Ontology Development of e-Learning Moodle for Social Learning Network Analysis

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Abstract—Social learning network analysis has drawn attention for most researcher on e-learning research domain. This is due to the fact that it has the capability to identify the behavior of student during their social interaction inside e-learning. Normally, the social network analysis (SNA) is treating the students' interaction merely as node and edge with less meaning. This paper focuses on providing an ontology structure of e-learning Moodle that can enrich the relationships among students, as well as between the students and the teacher. This ontology structure brings great benefit to the future development of e-learning system.

Keywords—Ontology, e-learning, © Learning Network, Moodle.

I. INTRODUCTION

SOCIAL learning network and ontology are still less explored. Researchers are still focused on improving Social Network Analysis. There are researchers who work on ontology/semantic, and they proposed an SNA based on semantic web. Mike focuses on how to gain and integrate data on social network analysis [1]. Other researcher tries to reveal the semantic relationship by understanding the nature of relation. Ontology can improve the measurement of SNA by giving meaning to the social relationship, not only by simple edges and node. Li and friends [2] have merely classified the relationship by giving meaning such as friend or enemy. This meaning can classify the social learning of user even though the group does not provide detail meaning.

II. RELATED WORKS

The identification process of student behavior inside e-learning is very important to improve the usability of the system. Previous researchers have proposed different models of analyzing the interaction between student and student (S-S), student and teachers (S-T) or even Student-Module-Teacher (S-M-T) by using SNA [3], [5], [6], ontology and clustering [7], [8], and meaningful learning concept [9],[10].

Social Network Analysis (SNA) is one of the great approaches to classify the user behavior inside the social network by measuring the intensity of communication among them. Analysis on classifying the behavior of student also studied using social network analysis. In 2003, researchers

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have proposed a combination of qualitative evaluation with social network analysis to investigate the social interaction in the classroom. The activities in the e-learning system such as discussions, solving doubts, sharing information and creating products are the parameters to be analyzed by the SNA. They succeeded in detecting the model of collaborative design that derived from activity inside a classroom [3]. Other researchers intended to investigate deeply on the relationships among social entities. Al-Fayoumi et al. [4] have proposed an algorithm, named Clever Ant Colony Metaphor, that able to cluster the social network structure through maximum clique and sub grouping criteria.

In 2008, researchers have proposed a framework that combines both the content analysis and the social network analysis to analyze asynchronous discussion forum. The unrelated messages, which are obtained from the content of the discussion forum, are filtered before they are being analyzed using SNA. The results have shown that the proposed framework able to integrate and analyze the communication transcripts, as well as the network structures [5]. Additionally, their study has been improved further by using Soller model for content analysis and network indicator to evaluate the participation levels [6].

Moreover, other researchers have studied on measuring and analyzing the extent of knowledge sharing between e-learning users that occur in their communication system using social network analysis [11]. The result shows that the majority of the students tend to interact with other students, and they share knowledge via the community server. Furthermore, Drazdilova have combined clustering technique in the social networking to classify students' [12]. They used hierarchical agglomerative clustering method to create a cluster on a student by computing their matrix similarity. Recently, in 2010, researchers have combined social network analysis (SNA) with automatic text analysis (ATA) to monitor and analyze the social level of interaction, as well as the emotional state of a learner [13]. They have come up with their own prototype of tools to describe the emotional condition of the tutor and learner during the interaction.

III. ONTOLOGY DEVELOPMENT FOR E-LEARNING MOODLE

There two main steps for creating ontology structure in e-learning Moodle. First is the data collection, and second is the procedure of ontology development.

A. Data Collection

The data for ontology structure is collected from e-learning

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Moodle at the Universiti Teknologi Malaysia. All activities inside e-learning Moodle are considered as class for ontology structure. The case study for the ontology structure in this study is Wiki activities.

B. Procedure

In order to create ontology structure, author need to explore all Moodle activities on e-learning UTM. After that, author will identify all possible activities. The data will be converted into ontology classes and datatype properties.

