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ONTOLOGY REASONING USING SPARQL QUERY: A CASE STUDY OF E-LEARNING USAGE

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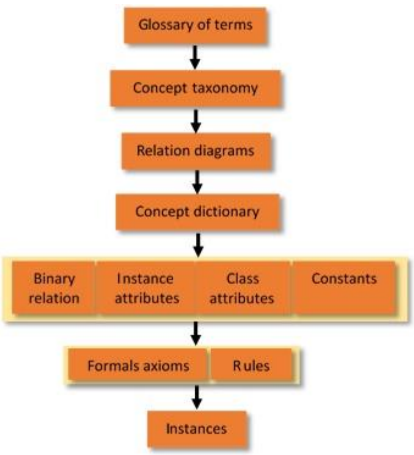
Graphical abstract



Abstract

The involvement of learning pedagogy towards implementation of e-learning contribute to the additional values, and it is assign as a benchmark when the investigation and evaluation will carry out. The results obtained later believed would be fit to the domain problem.The results might provide instructional theories including recommendation after reasoning that can be used to improve the quality of teaching and learning in the virtual classroom. Ontology as formal conceptualization has been chosen as research methodology. Ontology conceptualization helps to illustrate the e-learning usage including activities and actions, likewise learning pedagogy in the form of concepts, class, relationships and instances. The ontology constructed in this paper is used in conjunction with the SPARQL rules, which are designed to test the reasoning ability of ontology. Reasoning results should be able to describe the knowledge contained in ontology, as well the facts on it. The SPARQL rules contains triplets to verify if the students are actively engaged in a meaningful way towards e-learning usage. The backward engine is optimized to store the facts obtained from queries. Development of ontology knowledge based and reasoning rules with SPARQL queries allow to contribute a sustainable competitive advantages regarding the e-learning utilization. Eventually, this research produced a learning ontology with reasoning capability to get meaningful information.

Keywords: *ontology, SPARQL query, ontology reasoning, knowledge representation, e-learning activities and actions.*

Abstrak

Penglibatan pedagogi pembelajaran ke arah pelaksanaan e-pembelajaran menyumbang kepada nilai-nilai tambahan, dan ia sebagai penanda arasapabila penyiasatan dan penilaian akan dijalankan. Keputusan yang diperolehi kemudian dipercayai akan cergas kepada domain masalah yang berkaitan. Keputusan mungkinakan menyumbangkan teori pengajaran termasuk cadangan-cadangan yang boleh digunakan untuk meningkatkan kualiti pengajaran dan pembelajaran di dalam bilik maya. Ontologi sebagai konsep formal telah dipilih sebagai kaedah penelitian ini. Ontologi berbasis konsep membantu untuk menggambarkan penggunaan e-pembelajaran termasuk aktiviti dan tindakan, sebaik juga pedagogi pembelajaran ke dalam bentuk konsep, kelas, hubungan dan keadaan. Ontologi yang dibina dalam pembentangan ini digunakan bersamaan dengan kaedah-kaedah SPARQL, yang direka untuk menguji keupayaan penalaran daripada ontologi. Keputusan penalaran harus dapat menjelaskan pengetahuan yang terkandung dalam ontologi, serta fakta-fakta di atasnya. Peraturan SPARQL mengandungi triplet untuk mengesahkanjika pelajar terlibat secara aktif dengan cara yang bermakna terhadap penggunaan e-pembelajaran. Enjin penyokong dioptimumkan untuk menyimpan fakta-fakta yang diperolehi daripada peraturan yang dibuat. Pada akhirnya, perkembangan ilmu ontologi berasaskan pengetahuan dan penalaran menggunakan SPARQL membenarkan untuk member sumbangan kepada kelebihan daya saing yang mampan mengenai penggunaan e-pembelajaran. Akhirnya, kajian ini menghasilkan ontology pembelajaran yang mempunyai keupayaan untuk reasoning guna mendapatkan maklumat yang bermakna.

Katakunci: *ontologi, SPARQL query, penalaranontologi, representasi pengetahuan, aktiviti dan aksi e-pembelajaran.*

1.0 INTRODUCTION

E-learning is trusted to replace classroom learning [1]. It brings a huge recognition for higher institution and become vital to provide e-learning as a tool to deliver learning materials or to support synchronous and asynchronous communication between lecturer and students or among students. Recent tool known as Learning Management System (LMS) have been presenting to handling the large number of educational data, and this is running the important role in e-learning environments [2]. It provides convenience for lecturer to organize learning materials and provide easiness for students to access. In spite of advantages of e-learning systems and LMSs, it brings unsolved issue. Lecturer cannot guarantee the students' performance in their virtual learning. The different circumstances shown when they are in the classroom, lecturer is able to openly observe the students' performance and behavior.

