Semantic Web Technology and Ontology for E-Learning Environment

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Abstract

Most of the existing e-learning systems deliver learning materials to all learners based on "one-size-fits-all" approach. They do not sufficiently consider the learners' preferences or their distinctive needs. Consequently, learners are presented with limited personalized materials. E-learning systems need to tailor and deliver learning materials in a way that best suits learners' unique needs. Semantic web and Ontological technology have the potential to develop learning content that are more personalized and more adapted to each learner's needs. This paper proposes an adaptive e-Learning framework called (PALO), which builds on semantic web technology and is able to provide learners with personal materials. OWL ontology and SWRL rules are integrated to model learning objects and learner profiles based on different learning styles and knowledge level. The learners learning style are detected based on the four dimensions of Felder-Silverman model. In this study, an enhancement to automatically and dynamically detecting the learning style is proposed by using a literature-based method with a complement of expected time. It makes the time complementary for each learning style dimension to obtain the exactly style of the learner. The evaluation showed a high precision in classifying learning styles and in retrieving learning materials that are strongly appropriate to the knowledge level of learners and to their learning styles.

Keywords: *Ontology; OWL; SWRL; Learning Style; Learning Object; Protégé.*

1. Introduction

As internet is reaching in every corner of world, it became the primary source of learning and education. Every age of people do searches over the internet to learn things according to their needs. But each learner has not only its own distinctive needs, they have different learning style. Everyone gathers data its own way over the web. Some follow the blogs, others follow the learning websites to get knowledge. Therefore, a large number of learners may have trouble in gathering the most opportune learning resources for themselves. Due to enhancements of learning resources which are equally distributed over the internet, so learners can access more learning resources through e-learning systems. These further resources which are adjusted to courses are not just auxiliary for the learners, who have found them, but additionally provide the assists to other classmates. So, sharing more resources helps to expanding better performance in learning. Knowledge management tools recently have been utilized to enhance e- learning activities[1]. Last two decades another emerging area of web technologies is semantic web. It has shared and common understanding vocabulary to make a concept meaningful for every learner. Therefore, the implication of semantic web and the ontologies provide a way to improve the e-learning systems. The main purposes of said technologies are to perform models and manage the resources of learning in a more explicitly and effectively way [2]. Many of research has presented new frameworks of e-learning systems that help learners to obtain learning resources according to their learning styles and needs.

This paper presents a novel framework to retrieve the learning resource according to the learner's style and knowledge which is designed according to learner's profile, learning resources and learning styles. This framework works both with a ontology which uses Web Ontology Language (OWL), and SWRL(Semantic Web Rule Language) which is intended to be the rule language of the semantic web [3]. These rules are stored in the form of ontology that are applied through protégé[4]. The rules can determine the learning style of the learner by compare the result of learner which obtained from :1- doing the test of Felder-Silverman Learning Style Model (FSLSM) to determine which styles are adequate with the learner in each dimension of FSLSM, the FSLSM has four dimensions: the processing dimension includes active and reflective attributes, the perception dimension refers to sensing and intuitive, the input dimension contains the visual and verbal styles and understanding dimension includes sequential and global preferences , 2- or can be determined by applying a literature-based method [5] that uses learners' behaviors on learning objects to detect the styles of learners and enhance the result for this method by making the time complementary for each learning style dimension to determine the exactly style for the learner. This paper also presents the sequences of the learners learning style that orders according to the results obtained from Felder-Silverman learning style model and literature-based method. Subsequently, each learner has option of four styles , the learner can choose one style which have the high score from these four learning styles and get resources that fit with the chosen style. The rest of this paper is organized as follows. Section 2 describes the literature review . Section 3 illustrates an overview of PALO framework architecture. In section4, test the result of ontology and adaptation rules by using DL-Query [6]. Section 5 evaluates the retrieval efficiency of ontology. Conclusion and future works are covered in section6.

2. Literature Review

2.1 Semantic Web and Ontologies

The term Semantic Web was coined by Tim Berners-Lee, the inventor of World Wide Web. The Semantic Web is defined as " *an extension of the current web in which information is given well-defined meaning* "[7].

The challenge of current www is: A huge of data amount is interpretable by humans Only, machine is limited support. Berners-Lee recommends advancing the Web by machine-processable information. For instance, today's search engines are now very effective, but still have disadvantage like get irrelevant result of query. Machine processable information can indicate the search engine to the relevant pages and can in this way enhance the precision and recall [8].The main component of semantic web is:1- URI (Uniform Resource Identifier) and Unicode: is the main part of the basic layer that allows to uniquely identify resources (e.g., web page). A subset of URI is Uniform Resource Locator (URL) , contains representation access mechanism to identifies resources [9]. 2- XML (Extensible Markup Language) is defines a set of rules for encoding documents in format that allows people to structure their documents by defining and adding their own tags, and this format can be readable from human and machine. Basically, XML does not have a semantic model it has just a "surface model", a tree. In this way, XML is not the solution for propagating semantics through the semantic web. It just assumes the part of a "transport mechanism", as an effortlessly machine-processable format of data[10].3- RDF (Resource Description Framework) and RDF schema have already standardized by World Wide Web Consortium for modeling Web Objects as a major aspect of building up the semantic web[11]. RDF is a framework to represent data about data (metadata), it includes a set of triples (O, A, V) that might be utilized to describe any conceivable relationship between the data – Object, Attribute and Value [9]. 4- Ontology is a formal explicit

specification of a conceptualization. Ontologies are formal models that describe a specific domain and determine the meanings of terms by describing their relationships with other terms in the ontology. Ontology involves a set of knowledge terms, containing of the semantic interconnections, vocabulary, and some inferences rules and logic for some specific topic [10].5- OWL (Web Ontology Language) is a language for web information processing. It was intended to give a typical approach to process the content of web information (rather than showing it) [10].

