SEALMS: SEMANTICALLY ENHANCED ADAPTIVE LEARNING MANAGEMENT SYSTEM

M.Farida Begam[1] and Gopinath Ganapathy[2]

[1]Department of Information Technology, Manipal University Dubai, U.A.E,
farida@manipaldubai.com
[2]School of Computer Science and Engineering, Bharathidasan University, India
gopinath.g@csbdu.in, drgg@bdu.ac.in

ABSTRACT

Semantic web technologies have been attracting interest in many domains. E-learning is not an exception which also involves with many activities or tasks such as instructional design, content development, authoring, delivery, assessment, feedback and etc. which can be sequenced and composed as workflow. Web based E-learning services should be focused in this aspect to fulfill variant e-learners' requirements. This paper focuses on the Adaptive instructional design framework in which three significant facets are considered 1) Knowledge extraction from user's behavior, interactions and actions and convert them into semantics 2) Detection of learners style from the semantics defined in the knowledge base and 3) Composition of the workflow for the variant learners to satisfy their requirements dynamically. In this paper we have proposed SEALMS –Semantically Enhanced Adaptive Learning Management System a theoretical framework tracks the learners profile and composes the services for learners using OWL-S. Modules of SEALMS include intelligent agents which perform a kind of reasoning and deriving results from the input fed, finally personalized workflow has been recommended for the e-learner. SEALMS is also a cyclic model where the feedback can be taken and reviving process can be initiated from the start to obtain the better results.

KEYWORDS

Learning Style, Learning Objects, workflow, web services, Semantics, Ontology, and OWL-S

1. INTRODUCTION AND OBJECTIVE

E-learning has been received more attraction among learners community. People who really believe in continuous learning-teaching processes also rely on World Wide Web. Designing a Semantic Web based e-learning framework which allows learners to determine their learning agenda and control their own Learning is a current necessity. This way of personalization help them to understand and assimilate the concepts and pertain knowledge in practical solutions. Dynamic Composition of e-Learning contents and e-learning services and Semantic Querying for Learning materials and constructing learners preferred courses are the features which to be implemented in the any adaptive e-Learning management system. E-learning services provided for the learners need to be customized according to their choice and requirements. This process involves detecting learners' style and building knowledge base and composition of workflow of

Sundarapandian et al. (Eds): ICAITA, SAI, SEAS, CDKP, CMCA, CS & IT 08,
pp. 49–57, 2012. © CS & IT-CSCP 2012 DOI : 10.5121/csit.2012.2505

e-learning services. The main objective of the e-learning framework SEALMS which is proposed in this paper is to develop a completely new, semantically enhanced, automatically composed adaptive e-learning system for dynamic learners.

This paper is organized in the following manner. Section 2 gives the insight of theoretical aspects of the framework. Section 3 is meant for literature survey and related work, Section 4 and 5 is dedicated to define the SEALMS framework and every module's functionality and implementation. Section 5 concludes the paper.

2. THEORETICAL BACKGROUND

In this section, we provide the theoretical concepts about various aspects of this paper.

2.1. Automatic Learning Style Detection

An adaptive system must be capable of managing learning paths adapted to each user, monitoring user activities, interpreting those using specific models, inferring user needs and preferences and exploiting user and domain knowledge to dynamically facilitate the learning process [1]. As per the definition by James and Blank [2] learning style is "the complex manner in which, and the conditions under which, learners most efficiently and most effectively perceive, process, store and recall what they are attempting to learn". The another definition of the same is learning styles represent a combination of cognitive, affective and other psychological characteristics that serve as relatively stable indicators of the way a learner perceives, interacts with and responds to the learning environment [3]. The learning style notion which we mean in this paper does not deviate much from this definition. This module of the framework does not require the learners to fill the questionnaire and spend their time instead the style is detected/extracted automatically from the learners profile and stored in the knowledge base. The suggested method of detection of learning profile uses OWL – Web Ontology Language to represent the profile semantically and extract the same to dynamically set the workflow for a specific learner.