There are seven main stages that contributing on developing ontology structure as listed below:
1. Scope definition
2. Considering Reuse
3. Enumerate terms/classes design
4. Define Taxonomy
5. Define the property
6. Define Facets
7. Define Instance
8. Check Anomali

OWL classes are real representation of concept. Classes are expressed through mathematical concept that able to describe the prerequisite of the membership of the class. For example, the class for Goat encloses every individual that are goats in the area. Classes are perhaps categorized into superclass and subclass called taxonomy. Example classes are Flower and Rose. Rose is subclass of Flower, in other words, "All Roses are Flowers" and "All members of class Rose are members of class Flowers". OWL-DL provides features to check superclass-subclass relationship automatically using reasoner.

C. Ontology Class Design

The scope of ontology that will be created here is based on Moodle e-learning used in UTM. By default ontology has contain class named Thing, this class is the highest class that represent all set of individual, therefore all the class is subclass of Thing. The classes for this ontology stucture is created by add sub class as shown in Fig. 1.
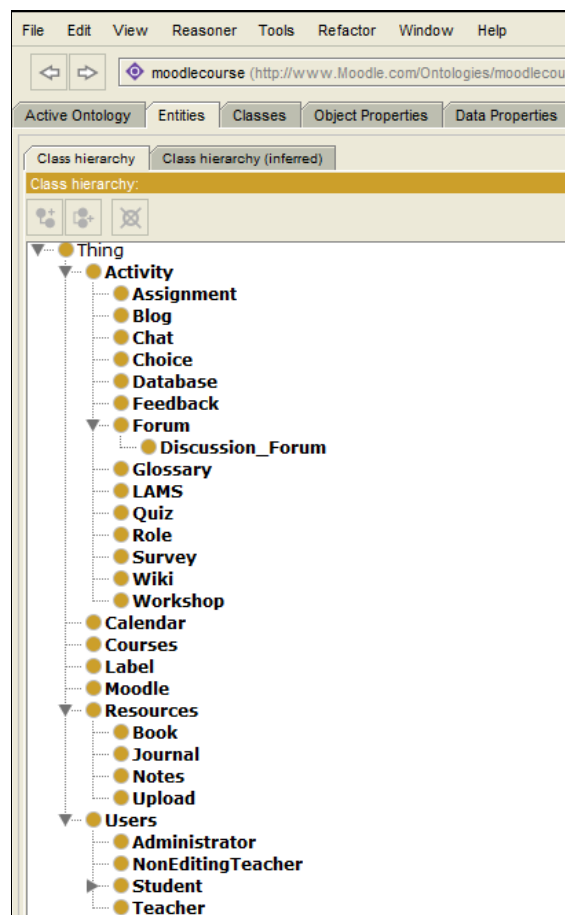

Fig. 1 Create class for ontology Moodle in Protege

The Ontology of UTM Moodle consists of several main classes and some classes have subclass such as:
- Moodle
- Activity
o Assignment

Sub class that reflect the task that given to student for each course to measure student performances
o Blog

Sub class of Moodle activity that can be used for expressiveness and conversation with other people.
o Chat

Sub class of Moodle activity that can facilitate people to meet in certain virtual room and communicate each other directly through message.
o Choice

Sub class for poll system
o Database

Sub class for sharing data
o Feedback

Sub class that store the comment or criticism from user
o Forum

Sub class that provide discussion and considered as one of great communication media
- Discussion Forum

Sub class of Forum that more intends on discussion

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o   Glossary

Sub class that stored dictionaries term of each course

o   LAMS

Sub class to change the layout of course activity.

o   Quiz

Sub class that handled variety of Quiz such as multiple choice or true/false

o   Survey

Sub class to store the feedback of student through questionnaire

o   Wiki

Sub class that provide user to work together as collaborative team

o   Workshop

Sub class for handling the workshop or lab course

o   Role

Sub class that responsible to manage the permission of users

• Resources

o   Book

Sub class that responsible for store book in the system

o   Upload

Sub class for handling the uploading process

o   Journal

Sub class for journal activity

o   Label

Sub journal that manage the labeling process of each activity

• User

o   Student

o   Non Editing Teacher

o   Teacher

o   Administrator

• Courses

• Calendar

In order to complete the categorization of sub class, Users class can be consisted of several disjoint sub classes. For example, Student sub class is disjoint with Teacher sub class as portrayed in Fig. 2.