2.2 Felder Silverman Learning Style Model

Learning style is viewed as a critical parameter to decide the most appropriate method of learning for a learner . Style of learning is a way to deal with learning that stresses the way that people have the characteristics and preferences with respect to how to get and process information in ways that are very different . There are different theories that model the learning styles, one of which is the hypothesis of Felder-Silverman learning style. Learning style model created by Felder and Silverman [5] contain a four-dimensional, two-dimensional replication of the model is a Myers-Briggs and Kolb. Dimensions Perception (sensing / intuitive) comparable to Perception on the Myers-Briggs and Kolb; Dimensions Processing (active / reflective) are additionally found in the model Kolb. Felder-Silverman utilizing Input measurement (visual/ verbal), and Understanding (sequential / global) [5]. The ILS instrument contains 44 questions, 11 for each of the four dimensions. This questionnaire is available and can be done on the web[12]and gives scores as 11A, 9A, 7A, 5A, 3A, 1A, 1B, 3B, 5B, 7B, 9B or 11B for each of the four dimensions[5].

2.3 Learning Objects

Online digital learning resources are commonly known as learning objects in e-learning systems. These learning objects can actually be thought as learning components that are presented in any format and are usually stored in learning object repositories that assist in performing several functions like object generation, search, review etc. Use of learning objects in learning management system is on the rise with rapid evolution of internet and web technologies but it doesn't provide assistance in personalized manner.

The main challenge in learning objects is how to obtain the resource according to the previous knowledge and the style of the learner to reduce the time consuming of search and reduce the number of hits. This problem solved by using semantic web to enhance the retrieval of the learning resources . Semantic web has several techniques and tools are under development which can play a significant role also within E-Learning. Specifically, ontologies can be utilized to query and explore through the learning material and would thus be able to enhance the learning procedure. The classification of learning objects which is used in this paper is according to the study of Pham Quang Dung and Adina Magda Florea [5]. Each learning object is labeled with one of FSLSM, Table 1 is described the labels of learning objects.

Table 1 . Labels of learning objects in POLCA[5]

Active	Reflective	Sensing	Intuitive	Visual	Verbal	Sequential	Global
Self-assessment exercise, multiple-question-guessing exercises	Examples, outlines, summaries, result pages	Examples, explanation, facts, practical material	Definitions, algorithms	Images, graphics, charts, animations, video	Text, audio	Step-by-step exercises, constrict-link pages	Outlines, summaries, all-link-pages

3. Proposed Framework for Adaptive Learning Ontology (PALO)

In this section the overview of framework of PALO is discussed as illustrate in Figure 1. The main purpose of PALO is to receipt the interesting learning resources to learners based on their styles and knowledge in e-learning environment . The Framework is organized as three main layers, namely, the interface layer, the adaptive layer (Intelligent layer) and the resource layer. These three layers interact to adapt with learner to achieve a relevant instructional process. The following subsections will briefly explain each part in the framework.