For the negative case, lecturer might encourage students to be more active and engage students' participation in the class discussion or group works. Lecturer also might create paper based report for students' activity grades. But, what will happens in the virtual learning? Lecturer composed the activities in the online course such that resource, forum, assignment, quiz, wiki, blog, chat, or survey. By this availability, students are able to interact with lecturer and among students. They are also able to access learning material uploaded by lecturer. When they log in and performed activities in the e-learning they are creating educational data. The educational data is in terms of their activities and actions history. For example, one student log in into e-learning and access to the resource page, he is later downloading certain lecture material. By this time, he is generating his online activity history called as a 'resource download', resource is for activity information and download is for action information. Lecturer is able to see the history of activities and actions have been done by students. This history stored in a file called as a log file and this file contains huge data about the virtual learning usage. However, the log file is merely created for human consumption, because this is human-readable file. This educational data can be used for analysis to investigate students' behavior during their virtual learning. Along with the growth of e-learning existence, it is necessary to conduct this analysis to define the facts about student's capability such that the knowledge gained [3]. Recent scholars had been done the analysis on e-learning domain for different purposes using diverse methodologies. Yet, the majority was observed the student learning data, the result obtained such that the availability tools to search learning materials based on students need. Nevertheless, the need of tools to analyze students' behavior is become viral. It allow lecturer to define learning pattern and interactions among students, as early warning for the case of 'risk' students [4], and to provide dynamically changing for lecturer in term of teaching strategy [2]. The semantic ontology approach has been presenting to overcome these needs, it define the e-learning log file in the form of class, instance, relationship, data object, and data type. It allow log file transform into machine-readable file, for instances it brings convenience way to develop automatic tool to analyze learning pattern and interactions of e-learners.

2.0 RELATED WORKS

Knowledge representation (KR) ontology engage several things on ontology conceptualization to formalize knowledge [5]. Some of the benefits by applying ontologies is able to represent knowledge which is usable in computer applications; permit sharing knowledge among several computers; assist humans to enhance the understanding and associating of knowledge area [6]. The use of ontology in e-learning system can have a role: to explain semantic level of e-learning system and define the context of e-learning usage based on knowledge representation.

Ontology in e-learning system can interpret the learning process by linking learning pedagogy in the form of relevant knowledge. In the online learning environment, various activities and actions are provided to promote learning interactions. Since that, the interactivity is one of the criteria or indicators to show the quality of online learning [7]. Interaction with e-learning implies the communication between user and system. Based on the capability of ontology, previous works were established to develop educational mining tools as stated in Table 1. Recent works have not been applied the learning pedagogy to ensure the analysis results fit to the domain problem. Moreover, the analysis were obtained by investigate in the activity usage level. Therefore, in this research the continuous investigation is proposing to construct the ontology model for e-learning activities and actions. Subsequently, the adoptions of meaningful learning pedagogy have been chosen as a benchmark for analysis phases.

Table 1 Studies using Ontology on E-learning Framework

Author (s)	Title	Component of E-learning/ Ontology Case Study Name	Language (s)	Purposes	Embed Into LMS
Henze et al, [8]	Reasoning and Ontologies for Personalized E-Learning in the Semantic Web	Information Resource/ Domain ontology, User ontology, Observation ontology	RDF	To provide individually optimized access to information by taking the individual needs and requirements	×
Gascuena et al, [9]	Domain Ontology for Personalized E-Learning in Educational Systems	Content-(Course Activity)/ Material course ontology	OWL	To proposed domain ontology for describe learning materials that compose an adaptive course which considered two interesting aspects; the learning style more adequate for an educational resource, and the device that best uses it.	×
Heiyanthuduwage and Karunaratne[10]	A Learner Oriented Ontology of Metadata to Improve Effectiveness of Learning Management Systems	User Interaction/ User Oriented Ontology	XML, RDF	To increase the usability of learning content and customizing a LMS to make it learner oriented.	Moodle
Zimmermann et al, [11]	An Ontology Framework for e-Learning in the Knowledge Society	Content-(Course Material)/ Topic ontology	RDF	To propose ontology for adapt course material management from digital sources into e-learning system.	Web-based LiLi
HadjM'tir et al, [12]	Ontology-based Modeling for Personalized E-learning	Content-(Appearance)/ Learners profile ontology	OWL	To proposed the user profile ontology, and to create a rich learning area based on a domain model which allows to establish a suitable user model. The major contribution of the ontology model is to offer a coherent course structure.	×
Chu et al, [13]	Ontology technology to assist learners' navigation in the concept map learning system	Content- (Course)/ Ontology-based concept map learning system (CLS)	RDF	To help users search the concept map, determine relationships between nodes or predicates, and find the common concept or predicate among the concepts to help reduce the user's cognitive load	Web-based (CLS)
Chung and Kim [14]	Ontology Design for Creating Adaptive Learning Path in e-Learning Environment	Content- (Resource Activity)/ Curriculum ontology, Syllabus ontology, and Subject ontology	RDF, OWL	To developed ontology-based e- Learning support system that allows learners to build adaptive learning paths through understanding curriculum, syllabuses, and subjects of courses	×

3.0 METHODOLOGY

The continues issues on the web based application has been investigated by Rokou et al, includes the web character of the program, the pedagogical background, and the personalized management of the learning material [15]. The web character implies the information system itself includes the data communication through network and protocol such that HTTP server, the pedagogical background implies the association of learning concepts in order to achieve the learning goals, the personalized management implies the availability to provide user's needs based on certain characteristics. To address these problems, an ontology approach is introduced in this paper. Ontology describes the conceptualization of learning management systems along with the association of learning pedagogy in the form of class, instances, relationship, and attributes. Moreover, the ontology language such that XML, OWL and RDF are able to support web-based applications, it provides feasibility to mining the educational data.