D. OWL Object Properties of e-Learning Moodle

Properties in OWL describe the relationship among the classes. There are two main types of properties: Object and datatype properties. Object properties are related to the relationship between individual, while datatype properties is individual link to data type of XML schema. The third property is annotation properties. This property can be utilized to add information.
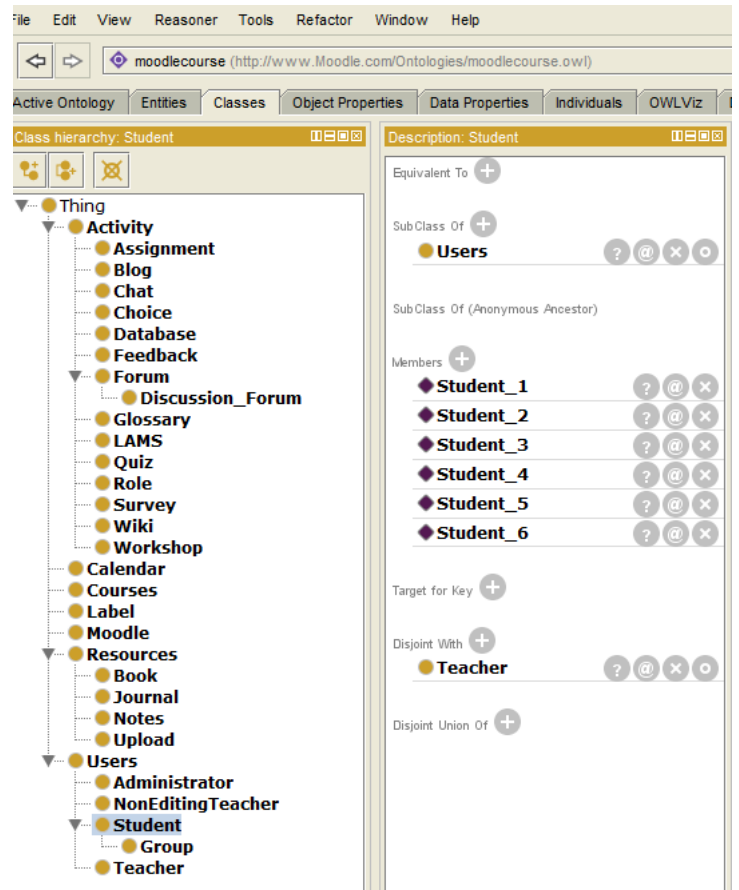

Fig. 2 Disjoint classes for Student-Teacher

There are four object properties of OWL that provided in protege such as:

• Functional Properties

Functional property is limited only one relationship to other individual for a specified individual as illustrated in Fig. 3. In this case, functional data type properties student: Has_group is considered as functional properties.
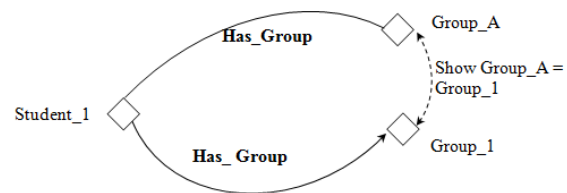

```
<owl:FunctionalProperty rdf:ID="Has_Group">
    <rdfs:domain rdf:resource="#Student"/>
        <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
    <rdfs:range rdf:resource="#Group"/>
    </owl:FunctionalProperty>
```

Fig. 3 Example functional property - Has_group

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- Inverse Properties

Properties that describe the individual are as an inverse of other individual. In this study, Has_Student is inverse property of Has_Teacher, as shown in Fig. 4.
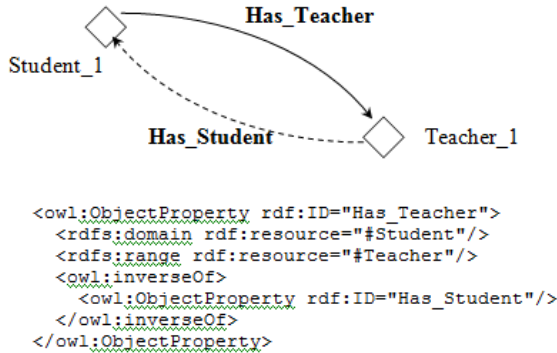


```
<owl:ObjectProperty rdf:ID="Has_Teacher">
    <rdfs:domain rdf:resource="#Student"/>
    <rdfs:range rdf:resource="#Teacher"/>
    <owl:inverseOf>
        <owl:ObjectProperty rdf:ID="Has_Student"/>
    </owl:inverseOf>
</owl:ObjectProperty>
```