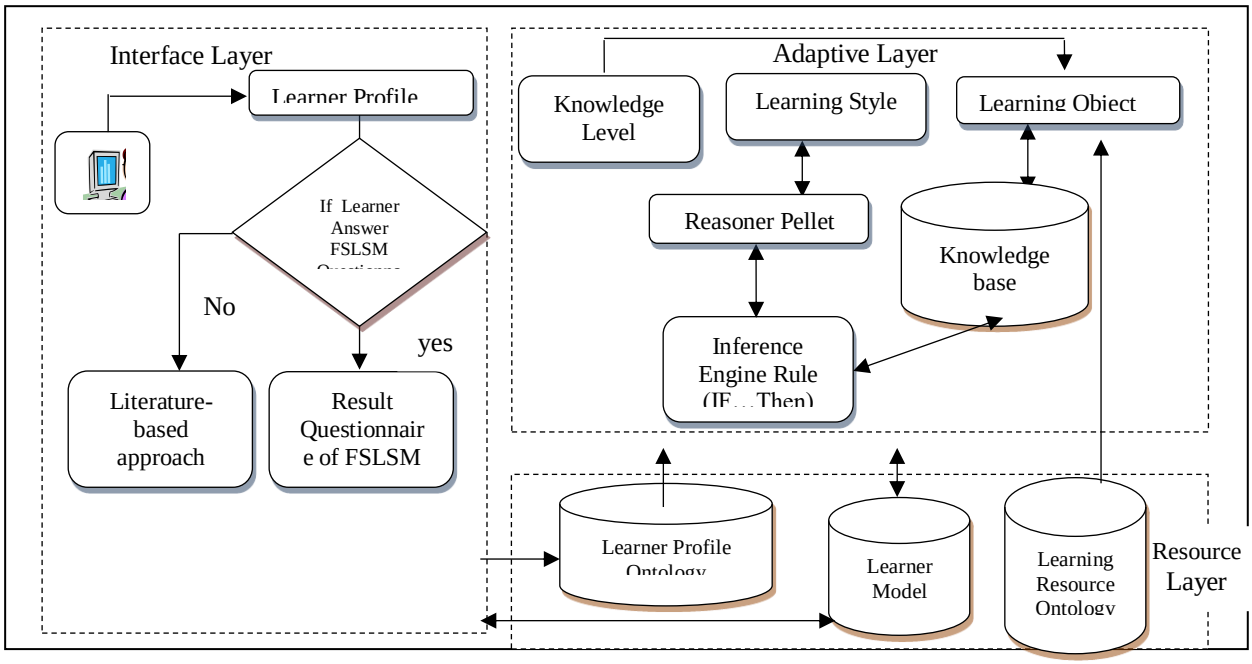

Figure 1. Adaptive Learning Ontology Framework

3.1 Interface Layer

This is the first layer, used by the learners, the learner is registered by enter the personal information to create learner profile. There are two ways to determine the learning style of learners, one is static by answering the Felder - Silverman questionnaire, and second one is automatically usage of literature - based method.

The following steps explain how the learner style is determine.

1- Firstly the learner is log in the system and completes the Felder-Silverman questionnaire, is an optional choice for each learner.

2- If The learner answer the questioner at that time then the framework is make the following procedure:
   a. Take the result of ILS test [12].
   b. If the Score of option A > option B in active-Reflective dimension, subtract option A from option B, then the learner style is belong to Active, else subtract option B from option A and the learner style is belong to Reflective.
   c. Repeat step 2 for remaining style (visual-verbal) (sequential-global) (sensing-intuitive).
   d. For each resource supported learning style suggest to the learner.
   e. Learner will receive four styles of learning style.
   f. The learning object deliver to the learner according to his style.

3- Else the system identifies the Learning styles automatically by used a literature-based method to estimate learning styles [5] which is explained bellow:

a. Approximate the Expected time spent on each learning object, Time expected_stay is determined.
b. Record The time that a learner really spent on each learning object, which is Time spent.
c. Compute the ratio of time spent and Expected time.

$$RT_{LS\_element} = \frac{\sum Time_{spent}}{\sum Time_{expected\_stay}}$$

d. find out the *RV*LS_element which is the ratio of visited learning object and the total learning object for each style.

$$RV_{LS\_element} = \frac{\sum LOs_{visited}}{\sum LOs}$$

e. Finally calculate the average ratio *R*avg =(*RT* + *RV*)/2.
f. The Threshold membership values for classification of linguistic variables may be taken as Range varies from [0 1] positive term to estimated the learning style based on the following simple rule: if Ravg value is between 0–0.3 the LS preference is weak and if the value of Ravg is between 0.3–0.7 the LS preference is moderate and the strong LS preferences if Ravg is between 0.7-1.

3.2 Adaptive Layer

This layer is used for analyzing, the answer of learners in FSLSM questionnaire, and the literature-based method [5] that uses learners' behaviors on learning objects, to determine the learner style, then the obtained style is saved in the learner profile. The learning style provide a learning resources that appropriated with the learner. The Knowledge base in adaptive layer is used to store the data in the type of ontologies. After constructing the ontological knowledge model (e.g. questionnaire), OWL is employed to perform the knowledgebase. OWL can define the structure of information by arranging concepts inside the domain and relations between sets of concepts . It can be add some rules using SWRL rules in order to empower the knowledge base. The semantic web rule Language (SWRL) produce the adaptive rules between learner profile, learning style, learning object and knowledge level of learners to obtained a learning resources which is suitable with learners style and knowledge. To updated the knowledge base in real time the inferred knowledge is used. The Inference Engine is updating the personalized Learner profile dynamically. The inference engine applies logical rules to the knowledge base and deduced new knowledge. So, new information is added and it is send to the inference engine, which works based on rule-based reasoning and then the learner profile is updating dynamically and some personal information will added like the styles and the suggestion learning objects. The logic that an inference engine uses is typically represented as IF-THEN rules. The OWL reasoner (Pellet) is used for reasoning OWL and SWRL. The query language DL-Query used to make a query.

3.3 Resource Layer

A resource layer has three ontologies : learner profile ontology , learner model ontology and learning resource ontology.