In our approach as shown in Figure 1, we gained the log file data from e-learning system. This file contains usage data from instructors and students, thereafter the mapping process carried out to map the data from log file to ontology learning. This process to gain the knowledge discovery from log file, because the ontology constructed based on conceptualization of e-learning and meaningful learning pedagogy. The next phase is to mining the log file such that to generate the learning and interactions pattern, cluster the usage based on meaningful learning characteristics, and define the recommendations based on the analysis results.

The aim of this paper is to highlight the construction of ontology knowledge based for e-learning usage and to validate the reasoning functionality of the ontology using SPARQL queries.

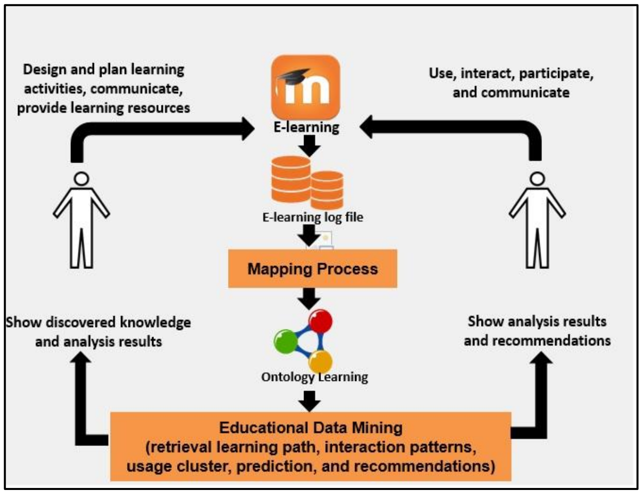


Figure 1 Research Procedures

3.1 Ontology Construction

An ontology is an explicit specification of a conceptualization[16]. The structural parts of ontology are as follows: (1) Concepts (class, categories, and types), describes the important idea of main domain, for example in the domain e-learning, the important idea about learning activity e.g., user, type of activity, type of actions, curriculum level, etc. Those main ideas will be stated as concepts; (2) Property (attribute, slot, and role) describes the possibly intercourse between concepts. On the classical taxonomy property *is-a* and *consists-of* merely used to represent the member of sub-class. Ontology also capable to set binary property, one example of this case for restriction domain-range; (3) Instances (individuals, member) describes as a member of each concept. The simple way to add instances is direct put onto ontology; however ontology is capable to import instances from database. On this case, we have to strictly consider about design of field on database, data type, size and others data constraints; (4) Formal axioms, set of formal axioms merely use as a domain knowledge. The formal expressions have respect to the further process such as: computation or search engine. Formal axioms derived from informal questions or statement, for example someone cannot be a student and lecturer in the same time moreover it will follow by rules constructions.

Methontology is one of methodology to construct ontology conceptualization. It is ideal for knowledge based system [5] as the aims of this paper. There are eleven phases involved in the methontology[17], however the process is not sequential as in waterfall model.

1. Build glossary of terms
2. Build concept taxonomies
3. Build ad hoc binary relation diagrams
4. Build concept dictionary
5. Describe ad hoc binary relations
6. Describe instance attributes
7. Describe class attributes
8. Describe constants
9. Describe formal axioms
10. Describe rules
11. Describe instances

3.2 SPARQL Query

Based on the definition, Semantic Web has the same goal as a Web content, however the semantic web cannot be simply expressed in natural language that is understood by only humans, but also in a form that can be understood, interpreted and used by software/machine (software agents). Semantic Web allow a variety of software to find, share and integrate information in an easily way. SPAQRQL query is a bridge for human/machine to retrieve information from data in the database.

SPARQL is a query for RDF/OWL, used to retrieve the data that is written using RDF/OWL or XML. This query uses an URI to retrieve the structure or information of RDF/OWL. SPARQL query language is nearly the same as regular SQL query, however the queries structure have more complexity. If the RDF/OWL changes the structure of the language, the SPARQL will however changes. To be able to retrieve information from database, SPARQL need the wrapper whichis common development using Java language. The full tutorial of SPARQL query commands have been described in Prud and Seaborne [18].

In this paper, we were using SPARQL query to test reasoning capability of our ontology model.

4.0 RESULTS AND DISCUSSION

The findings describe in the sub sections below are following the phases in methontology.

4.1 Glossary of Terms

The glossary of terms shows in Table 2 defined to tackle all the relevant terms of main domain. The main domain of this paper is Moodle e-learning particularly in usage of activities and actions and characteristics in meaningful learning.

