Kollia et al., 2011). For instance, CQ1:" Who is teaching **Web of Data** Subject?". Testing and Results of this competency questions is shown in Figure 14.

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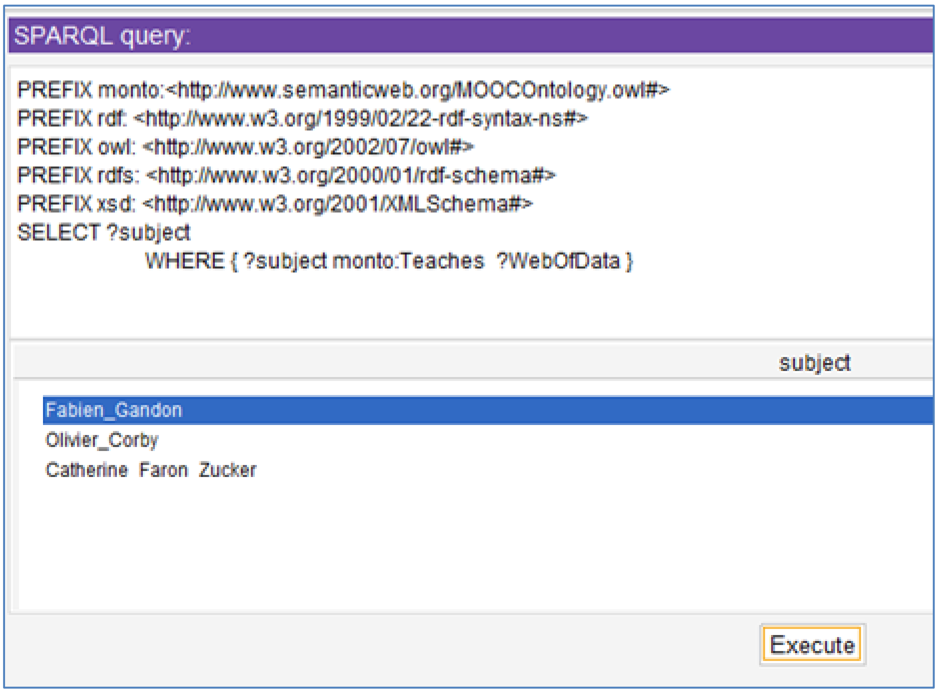

Fig. (14): Testing and results of competency questions using SPARQL Query

4. CONCLUSIONS

This paper reveals that ontology has an important role to overcome the challenge of having a large number of online courses. This aids to enhance learning and teaching process by defining common vocabulary, sharing and reusing among people and machine. Then, it presents the process of constructing MOOC Courses Ontology structure. It starts by creating the classes, object properties , datatype properties, defining some instances to be able to make queries and define constraints on the properties such as: cardinality constraints, domain and range constraints. In the last phase, we have ensured that our ontology has successfully created by using reasoning of Harmit and Pellet reasoner to check the consistency of the classes and generate inferred class hierarchy. Finally, OWLViz Protégé plugin has used to visualize the ontology structure and to show the clear picture of all relationship among the classes. This ontology structure will bring a significant advantage to the future improvement of e-learning system.

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