3.3.1 Learner Profile Ontology

Learner profile contains information about learner's personal information, prior knowledge, and learning styles as illustrate in Figure 2. The ontology is defined as classes,

namely the learner class which is related to the learning style and knowledge level class through the *belong_to_style*, *has knowledge* properties as an object property. The class learner is defined *name, birth date, phonNo* and *study-year* properties as Data type property. The learning style class is divided into four subclasses :1. active-reflective class: have two subclasses active and reflective class , 2.visual-verbal class: have two subclasses visual and verbal class, 3. sensing-intuitive class: have two subclasses sensing and intuitive class, 4.sequential-global class: have two subclasses sequential and global class. The knowledge level class has three subclasses beginner , medium and advance class. Table 2 is mentioned some of reasoning rules of learner profile objects property.

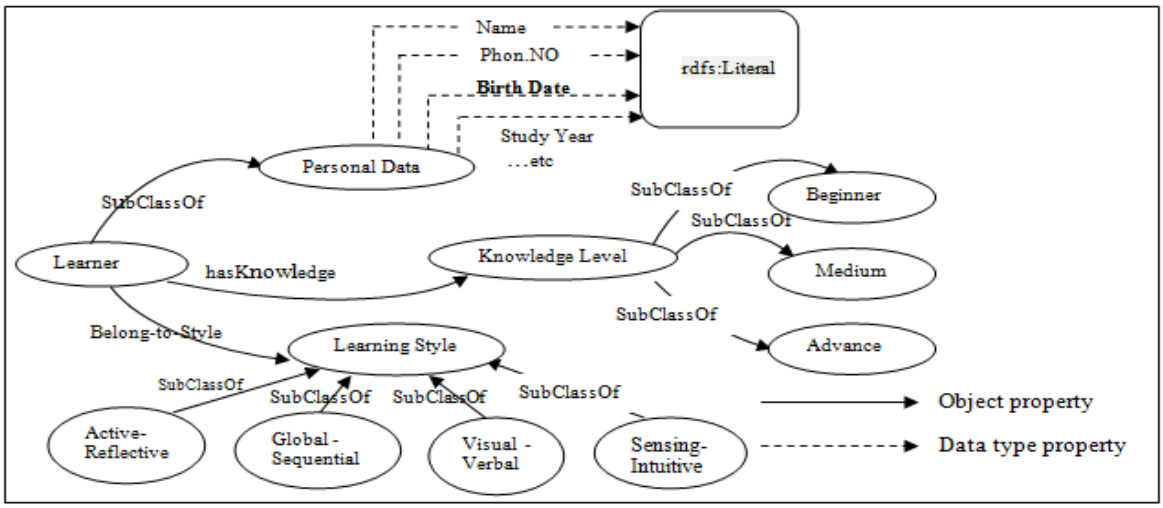

Figure 2. Learner Profile Ontology

Table 2. Reasoning Rules of Learner Profile Objects Property

Description	First Order Logic	Reasoning Rules
If learner obtained score in optionA greater than optionB in Active-Reflective style then subtract A from B and the style belong to the side of option A which is Active according to FSLSM.	∀x.Learner(x) ∧ ∀b.ACT-REF-OptionB(x, b) ∧ ∀a. ACT-REF-OptionA(x, a) ∧ (a > b) → (a - b) ∧ belong_to_style(x, active)	Learner(?x), ACT-REF-OptionB(?x, ?b), ACT-REF-OptionA(?x, ?a),greaterThan(?a, ?b), subtract(?c, ?a, ?b) -> belong_to_style(?x, active)
If learner obtained score in optionB greater than optionA in Active-Reflective style then subtract B from A and the style belong to the side of option B which is reflective according to FSLSM .	∀x.Learner(x) ∧ ∀b.ACT-REF-OptionB(x, b) ∧ ∀a. ACT-REF-OptionA(x, a) ∧ (a< b) → (b - a) ∧ belong_to_style(x, reflective)	Learner(?x), ACT-REF-OptionB(?x, ?b), ACT-REF-OptionA(?x, ?a), greaterThan(?b, ?a) ,subtract(?c, ?b, ?a) -> belong_to_style(?x, reflective)

3.3.2 Learning Resource Ontology

It contains all the knowledge for a particular course, which have many concepts and these concepts can be represented in a form of learning object such as presentations, questions activities, examples, exercises,...etc. The learning resource ontology is illustrated in Figure 3. class learner has *takes* object property used to list the courses taken by the learner and to join between learner and course class. The concept class contains several objects properties like:1-*ccBelongsto* : relate the concept to its related course, 2-*consistOf* : relate the concept and its