Table 2 Glossary of Terms

Name	Description	Type
Activity	Activities in Moodle e-learning	Concept
Assignment	A sub concept of activity, to assess student's knowledge in the respective course	Concept
Blog	A sub concept of activity, to encourage students to write scientific electronic article.	Concept
Chat	A sub concept of activity, as a synchronous communication among users.	Concept
Choice	A sub concept of activity, where the teacher asks a question and specifies a choice of multiple responses.	Concept
Database	A sub concept of activity, to store the e-learning data.	Concept
Feedback	A sub concept of activity, to create and conduct surveys to collect feedback.	Concept
Forum	A sub concept of activity, where students and teachers can exchange ideas.	Concept
Discussion Forum	A sub concept of forum, where students and teacher discuss about particular topic.	Concept
Glossary	A sub concept of activity, allows participants to create and maintain a list of concepts.	Concept
LAMS	A sub concept of activity,for designing, managing and delivering online collaborative learning activities.	Concept
Quiz	A sub concept of activity, allows the teacher to design and build quizzes consisting of a large variety of question types.	Concept
Role	A sub concept of activity, a role is an identifier of the user's status in some context.	Concept
Survey	A sub concept of activity, is a course activity that provides a number of verified survey instruments	Concept
Wiki	A sub concept of activity, a collection of collaboratively authored web documents.	Concept
Workshop	A sub concept of activity, a peer assessment activity with many options.	Concept
Calendar	A sub concept of activity , the calendar can display site, course, group and or user events	Concept
Courses	A sub concept of Moodle, courses are the spaces on Moodle where teachers add learning materials for their students. Courses are created by admins.	Concept
Meaningful_Learning	A sub concept of Moodle, a learning pedagogy chosen as an analysis benchmark	Concept
Active	A sub concept and one of characteristic of meaningful learning.	Concept
Authentic	A sub concept and one of characteristic of meaningful learning.	Concept
Collaborative	A sub concept and one of characteristic of meaningful learning.	Concept
Constructive	A sub concept and one of characteristic of meaningful learning.	Concept
Intentional	A sub concept and one of characteristic of meaningful learning.	Concept
Moodle	Concept right after main concept Thing in ontology.	Concept
Resources	A sub concept of Moodle, a resource is an item that a teacher use to support learning.	Concept
Book	A sub concept of resources, multi-page resources with a book-like format	Concept
Journal	A sub concept of resources, allows a teacher to ask students to reflect on a particular topic. The students can edit and refine their answer over time.	Concept
Label	A sub concept of resources, to highlight and to distinguish different areas.	Concept
Upload	A sub concept of resources, adding the file onto e-learning, the file allows in variety types.	Concept
Users	A sub concept of Moodle, the actor who perform the e-learning activities and actions.	Concept
Administrators	A sub concept of Users, the actor who have main privilege to handle e-learning system.	Concept
NonEditing_ Teacher	A sub concept of Users, is able within a course to view and grade students' work but may not alter or delete any of the activities or resources.	Concept
Student	A sub concept of Users, participate in course activities and view resources but not alter them or see the class grade book	Concept
Teacher	A sub concept of Users, can do almost anything within a course, including adding or changing the activities and grading students. By default, teachers can also assign a Non-editing teacher role and a Student role to other users.	Concept

4.2 Taxonomy

Concept taxonomy defined the hierarchy of terms defined in the glossary of terms. Figure 2 shows part of hierarchy in our ontology model. Where courses, users, and discussion are subclass of Moodle concept. Teacher and student are subclass of users concept, and teacher concept have an instance Teacher_1, where the instance Teacher_1 teaches Course_1 which instance of Courses concept.

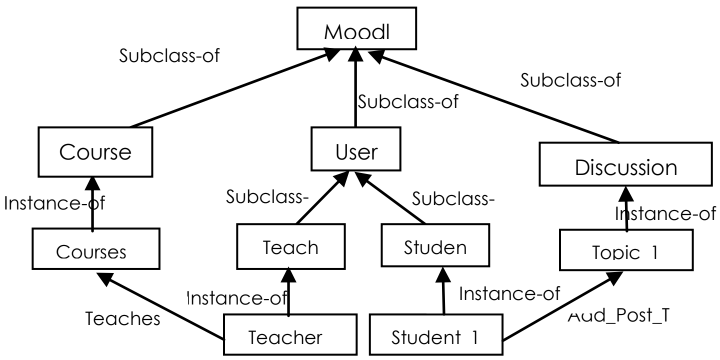


Figure 2 Part of Taxonomy

4.3 Relation Diagrams

Once the taxonomy has been constructed, the relation diagram obtained to define the characteristics of relations. The characteristics of relations are useful for machine when doing the reasoning process. For instance, based on the previous taxonomy that Teacher concept can teaches Course concept, we set Teaches relation inverse with Teach By relation as shows in Figure 3. In addition, Figure 4 shows when student enroll in a course, and course teach by one teacher, we can find the respective teacher, therefore we set enroll as transitive relation with teach by.

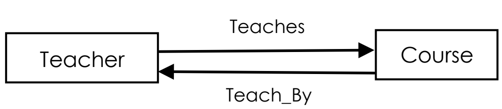


Figure 3 Inverse Relation

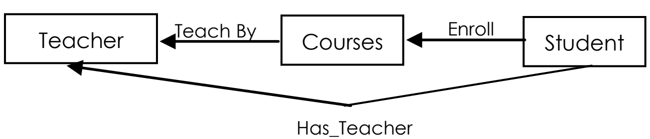


Figure 4 Transitive Relation

4.4 Dictionary

Concept dictionary consists of concept name with their class attributes, instances attributes, and their relations as show in Table 3.

4.5 Relations in Detail

For each relation, the ontology must specify the source, target, mathematical properties and inverse relation (if any) as show in Table 4.

