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Personalized learning management system using semantic web based learning style detection

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ABSTRACT

Providing e-learning web services can be achieved through semantic web technologies. Universities and institutes offer E-learning courses which breaks the barriers like space, time and people. Learning Style is the major criteria in achieving adaptivity in Learning Management Systems. In this paper we propose the methodology using semantic web technology (OWL) for finding the learning style of the learner dynamically. This approach detects learning style of the learner automatically based on learner's interaction, interests and behavior that are captured as ontologies and suggests the learning style of the learner. We consider Felder Silverman Learning style model in our approach to advice the learning style for that learner. Learning style detection algorithm has been proposed. This approach is modeled in Protégé and the learning style obtained as outcome can be used for sequencing the e-learning services.

Keywords: Learning Style; ALMS; Learning Object; Ontology; OWL; Knowledge Base

1. INTRODUCTION

Learning Style detection is the one the most difficult processes. It is a way using which learners most efficiently and most effectively perceive, process, store and recall what they are attempting to learn (James, 1993). Web based E-learning systems provide same teaching materials as Learning Objects (LOs) irrespective of the learners preference and learners level of knowledge and competency. In many e-learning systems learning style or learner's requirements are given very less significance. Adaptive Learning Management System (ALMS) is the one which is more flexible and interactive and considers learners centric teaching methodologies. In ALMS, learning paths should be provided automatically. ALMS should manage learning paths adapted to each user, monitor user activities, interpret those using specific models, infer user needs and preferences and exploit user and domain knowledge to dynamically facilitate the learning process. Learning style or learning path should be considered in any ALMS to achieve high performance and better feedback. Learners with different requirements or learning styles should be identified based on their behavior, actions and interactions with the system and provide e-learning agenda or sequence of e-learning services (e-learning flow) based on their style (Popescu, 2010).

Motivation: Online education is upcoming trend in education world where a learner tries to get some learning objects (LO) on particular subject or topic. He/she reads some books online, solves some problems in that domain or goes through some slides. Whether the LOs accessed by the learner satisfy the learner's requirements or style. That cannot be answered. The Pedagogy should be adaptive according to the need and requirements of the learners. In many web based learning environments all the learners are provided with same content. Learning Style, Prior knowledge, Interest and Cognitive level are to be considered while rendering the modules to the e-learner. We have developed a framework which considers the e-learners interactions and behavior to devise the learning style of the learner and identifies the workflow of e-learning which we term it as e-learning flow henceforth and provide the sequence of Learning objects according to the flow identified. In this paper we majorly discuss about learning style detection using OWL through Protégé. In section 4 this technique has been discussed elaborately.

2. THEORETICAL BACKGROUND

A. Learning Style Model and Techniques: Learning style detection can be achieved using two ways. Automatic approach is the way in which users input is not taken directly and user behavior, interaction, browsing history are the inputs to identify the learning style of the user. The other approach is collaborative in which users have to attempt lengthy questionnaire and the feedback about the learning style is obtained. Learning style concepts and related theories are very important in designing ALMS that provide e-learning services**.** The research results of cognitive psychology about processing information, active learning and the structure of information are the base needed for learning style (Kanninen, 2008). In our approach, we do not concentrate on collaborative way in order to free the user from boring questionnaire filling.

We have studied about various models used for detecting learning style. Kolb model divided the learners into convergent learners, divergent learners, assimilators, and accommodators (Kolb, 1984). Keefe's learning style detection method checks whether the learners has following skills: Sequential Processing Skill, Discrimination Skill, Analytic Skill and Spatial Skill (Keefe, 1987). It divided the learners into four styles, i.e., acting, hearing, reading and seeing. VAK Model uses the three main sensory receivers: Visual, Auditory, and Kinesthetic (movement) to determine the dominant learning style. It is sometimes known as VAKT modalities—channels by which human expression can take place and are composed of a combination of perception and memory (Honey, 1982). (Visual, Auditory, Kinesthetic, & Tactile). Table 1 lists the major learning style models used in learning environment.

Researchers used either learning style model or semantic web based approach. But not the both. In our approach a novel idea is conceived to combine the both to get dynamic and automatic outcome to devise the learning style of the learner.