sub-concepts, 3- *similerto*: to map between concepts which have same semantic meaning, 4- *oppositeOf* :to map between concepts which have opposite semantic meaning, 5- *nextConcept*: is the next concept possible to the given concept, 6-*previousConcept* : the previous concept of the current concept, 7- *hasrequisite*: the concepts may to know before start study concept, 8- *isprerequisiteFor* :it is inverse of *hasrequisite* and denote the concepts for which it is a prerequisite for, 9- *isdescribedby* explain a concept by using digital resources and it is opposite of *describe* property in the resource class. The *conceptname* is a data type property for class concept to define the concept name. The resource class has objects properties like : 1- *support* : is to relate the resources to the learning style, 2- *suggest*: is to suggest the resource of learning object to the learner according his style, 3-*ProvideTo*: provides the resource of learning Object to the learner according to knowledge level of him, 4- *Includedin*: it is resources included in a course and it is inverse *of hasResource* , 5- *describes*: has inverse relation with *isdescribedby*, this property relate the resources to the concepts ,6- *hasDescription*: it is to join between the resource and its descriptions. The course class has objects properties like:1- *hasconcept*: which joined the course and its related concepts, it is also has inverse relation of *ccBelongTo*, 2- *hasresource* :denote to the set of resources which compose a course. The *courseName* and *courseDescription*, are a data type property. The Resource Description class has two objects properties: 1- *difficultlevel* property is for determine the knowledge level of resource, 2- *helptoachieveknowledge* property is for join resource description with the concepts. The Resource Description class is also contain of data properties such as *createdby*, *hasKeyword*, *type*, and *language*. Table 3 is mentioned some of reasoning rules of objects property.

3.3.3 Learner Model

Learner model takes all information after reasoning learner information with the rules in adaptive layer which deduces anew knowledge , learner model will take all this new information which determine the learner style and suggest the learning object to the specify style and provide resources according to the learner knowledge.

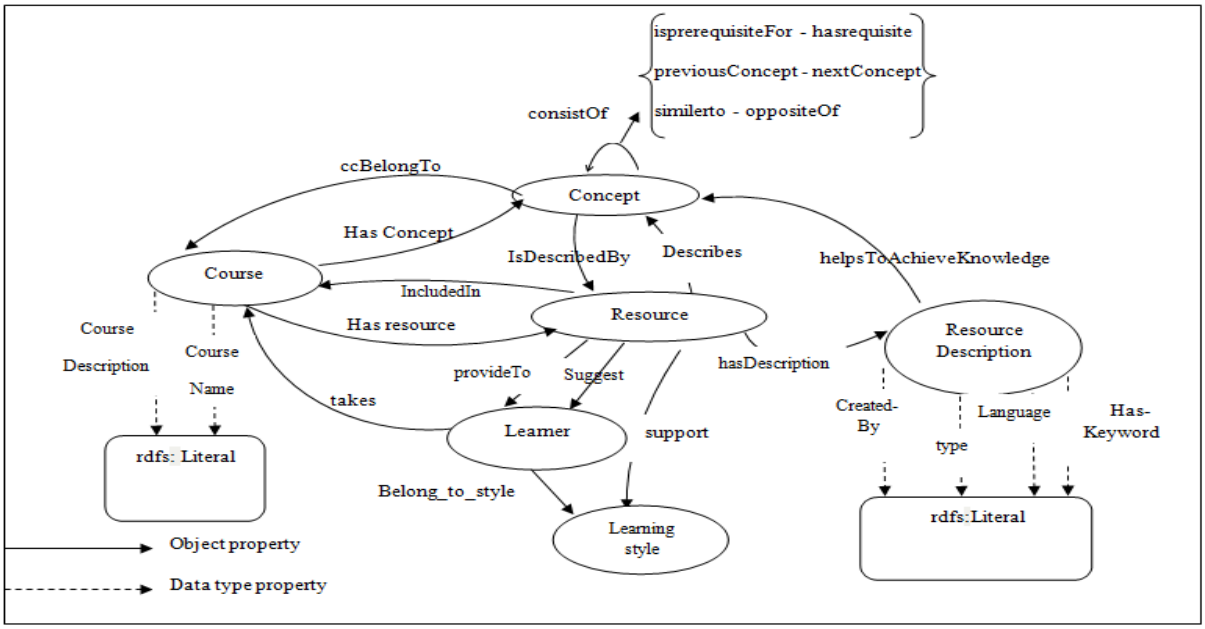

Figure 3. Learning Resource Ontology

Table 3. Reasoning Rules of Objects Property

Description	First Order Logic	Reasoning Rules
The learner(?a) has learning style(?x) and the resource (?y) supported learning style then suggest the resource to the learner.	∀a.Learner(a) ∧ ∃x.Learningstyle(x)∧ ∃y.resource(y)∧belong_to_style (a, x) ∧support(y, x)→suggest(y, a)	belong_to_style(?a, ?x) , support(?y, ?x), -> suggest(?y, ?a)
The Video resource is Support the learning style visual.	∀x.Video(x) ∧ ∀y.Visual(y) → Support(x,y)	Video(?x) -> Support(?x, visual)
The learner hasKnowledge(?x, beginner), will obtain easy level of resources.	∀x.Learner(x) ∧ ∃z.knowledgeLevel(z)∧∃y.reso ure(y) ∧.hasKnowledge(x ,z) ∧ difficultLevel(y, z) → provideTo(y, x)	hasKnowledge(?x, beginner), difficultLevel(?a, easy) -> provideTo(?a, ?x)

4. Results

The Ontology development tools [4] are used to obtain the results by doing some query for ensure the efficient of the ontology. Protégé is one of the ontology development tool. It provides an user friendly java based GUI to develop and edit ontologies, Plug-ins are supported by Protégé to provide additional functionality such as multimedia support, methods of problem solving, reasoning engines and querying, etc[13].