Table 3 Part of Dictionary

Concept _Name	Class_ Attributes	Instances_ Attributes	Relations
Teacher	-	Has_Name Has_IdNumber	Teaches Has_Student Action_To
Student	-	Has_Name Has_IdNumber	Enroll Has_Teacher Action_To
Courses	-	Has_Shortname Has_Fullname Has_IdMember	Teach_By
Activity	Has_Active_ Weight Has_Collaborativ e_Weight Has_Constructive _Weight Has_Authentic_ Weight Has_Intentional_ Weight	-	-

Table 4 Part of Detail Relations

Relation_ Name	Source	Target	Mathematic al_Properties	Inverse_ Relation
Teaches	Teacher	Courses	Symmetric Transitive	Teach_By
Teach_By	Course	Teacher	Symmetric Transitive	Teaches
Has_Teacher	Student	Teacher		Teach_By
Has_Student	Teacher	Student	Symmetric Transitive	Has_Teac her
Has_Active_ Weight	Activity	Meaningful _Learning	-	-

4.6 Instances and Attributes in Detail

Each row of instance attributes contains a description show in Table 5, instance attributes might be different with concept attributes.

4.7 Constants in Detail

This phase describe in detail of the contacts in glossary of terms. For example, if we want to execute the reasoning to find teacher who teach a particular student, what we will get is the teacher name which has string as a datatype, and it gather from the property Has_Name from Users concept, as show in Table 6.

Table 5 Part of Detail Instances and Attributes

Instance_Attribute_ Name	Concept_ Name	Value_ Type	Measurement_ Unit
Has_Name	Users	String	Data
Has_IdNumber	Users	String	Data
Has_Shortname	Courses	String	Data
Has_Fullname	Courses	String	Data
Has_IdMember	Courses	String	Data
Has_ActiveWeight	Activity	Float	Quantity

Table 6 Part of Detail Constants

Name	Value_ Type	Value	Measurement_ Unit
Teacher that teach student	String	Has_Name	Users

4.8 Formal Axioms

Using the sample in Table 6, we defined the formal axiom that shows in Table 7. There are two variables defined namely X and Z, where X is teacher variable, Y is course variable. The concepts involved in the axiom are courses, teacher, and student, while the relations involved are Teach_By, Has_Teacher, and Has_Name. The axiom will reveal the value of Has_Name which gather from Teacher.

Table 7 Example of Formal Axiom.

Axiom name	Concept_ Name
Description	Teacher who teaches Student 'X'
Expression	Forall (?X, ?Y) [Teach_By Courses] (?X) and [Enroll Courses] (?Y) and [Has_Teacher Teacher] (?X) [Has_Name]
Concepts	Courses Teacher Student
Referred attributes	-
Ad hoc binary relations	Teach_By Has_Teacher Has_Name
Variables	?x ?y ?z

4.9 Reasoning Rules using SPARQL Queries

SPARQL queries have been constructed to test the reasoning capability of ontology model, the first query to gather all the concepts in ontology model.

The second query to gather the instance who teach particular course. While query three to gather the property of instance who teach particular course. The result of SPARQL queries show in Figure 5-7.

Query 1

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT ?subject ?object
        WHERE { ?subject rdfs:subClassOf ?object },
```

Query 1 is intended to obtain information on the parent class from a class. Child class is declared as a *subject* and parent class declared as an *object*. Meanwhile, to get the relationship *parent-child* relationship by declaring the relation *RDFS: sub Class Of*.

Query 2

```
Prefix
:<http://www.Moodle.com/Ontologies/moodlecourse.owl#>
PREFIX  rdf:  <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT ?Teacher ?Courses
        WHERE { ?Teacher :Teaches ?Courses.
?Courses :Courses_Name ?value.
FILTER (?value= "Courses 3")}
```

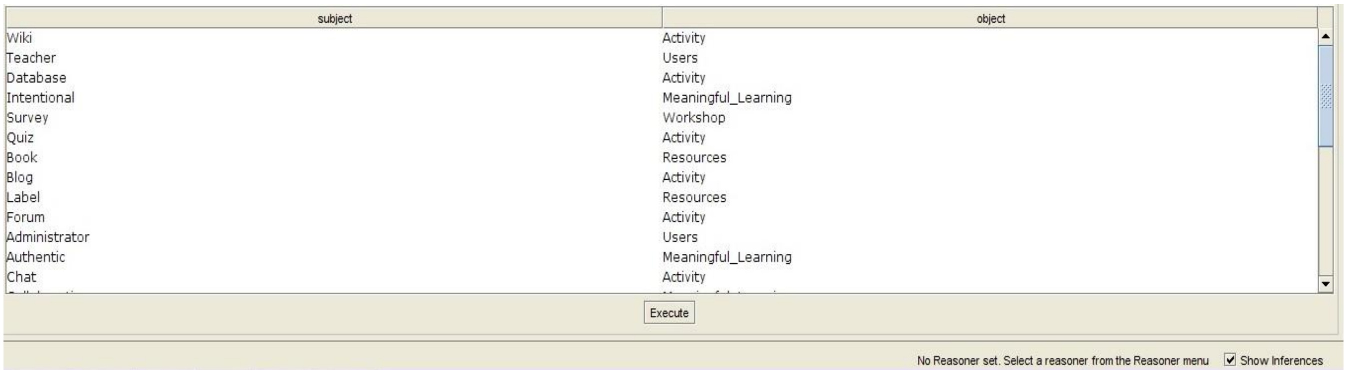
Query 2 is intended to obtain information about the teacher who taught in a course. Teacher declared as a *Teacher* variable and course declared as a *Courses* variable. To get the relationship of a teacher teaching on a course, then the relationship *Teaches* has been declared. In this query, the results to be revealed is a teacher code and course name, with an additional filter only for teachers who taught the course named Courses 3.

Query 3