Table.1.Learning style models

Model Name	Assessment Tool	Learning Styles identified	Description
Visual-Auditory-Kinesthetic-Tactile (VAKT)	Basic observation channels of human	visual (verbal), visual (non-verbal), auditory and kinesthetic	Basic for Dunn and Dunn learning style model and the Gregorc's Mind Styles Model and Style Delineator
Kolb's learning style model	Stages of Learning Cycle The learning cycle stages are: • Concrete Experience (CE) - feeling • Reflective Observation (RO) - watching •Abstract Conceptualization (AC) - thinking • Active Experimentation (AE) - doing	Accommodator Diverger Converger Assimilator	This process represents a learning cycle where all the bases on learning; experiencing, reflecting, thinking and acting are treated
Honey and Mumford's learning style model	Stages of Learning Cycle	Activist Reflector Theorist and Pragmatist.	Based on Kolb's work
Felder-Silverman model	4 dimensions 8 learning styles	sensory/intuitive visual/verbal active/reflective Sequential/global.	Considers way of learning, way of understanding, way of perception, and way of sensing as dimensions

B. Semantic web Technologies: The aim of the Semantic Web is exactly to provide the extra layer, to add structure or meaning to what is on the Web thus allowing intelligent navigation, personalization, querying and retrieval (Moreale, 2004). To achieve this, the information to be retrieved should be annotated with semantics. Moving towards web based and hypermedia education, personalization and getting structured meaningful information from various distributed resources to persuade individual user is greater challenge in emerging Semantic Web based Education. Increased Semantics offer students a more effective view of their learning and enables opportunities (Demetrios, 2004). It mentioned about the possible mechanisms using which reasoning of semantics can be achieved for better teacher learner community. Among those mechanisms, we have considered the concept of personalized content delivery in which intelligent tutoring systems have for some time being delivering content that was personalized for the user, based on an understanding of their goals and previous knowledge, Personalized sequencing where Adaptive Hypertext Systems attempt to provide pathways through materials by matching domain Ontologies with dynamically evolving user models and Adaptive assessment systems may choose questions for the learner at the boundary of their understanding; thus, improving the efficiency of assessment and providing feedback that provides detail in critical areas. Motivated by these opportunities, we have designed this learning style detection technique using ontologies (Milliard, 2006).

C. Ontologies: Ontology is formal, explicit specification of a shared conceptualization. Ontologies are the constructs which should be well defined, with machine readable computational semantics; commonly acceptable understanding that describes a particular domain. It is one of the ways of knowledge representation. Knowledge of particular domain is captured, stored and retrieved as ontologies. Ontologies are involved in extracting knowledge and making intelligent decision. Many intelligent agents use the ontology, derive the intelligence and pass this to other intelligent agents. Keeping ontologies as data model, Semantic web services increases the effectiveness of the output obtained from the WWW. It helps to improve machine supported interpretation. Web based e-learning solutions that incorporate collaborative techniques improve the accessibility of educational sources in a synchronous or asynchronous fashion. Collaboration, exchange of content and interoperations are required to increase the effectiveness of the LMS.

This can be achieved by capitalizing on the (1) semantic conceptualization and Ontologies, (2) common standardized communication syntax, and (3) large-scale service-based integration of educational content and functionality provision and usage. There are three main aspects to be analyzed and achieved for materializing this Semantic Web based e-learning systems. The first is the capacity for effective information storage and retrieval. The second is the capacity for nonhuman autonomous agents to augment the learning and information retrieval and processing power of human beings. And the third is the capacity of the Internet to support, extend and expand communications capabilities of humans in multiple formats across the bounds of time and space.

OWL Web Ontology Language is the one which is meant for processing the content of information. It is not used just for presentation. It helps to achieve more machine interpretability with the help of Ontology languages such as XML, RDF, and RDF Schema (RDFS) by providing additional vocabulary along with a formal semantics. OWL has three increasingly-expressive sublanguages: OWL Lite, OWL DL, and OWL Full. OWL has overcome all the above mentioned short comings of RDF and RDFS. It is built on top of RDF, and RDFS. It provides more and more appropriate and rich expressiveness with enhanced reasoning capability. Even though RDFS and OWL are used for ontology development, only OWL is now recommended. . With OWL, we can perform different ontology operations such as inheritance, unification, merging, alignment, and Integration which are useful in many domains and in reasoning.

3. METHODOLOGY

The following are the list of modules involved in our learning style detection.

A. Semantics Acquisition module: This module uses both collaborative and automatic learning style detection concepts where the behavior, interactions and interest of the learners are monitored based on certain list of activities. If the learner profile is available in knowledge base, that will also be obtained. Here the users are not directed to fill the lengthy questionnaire instead they perform certain activities of their own interest and belong to different learning styles for that relevant subject learning. For example, user may be asked to list out certain keywords which are relevant to the subject. The log information, frequency of accessing those activities, results obtained, time spent on those activities are tracked and used to find the learning style of the learner. The way to implement this module is maintaining session data and log information, fields/variables in web pages and using these data E-Learner's ontology constructed. As this module is based on web usage mining this module output given as static input to the learning style detection module