The DL Query tab in protégé gives a capable and simple to-utilize for searching a classified ontology [6]. reasoning rules using DL Queries illustrated bellow:

4.1.1. DL Query1

The query in Figure 4 is illustrated the suggestion of suitable resource for OOP subject to the Learner1, the resources are specified according to learner learning style and knowledge level. The query have multiple objects properties and individuals which are combined to make a full query , the object property *suggest* is for receipt the resource to the learner according the learner style , the *ProvideTo* property is used to receipt the resource according to the knowledge level of the learner, the *inculdeIn* property is used to specify the instance of subject which the learner is looking for. The results obtained of the learning object are precision and suitable to learner style and knowledge.

4.1.2. DL Query2

The query of Figure 5 is illustrate the learning style of Learner1 according to the learner profile, here the learner has four styles : verbal, reflective, sequential and sensing.

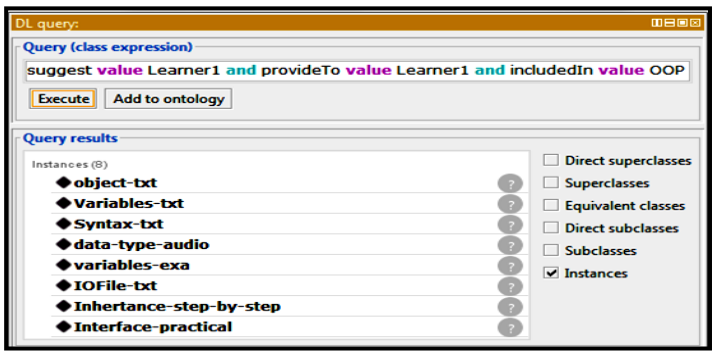

Figure 4. Snapshot of the DL Query 1

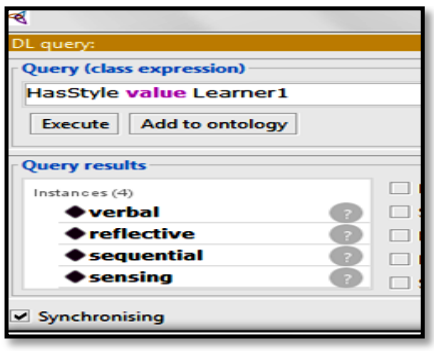

Figure 5. Snapshot of the DL Query 2

4.1.3. DL Query3

This paper also added some rules illustrate to the learner, the sequences of his learning style by compare the results which are obtained from each style, e.g if obtained 0.8 in Global , 0.7 in Intuitive , 0.6 in Active and 0.5 in visual the sequence will be Global- Intuitive- Active- Visual (as illustrated in rule1 bellow) so the learning resources sequences according to the order of the learner learning style will be (Outlines, summaries, all-link- pages / Definitions, algorithms / Self-assessment exercise, multiple-question-guessing exercises/ Images, graphics, charts, animations, video)[14].

Rule1 : Learner(?x), SEQ-GLO-OptionB(?x, ?glo), greaterThan(?glo, ?int), greaterThan(?act, ?vis), greaterThan(?glo, ?vis), greaterThan(?int, ?vis), SEN-INT-OptionB(?x, ?int), greaterThan(?glo, ?act), ACT-REF-OptionA(?x, ?act), VIS-VRB-OptionA(?x, ?vis), greaterThan(?int, ?act), -> order(?x, 'LearningStyle-ontology-25#GLo(linkpage-outline-summarie)_INT_(algorithm_–defintaion_)Act_(selfAssesment_-MQ)_Vis(anim-chrt-graph-img-vid)')

Rule1 is compared between the result of each style and order the styles from the greatest to the smallest. Figure 6 illustrate the inference rule of the order learning style and learning object of learner 2.The learner could also see his style order and search according to his favorite style and obtain the only learning resource which associated with the style as appear in Figure 7.

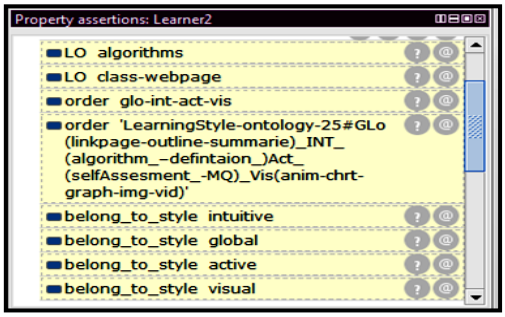

Figure 6. Inference rule of order learning style & objects

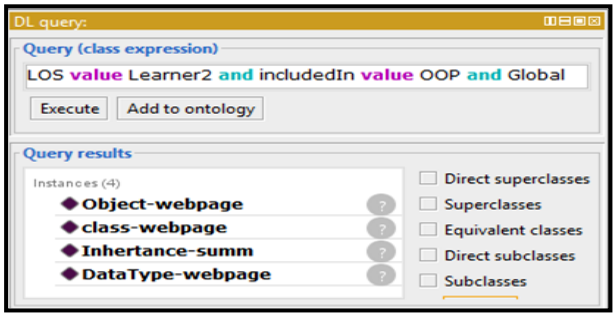

Figure 7. Snapshot of the DL Query for learner

5. Evaluation

The evaluation here done by compare between the current study and previous study[4] by enhancing the results of a literature-based method. Table 4 is showing the learning style of a learner's example result by using a literature-based method according to the study of Pham Quang Dung and Adina Magda Florea [5]. From Table4 we notes that the learner gets strong value in sequential-global dimension which are in the same dimension and it is rejected because of the classification of FSLSM, the learner must have strong value in one dimension.