```
Prefix
:<http://www.Moodle.com/Ontologies/moodlecourse.owl#>
PREFIX  rdf:  <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT ?Teacher ?Courses
        WHERE { ?Teacher :Teaches ?Courses.
?Teacher :Has_Name ?value.
FILTER (?value= "DewiOctaviani")}
```

Query 3 is intended to obtain information of a teacher taught a course or several courses. Likewise the previous query, there are *Teacher* variable and

Course variable has been declared beside the relationship *Teaches*. Information of teachers reveals based on the teacher's name, for it the relation *Has_Name* was declared. Additional filters can be used to focus on finding one of teacher.



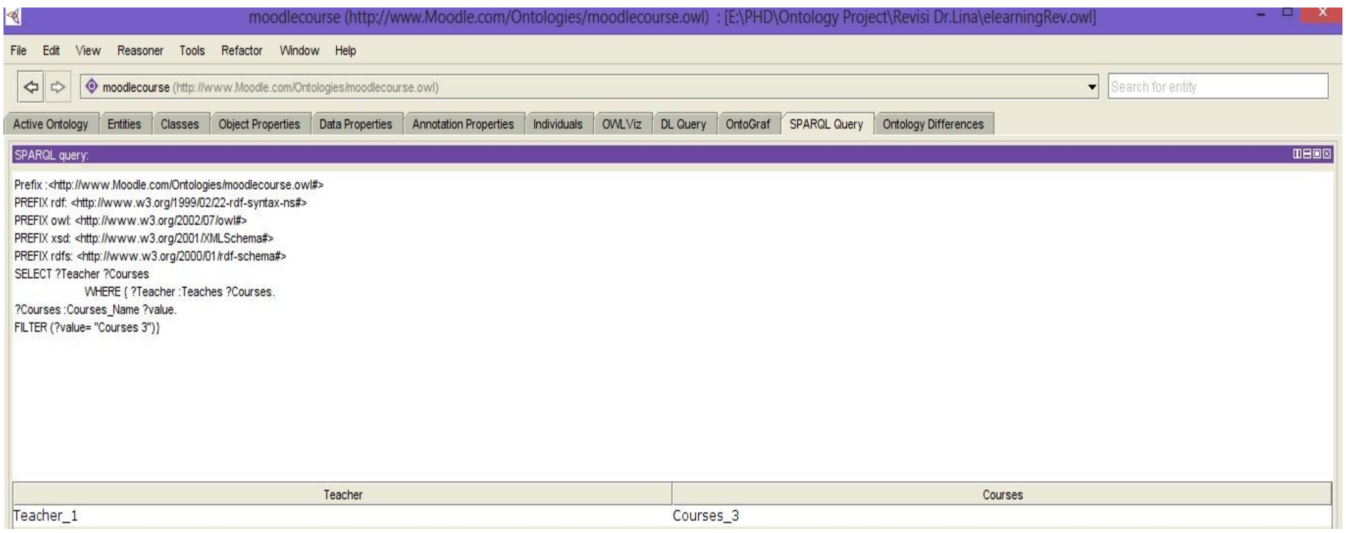


Figure 6 Result of SPARQL Query 2

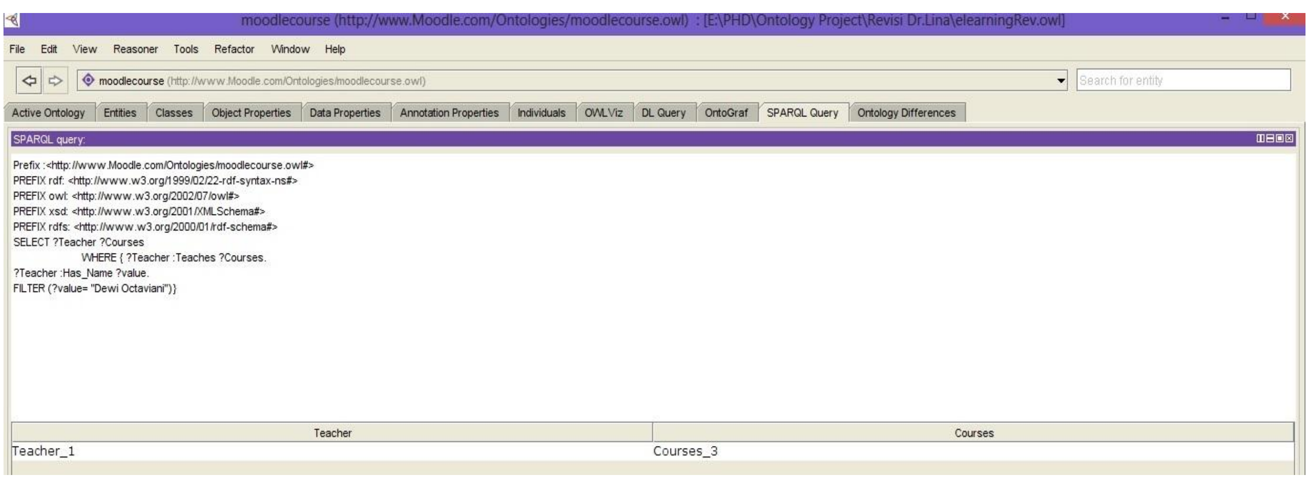


Figure 7 Result of SPARQL Query 3

4.11 Ontology Model Visualization

The ontology visualization show the actual ontology model has been constructed. Figure 8 shows the concepts designed in the glossary of terms, Figure 9 shows the object properties and data properties, Figure 10 shows the instances has been created in order to do reasoning process, and Figure 11 shows the full of ontology visualization.

Figure 8 Concepts in Ontology Model

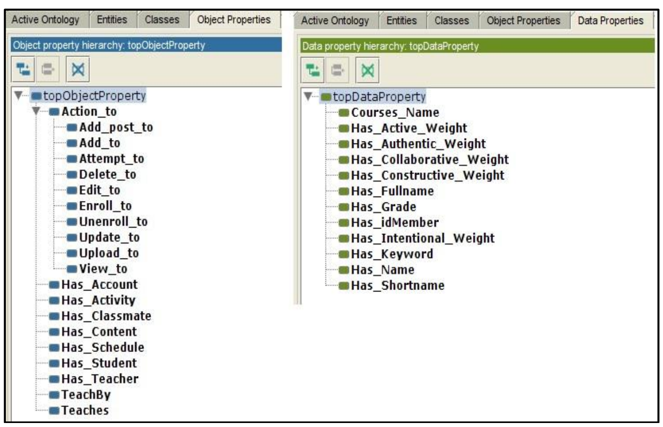


Figure 9 Properties in Ontology Model

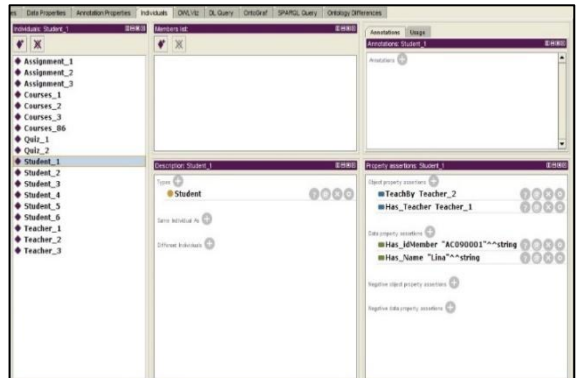


Figure 10 Instances in Ontology Model

4.12 DISCUSSION

E-learning is a self-learning process, which is able to eliminate the limitations of time and distance. E-learning is facilitated by a variety of activities to support virtual learning. Personalization is the next stage of the implementation of e-learning. Personalization is the process of observing the interactions among students within their virtual activities. The emergence of semantic technology, enabling attributes of learning pedagogies associated to the metadata of e-learning. This can be done by describing onto ontology in a form of concept, sub-concept, relationships, or instance. It is enable for human to explore the hidden message behind the interactions in e-learning, in addition, intelligent machine is able to perform reasoning process of learning activities. Reasoning process is underway to