B. Learning Style Detection: Ontologies obtained from semantic acquisition module and profile/historical details of the learner are used to determine learning preference/style of the learner. Sabine Graf approach is to be extended to detect the Learning style. Ours uses the methodology where learner's behavior, actions, interactions and learner profile (if already exists in knowledge base) are stored in terms of Ontologies. The semantics obtained from the Ontologies are input for detecting learner's requirements. The approach in has been adopted to construct the ontology and detect the learning style of e-learner. We have used Felder and Silverman learning style model's 4 dimensions, and considered 8 type of learners. The reasons for selecting this FSLMS Model is, any E-Learner will fit into any of the below mentioned category or learning style. The recommendation given by Filppula 2006 is used for our reference to identify the learning objects for each learning style. The following list describes about these 8 types of learning style characteristics with identified activities to find the learning style of the learner. The dimensions specified in FSLSM model are way of Learning, Way of Sensing, Way of perceiving, and way of understanding.

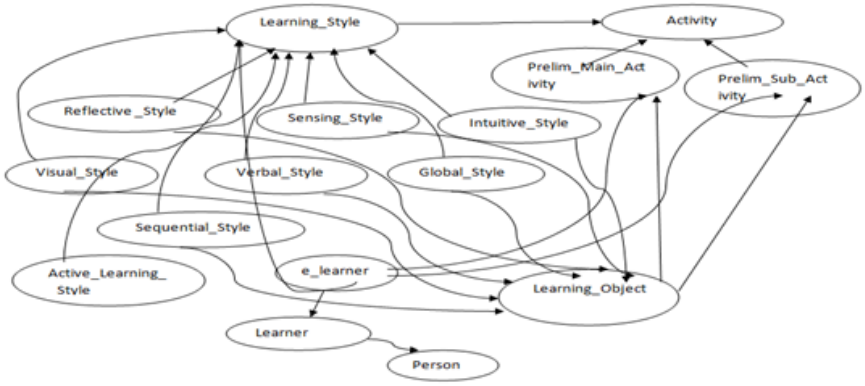

Figure.1.E-Learner Learning Style Ontology

1. Way of Learning

Active Learner Vs. Reflective Learner

Active Learner: Interested in Working in groups, willing to discuss with others,

Activity Identified: Forums, and Blogs links

Reflective Learner: Works alone, may be in a small group willing to work
Activity Identified: Game, and MCQ Test

2. Way of Sensing/ Perception

Sensing Learner Vs. Intuitive Learner
Sensing Learner: Careful learning / Concrete Learning Material/Existing ways
Activity Identified: Preliminary Test to know the knowledge level, Reading material
Intuitive Learner: Creating concepts and theories
Activity Identified: Problem Solving Quiz, Puzzles,

3. Way of Input

Visual Learner Vs. Verbal Learner
Visual: Interested in seeing pictures, diagrams, flowchart, slide shows, multimedia content
Activity Identified: Finding Flow chart, Algorithm and data analysis, graphs
Verbal Learner: Seeing books, Oral presentations, You tube videos, PPTs

4. Way of Understanding

Sequential Learner: Accessing all material in order
Activity Identified: PPT kept in order
Global learner: Takes whole structure/thing in single moment.
Activity Identified: Books, Complex Puzzle, connecting two different areas

C. Construction of Ontologies: To build ontology knowledge engineering approach has been used and following are the steps of the algorithm used to construct the domain ontology.

Determine the domain and scope of the Ontology: Based on certain basic and competency questions, the domain and scope of Ontologies are defined clearly

Consider reusing existing Ontologies: If one team develops Ontologies for a domain, other group can reuse or extend for their purpose.

Enumerate important terms in the Ontology: Helps to find out the relationships among various concepts used in the domain

Define the classes and the class hierarchy: Different approaches available such as top down, bottom up and combination of both. Whichever suits the requirements choose that approach to develop the hierarchy

Define the slots/properties of classes: This step is to provide information about classes, in turn helps to develop the proper internal structure of Ontologies

Define the facets/constraints of the properties: Consider the different facets about the property. For instance, Course may be delivered through multiple presentations. The cardinality, value type, participation in the relationship can be different facets of the Properties.

Create instances:

Creating instances of the classes in the hierarchy: We have identified the domain and scope and Questions to be answered and important terms to be used while modeling the ontologies. Our domain is E-learning and Scope is Learning Style Detection and the Questions to be answered: What is the learning style of the E-Learner?

Specifying the terms related to the domain: Learner, E-Learner, Learning Style, Activity, Learning Object, Main Activity, Results Obtained, Activity Access Frequency.

D. Steps in Learning Style Detection:

Input: E-Learners' choice on Prelim main and sub Activities and result of those activity-represented in Ontology
Output: Finding the learning style suitable for that E-Learner

1. Knowledge base is constructed using the ontology diagram specified in Fig. 2.
This involves creating classes, sub classes, data type properties, object properties and defining the roles and slots
2. Define the data property assertions and object property assertions, reasoning rules
3. Create the instances/individuals for all the classes
4. Run the reasoner and find the inferences using proper queries.