Table 4. An Example Result of Calculated *Ravg*

L.S	ACT	REF	SNS	INT	VIS	VRB	SEQ	GLO
Ravg	0.87	0.32	0.65	0.5	0.42	0.62	0.87	0.83

This research avoids problem by using time restriction and assumes the time expected in each dimension is the total time stay by the learner on the learning objects is taken as a percentage 100%, and make the time spent is complementary for each dimension to determine the exactly style for the learner, the Complementary in mathematics, means when you have part of some whole, the complement of that part is the rest , so if the learner stays specified time in one style the reminder time will convert to the second style in the same dimension ex. If the

learner spends an hour on the learning objects and the time spent of him is 80% from the total time in active style, the reminder time is 20% will be given to the reflective style .

This complement make distance in time ratio because the whole time is consider as 100%, so the learner cannot stay 80% in global and stay 80% in sequential because we are assuming the time is complement so if learner stay 80% in global the reminder 20% is converted automatically to sequential, This way make distance between the results and deduce the chance for given high value for two learning style in the same dimension. Table 5 is showing the result of learner's learning style by using a literature-based method with a complement of expected time, there is no two strong style in the same dimension.

Table 5. An Example Result of Calculated *R*avg

L.S	ACT	REF	SNS	INT	VIS	VRB	SEQ	GLO
***R*avg**	0.87	0.32	0.65	0.5	0.42	0.62	0.87	0.45

The Axioms and Rules of the ontology are used to obtained the classification of the learner style and joined with the appropriate learning object for each style. The Axioms used to classify the category name style of the learner and the SWRL rules are used to calculate average rate Ravg(by using a literature-based method with a complement of expected time) for each learner, here is mentioned some of the axioms and rules which used in the ontology.

Axioms:

- Learner and (Ravg-Act some decimal[>= 0.7 , <= 1]) SubClassOf categoryName value strong-Act.
- Learner and (Ravg-Act some decimal[>= 0.3 , < 0.7]) and (Ravg-Ref some decimal[>= 0.3 , < 0.7]) SubClassOf categoryName value moderate-Act-Ref.
- Learner and (Ravg-Act some decimal[>= 0 , < 0.3]) and (Ravg-Ref some decimal[>= 0 , < 0.3]) SubClassOf categoryName value weak-Act-Ref.

SWRL Rules:

- Rule1: Learner(?x), LOs-visited-Ref(?x, ?lov), Los-Ref(?x, ?lo), divide(?l, ?lov, ?lo), Timeexpected(?x, ?te), Timespent-Ref(?x, ?ts), divide(?t, ?ts, ?te), add(?r, ?l, ?t), divide(?rav, ?r, 2) -> Ravg-Ref(?x, ?rav).
  Description: Compute The Ravg- Reflective of Learner(?x) by take: visited learning object (?lov), total learning object (?lo), Timeexpected(?te), and Timespent-Ref(?ts).
- Rule2: Learner(?x), Ravg-Act(?x, ?raa), Ravg-Ref(?x, ?rar), greaterThan(?rar, ?raa) -> belong_to_style(?x, reflective).
  Description : : If the value of Ravg-Ref is greater than Ravg-Act the style of learner is Reflective.

The result of ontology for classifying learner learning style is illustrated in Figure 8 and Figure 9.

Figure 10 illustrate the different between the previous study which the result gives strong value in two styles in the same dimension, and current study were the result is don't gives strong value in two styles in the same dimension .