investigate the knowledge from amount of data, i.e. data log of e-learning which stores the history of e-learning activities. The ontology will create a flexible architecture platform to describe the activities and actions in ontology learning by linking the cognitive learning pedagogy. Ontology is able to understand and adjust to the level of usage, and later able to evaluate the meaningful usage, which can help to improve the quality of virtual learning. In this paper, e-learning data log sent to ontology for the benefit of reasoning process. There are three significant technologies involving in semantic ontology namely, XML, RDF and OWL. Ontology Web Language (OWL) added some vocabulary to describe properties and classes, among others: the relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, various types of properties, characteristics of properties (e.g. symmetry), and enumerate classes. While RDF (Resource Description Framework) will define the metadata file within three compositions, namely subject, predicate, and object. Subject and object are entities that indicated by the text, while the predicate is a composition that explains the viewpoint of the subject described by object.

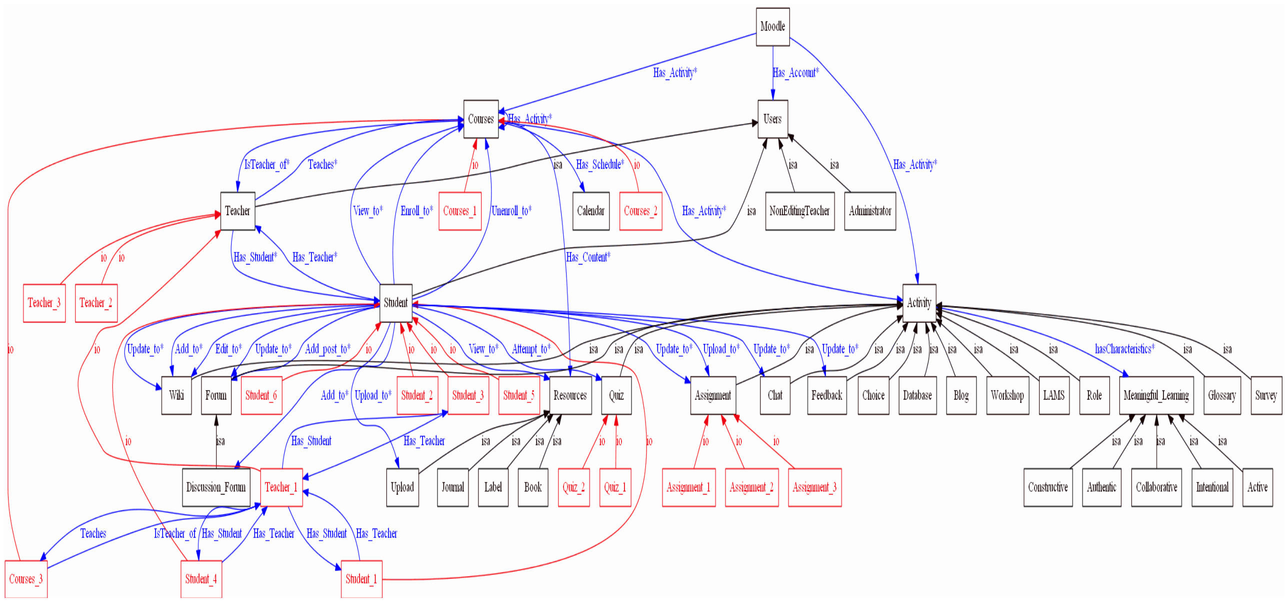


Figure 11 Ontology Visualization

Figure 11 shows the overall concept of the learning ontology. *Moodle* is described as the first concept which is located under the main concept which is *Thing*. As instances, part of concept descriptions exist in learning ontology described as follows. When someone makes a *Moodle* account, then he generates *Has_Account* relation which as *Users*. *Users* that have various sub-classes namely *Teacher, Student, Administrator* and *NonEditingTeacher*, these sub-classes has a relationship *is-a* with the *Users* class. Moreover, *Moodle* class consists of many other a sub-classes, one of them is a *Courses* class.

A *Courses* class might have variety of relationships with other classes, such as *Has_Schedule* with *Calendar* class, *Has_Teacher*with *Teacher* class, *Has_Student*with *Student* class or a *Student* conduct relations *Enroll_to*against *Courses* class, and *Has_Activity*in *Activity* class. There are many relationships that may occur as an *Activity* class has diversity of sub-classes. As instance, *Assignment* class is part of the *Activity* class represented by the relationship *is-a*. Relationships that may occur with the attachment relationship show in Figure 12 and 13 as examples.