Fig. 4 Example funcional property - Has_Teacher and Has_Student

- Symmetric

Property that grasps pair (a,b) as part of instance P, then pair (b,a) is instance of P as well. Has_classmate is an example of symmetric relationship of student which is portrayed in Fig. 5.
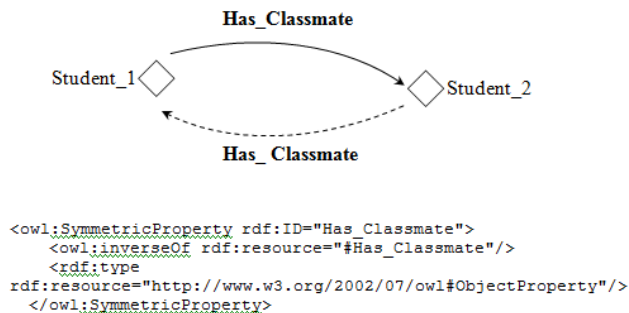


```
<owl:SymmetricProperty rdf:ID="Has_Classmate">
    <owl:inverseOf rdf:resource="#Has_Classmate"/>
    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
</owl:SymmetricProperty>
```

Fig. 5 Example symmetric property- Has_classmate

- Transitive

This mean if a pair (a,b) is an instance of P, then pair (b,c) is instance of P as well, in that case, pair (a,c) is an instance of P too, as illustrated in Fig. 6.

The detail description of object properties that obtained from Moodle e-learning is illustrated in Fig. 7. This figure also shows the descriptions and characteristics of Has_Groupmate.
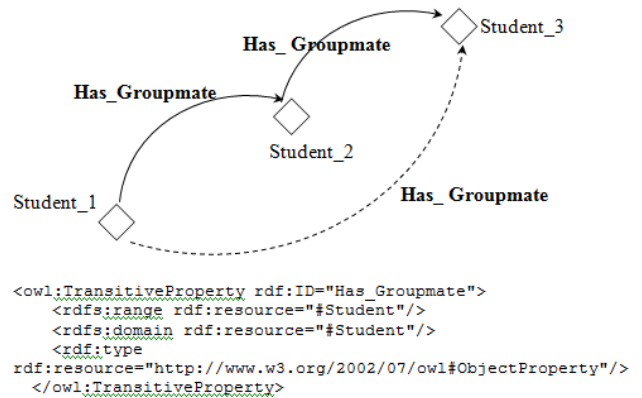


```
<owl:TransitiveProperty rdf:ID="Has_Groupmate">
    <rdfs:range rdf:resource="#Student"/>
    <rdfs:domain rdf:resource="#Student"/>
    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
</owl:TransitiveProperty>
```

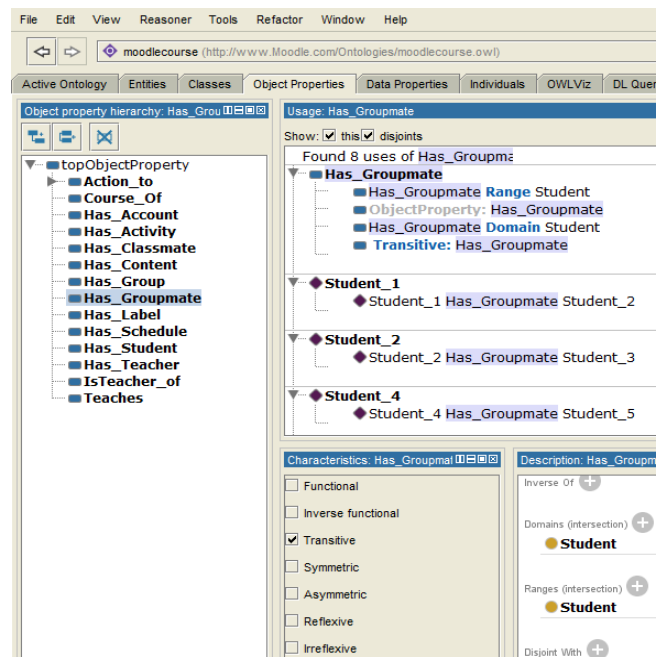Fig. 6 Example transitive property- Has_Groupmate

Fig. 7 Object properties of e-learning Moodle

E. OWL Datatype Properties of e-Learning Moodle

Datatype properties are connecting an individual to XML schema Datatype or rdf. They describe relationships between an individual and data values. Ontology structure of Moodle e-learning in this study has several datatype properties such as:

- Has_Shortname

Properties of domain Course with range string.