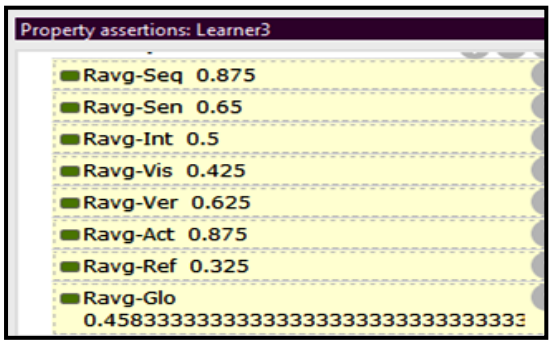

Figure 8. Rules Inferences Result of *Calculation Ravg*

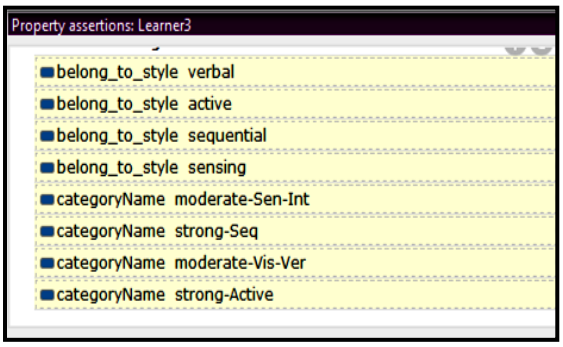

Figure 9.Rules Inferences for classify Learner style

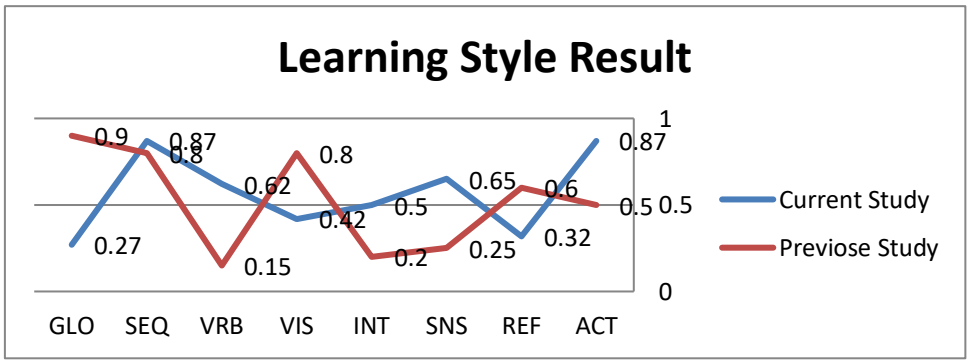

Figure 10. Comparing Between Previous Study and Current Study

The evaluation information retrieval is the rate of success of receipt the learning resource to the learner according to his learning styles and his knowledge level The precision and recall are using to measure the evaluation in order to determine the retrieval efficiency. Precision can be define as the number of learning resources retrieved that are relevant to the learning styles of the learner [1]. Recall can be define as the number of relevant of learning resources and are successful retrieved. The F-measure is efficient overall representation of precision and recall, as shown in Table 7. The Precision and Recall can be calculated as : Precision = A/A+c (1) , Recall = A/A+B (2). A is denote as the number of retrieved resources that are relevant, B is the number of relevant resources that are not retrieved and C is the number of retrieved resources that are not relevant. The F-measure is obtained by using Precision and Recall : F-measure = 2[(Precision * Recall) / (Precision + Recall)]. The evaluation result in Table 6 means that the retrieved learning resource Has strong number of the chosen a relevant resources for the learner.

Table 6: Evaluation Result

Query	Precision	Recall	F-measure
Q1	0.86	1	0.924
Q2	1	1	1
Q3	1	1	1
Q4	0.93	1	0.963
Q5	1	1	1

5.1 Semantic Web Search

The frontend of the web application let the learner enters the search query and the output of results is displayed according to the learner profile preferences. This website is coded by using PHP, java script, HTML and CSS. Figure 11 shows the frontend as visible to the learner.

The sparqllib.php is a simple RDF library used to query SPARQL[15] from PHP. The endpoint for the ontology is made by Apache Jena Fuseki server which is using for SPARQL endpoint and triple store. The ontology, saved as an RDF/XML file, which accessed, parsed and queried in the PHP application, SPARQL is used to query the RDF/XML file, which returns the results from the created ontology. These results are then displayed to the user in the result page as appear in Figure 12.

Figure 11. Interface of Search Query

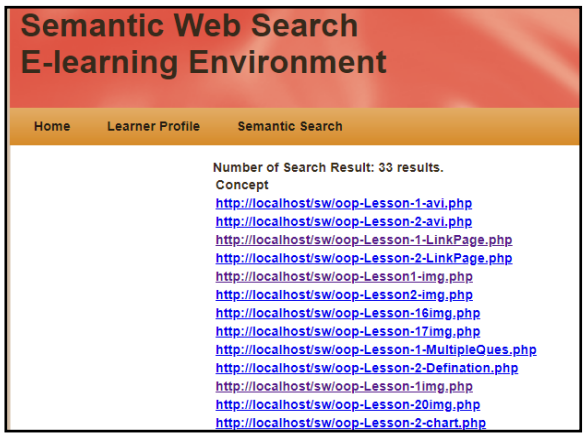

Figure 12. Learning Resources of the Query Result

6. Conclusion and Future Work

This study presents a proposed Framework for Adaptive Learning Ontology to retrieve learning resources according to the learner style and knowledge level. The ontology is built to adaptive between learner, learning style and learning object. The ontology determine the learning style by take the result from the answers of FSLSM questionnaire or by using a literature-based method which have been optimized by using time complement and enhanced the result of classify the learner style by avoiding the learner to get strong value of two styles in the same dimension. According to this optimization we get the incidence rate of obtained strong value of Ravg in the same dimension is 20% when using time complement and this enhance the process of determine the learner's learning style while the incidence rate of get strong value of Ravg in the same dimension is 50% when calculate Ravg without made the time is complement. The query which was retrieved by using DL-Query has strong value which mean the framework is worked well. The obtained results are acceptable but this way may change in the future to enhance the classification result of learner style, this is left as future works.

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