The flow diagram in Fig. 2 gives the flow of learning style detection. The domain ontology designed is depicted in Fig 1. In our implementation we followed these steps and created the knowledge base, tested the reasoning rules. E-Learner selects Main prelim and Sub prelim activities of his/her choice and performs those activities. E-Learner interaction and behavior (Activities attempted and frequency, time spent and results obtained) tracked and converted to E-Learner Current need and already available E-Learner information in the data base also used to convert them into E-Learner Ontology. To implement this step, E-Learners session data and web logs are the input to find the E-Learners' need. This concept is obtained from web usage mining. In E-Learner Ontology, based on the selected activity, reasoning rules specified in the knowledge base the inference of determining Learning style is carried out. Fact++ reasoner is used and DLQuery Language and SPARQL query language have been used to test

the knowledge base created. This modeling is done in Protégé and domain ontology obtained in Protégé OWLViz, Inferred results, and the outputs obtained using queries are in the Figures 3, 4, and 5 respectively.

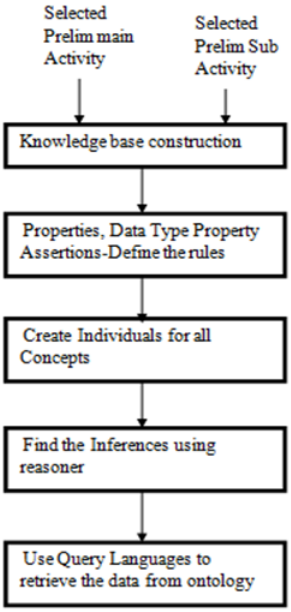

Figure.2.Learning Style Detection Flow Diagram

Figure.3.E-Learner Learning Style Domain ontology-Protégé Output

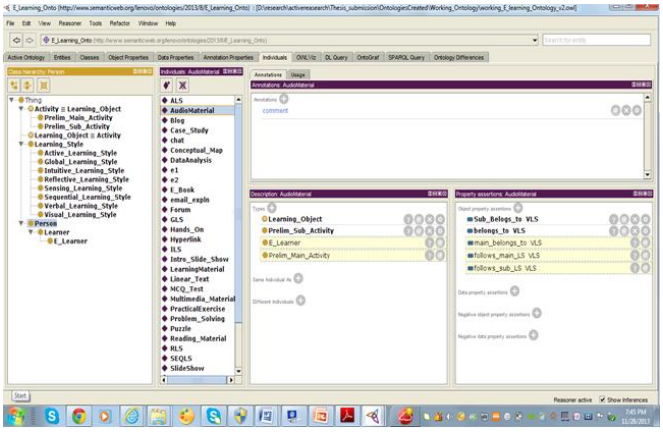

Figure.4.Protégé Inferred Results

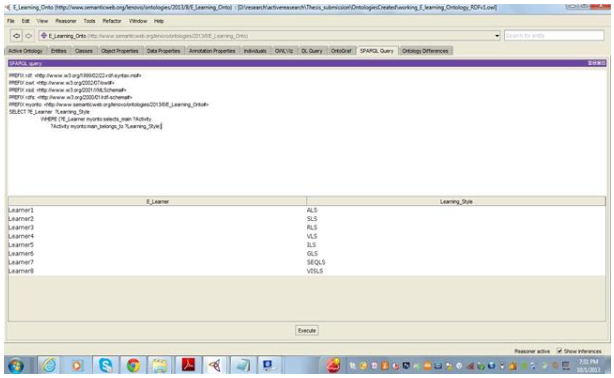

Figure.5.SPARQL Query Output

4. CONCLUSION

Lot of research is going on in semantic web based applications and it provides promising solutions. Semantic web provides wide ranges of solutions to many problems in different domains in information retrieval, Knowledge representation, intelligent systems, machine learning and many more. We have tried to find the usage of semantic web technologies in Learning Management System to incorporate personalization in online courses. From the research study carried out, it is to confirm that personalization achieved through this technology would be the permanent solution for an e-learning environment. In this paper we have suggested the method of finding learning style of the e-learner in order to provide the correct sequence of e-learning objects or services. We modeled the scenario in Protégé and obtained the output through querying the ontology. The student community today is referred to as "Digital children" by Layton where he describes them as "are more independent, more intellectually open, more tolerant, and more adventurous than most 20th-century children". E-learning is lacking the zeal and utilization. Fortunately, the awareness of e-learning and its benefits are increasing and attracting the student community to connect with the virtual platform to learn with effective understanding, share their knowledge, develop their competent skills.

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