- Has_Fullname

Properties of domain Course with range string.

- Has_Grade

Properties of domain Student with range int.

- Has_Name

Properties of domain Users with range string.

- Has_idmember

Properties of domain Users and Course with range string and the type of datatype properties is functional. This mean Users and course is strictly to have only one Id_member.

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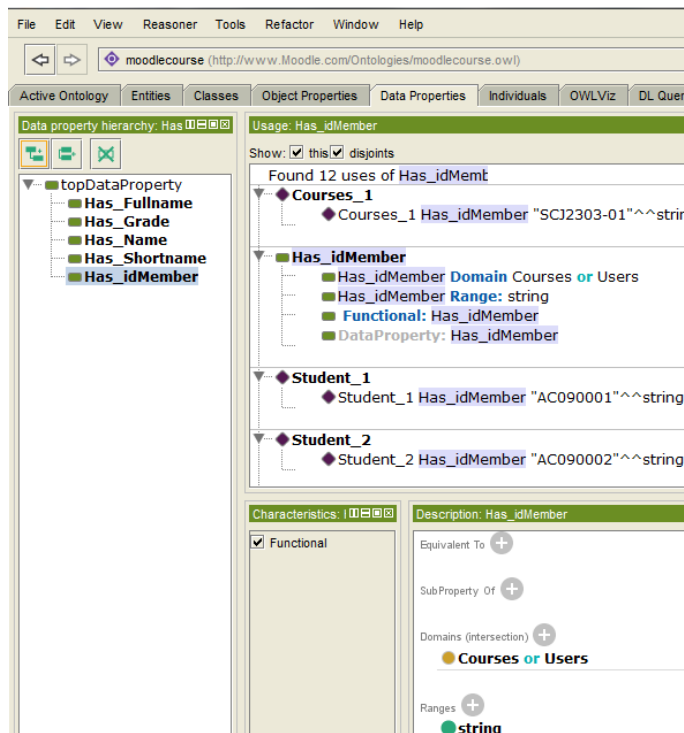The detail datatype properties of Has_idMember in Protege are shown in Fig. 8.

Fig. 8 Datatype properties of e-learning Moodle

F. OWL Individual of e-Learning Moodle

OWL provide user to define individuals and to emphasize properties about them. Individuals can also be used as class descriptions. In this research, some of individual is filled to give real value on class. For example, Course_1 Has_idMember: SCJ2303-01 and Has_Fullname: Internet Programming as shown in Figs. 9 and 10.
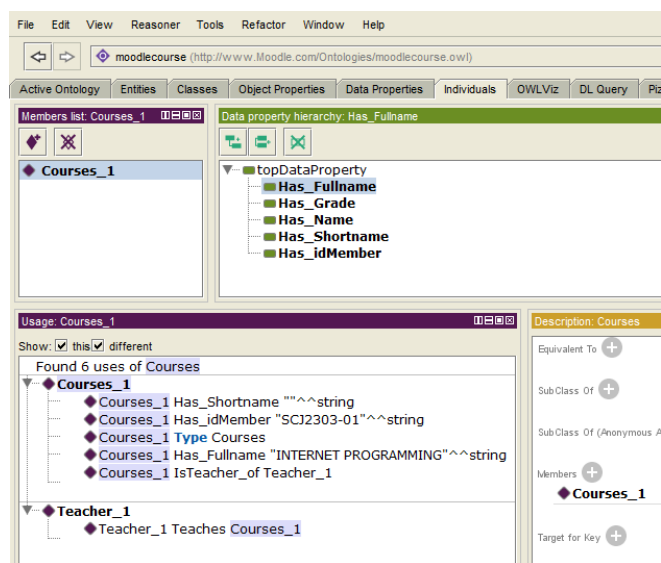