Figure 12 shows a *Student 1* which is part of *Users* class, obtained *Enroll_to*course number B100 and performed *Upload_To*onto *Assignment* class. Based on ontology reasoning ability and because *Course* class *Has_Activity Assignment* class, it can be conclude that Student 1 upload for assignment on B100 Course.

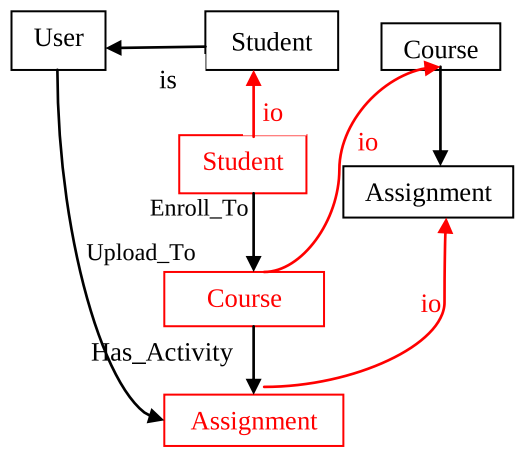


Figure 12 Student-Course-Assignment Relationship

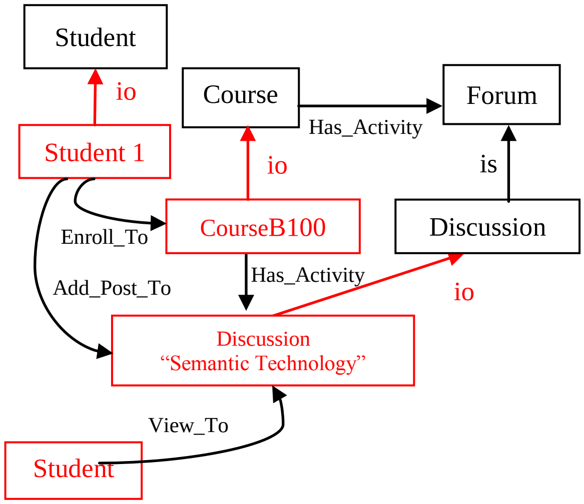


Figure 13 Student-Course-Forum Discussion Relationship

Another illustration shows in Figure 13, Student 1 *add* a post called "Semantic Technology" topic that has a relation *io* (instances of) in the *Discussion* class that is also part of the *Forum Activity* on *Course* B100. When Student 2 do *View_to* on the "Semantic Technology topic can be deduced that he saw the topic made by Student 1.

5.0 CONCLUSION

The objective of this paper to construct the ontology knowledge based for e-learning activities and actions and to test the reasoning capability. The set of knowledge representation which linked to meaningful learning pedagogy. Processes included: build glossary of terms, build concept taxonomies, build ad hoc binary relation diagrams, build concept dictionary, describe ad hoc binary relations, describe instance attributes, describe class attributes, describe constants, describe formal axioms, describe rules, and describe instances. The knowledge expected inferring user requirements to interpreted meaningful activities usage using SPARQL queries. Future works, we will accomplish to complete ontology structural and knowledge construction for overall activities and actions, set the rules, and establish the glossary of knowledge representation. In addition, e-learning experts and lecturers has a main role in order to gathering proper informal competency questions as of to achieve the competence expectation.

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