Fig. 9 Individual of Course on e-learning Moodle-1

```
<Courses rdf:ID="Courses_1">
    <Has_Fullname
rdf:datatype="http://www.w3.org/2001/XMLSchema#
string"
    >INTERNET PROGRAMMING</Has_Fullname>
    <Has_Shortname
rdf:datatype="http://www.w3.org/2001/XMLSchema#
string"
    ></Has_Shortname>
    <Has_idMember
rdf:datatype="http://www.w3.org/2001/XMLSchema#
string"
    >SCJ2303-01</Has_idMember>
</Courses>
```

Fig. 10 Individual of Course on e-learning Moodle-2

G. OWL Reasoning

The Final step is to check anomalies or inconsistency of ontology design that has been completed through previous steps. The tools to check consistency is known as reasoner. In this study, a reasoner Pellet is used to check the consistency of the Moodle ontology structure as illustrated in Figs. 11 and 12.
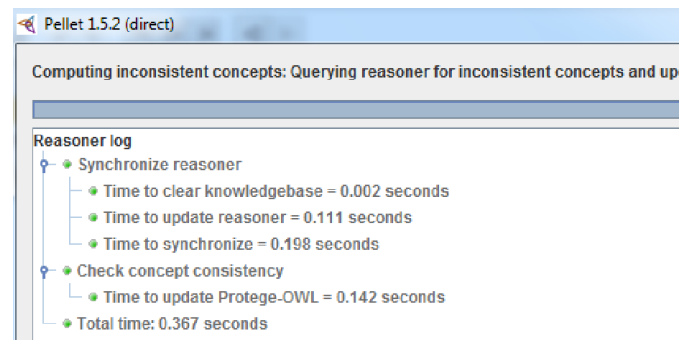

Fig. 11 OWL reasoning Pellet

Fig. 11 is checking consistency by reasoner Pellet and it took 0.367 seconds to check the consistency concept.

IV. CASE STUDY

In this study, the social learning network data e-learning UTM i.e. wiki is used to filled up the ontology structure. From Fig. 12, it can be found that Student_1 edit_to Wiki and Student_2 also conduct view_to activities. In addition, Teacher_1 has carried out add_to on wiki. This structure can clearly describe the relationship in Moodle activities and it can enhance the meaning of student relationship inside Moodle.

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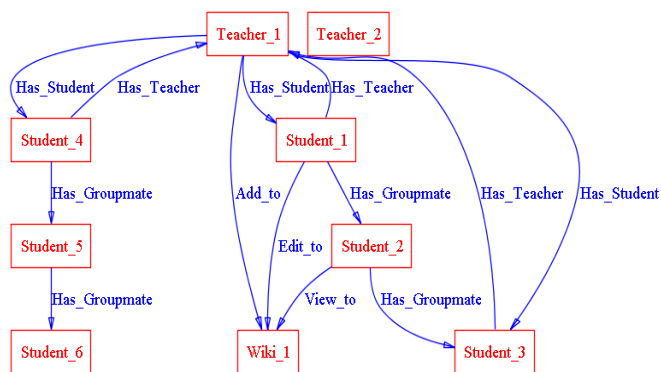Vol:7, No:6, 2013

Fig. 12 Case Study- Wiki data @e-learning UTM

V. CONCLUSION

This paper presents the process of building the ontology structure. It starts by defining the scope of Moodle e-learning and then followed by creating the classes. The object properties and datatype properties also have been defined in the structure. Some object properties have transitive and symmetric behavior. Furthermore, the individual from each class also filled up to the classes.

Finally, the last phase is to check the consistencies of the ontology design by using reasoning of Pellet reasoner. It needs to communicate with Pellet Dig server so that the server will give a feedback to the client. Next, the structure of ontology can be viewed through visualization of ontology viz to see the clear picture of relationship among the classes. The real data set from e-learning log of UTM Moodle has been used to fill up the individual of ontology structure. This ontology structure is believed as a method that can enhanced the social relationship inside social learning network in Moodle. This is due to the fact that one of the major benefits of building ontology using OWL-DL is to use reasoner to automatically compute the subclass-superclass relationship. Therefore this finding is expected to overcome the limitations of SNA in terms of meaningful relationship.

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