Need for semantically enhanced automatically composed e-learning services: Personalization has become very crucial factor in e-learning, finding personalized workflow for a learner can be established using various ways. First method may be taking input through questionnaire and finding the learners' profile for sequencing. Second method takes very less input from learners and detects the style automatically. We focused in second method which may be implemented in various Ways. In our method we use Semantic Web technologies and Ontologies to develop the representation of learning objects, assessment Ontologies and competencies Ontologies that link learning with personal preferences and interest.
The following requirements that led us to design SEALMS

- Enable the student to evaluate themselves where they stand and what they need
- Identify themselves what kind of learner he/she is
- Integrate semantically enhanced tools, processes and tools in learning environment to provide meaningful sequencing of learning objects that facilitate automatic workflow composition according to the learner's traits and requirements.
- Learner can access LOs in knowledge based repository in just in time.
- To incorporate better Teaching-Learning-Feedback cycle which is effective enough to match the learners profile

2.2. Automatic composition of web services

Downsizing the learning content to meaningful units with manual, semi-automated and automatic procedures is a tough process [4]. Composition of web services is difficult task where automation is tough to achieve. Manual composition of workflows, as any user driven process, is a task prone to errors and inconsistencies [5]. In e-learning processing, the learner who does not know about his/her requirements, and who's learning profile need to be found may not involve in composition of e-learning web services. By user profile, and their behavior the LMS has to find user requirements. Simply linking the input and output parameters in the web services will not help. Automation of this work flow composition helps him/her to relieve from the burden of deciding what services they need.

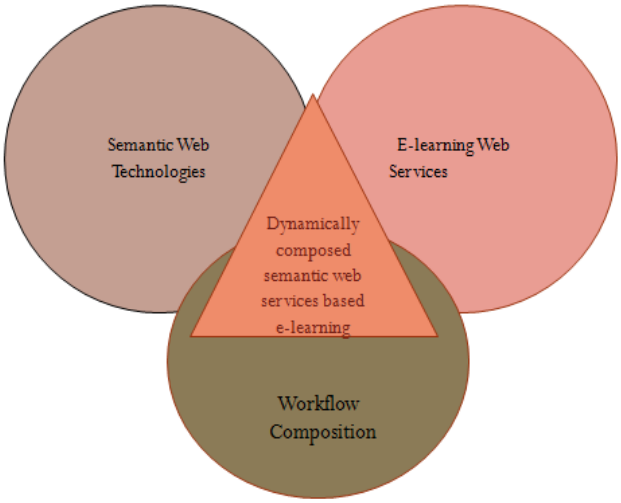

Figure 1. Conceptual Model

2.3. Benefits of SEALMS

The e-learning framework has been designed to combine the benefit of learning style detection, knowledge representation, ALMS (Adaptive Learning Management System), and work flow composition which is conceptually represented in Figure 1 to provide the following benefits to any e-learner.

- Meaningful workflow for dynamic learners whose behavior changes over time.
- Collaborating with people with similar experience
- enforces continuous learning
- Supports categories of learners styles
- Provides guidelines to Instruction designers to move toward with most appropriate design for their student community

3. LITERATURE SURVEY AND RELATED WORK

This section covers the similar work done by different approaches.

3.1. Learning Style Detection and Adaptive Learning Management System

Learning style concepts and related theories are very important as far as dynamic workflow composition of e-learning services is concerned**.** Learning styles are based on the research results of cognitive psychology about processing information, active learning and the structure of information [6]. There are different learning style detection models such as VAK learning style model, Kolb's learning style model, Honey and Mumford's learning style model and Felder-Silverman model. They have suggested learning style detection based on either collaborative approach or automatic approach. Collaborative approaches are based on questionnaire and input given directly by the learner. In automatic approaches, from learner's behavior, actions and interactions, learning style is detected. In this approach, learner may or may not aware of tracking of his/her interaction. The following is the list of work done in this automatic student modeling.

Popescu [1] introduced innovative e-learning frame work WELSA-Web based Educational system with Learning Style Adaptation that adapts to learning style of the students. They have used implicit or automatic modeling method which is based on students' observable behavior. WELSA combines both adaptive sorting and adaptive annotations techniques. Sabine Graf et al [7] propose an automatic student modeling approach, which analyses the actual behavior and actions of students during they are learning in an online course in order to infer students' learning styles which is similar to our SEALMS. It aims at identifying learning style preferences within the four dimensions of the Felder-Silverman learning style model (FSLSM). The approach is based on patterns derived from literature and a simple rule-based method for calculating learning styles from the students' behavior.

Nabila Bousbia et al [8] proposed automatic learning style detection from observable indicators related to the learner's behaviors and actions. They use user's interactions and browsing response for detection. Farman Ali Khan et al [9] proposed learning and assessment tool/framework tracks the learners' knowledge progress, provides an assessment, and supports the learner by offering hints, help, and feedback. The proposed learning styles and affective states tool not only calculates the learning style from patterns of behavior but it also predicts certain components of the affective state i.e. motivational/emotional state of each individual user while interacting with the system. Khan et al [9] discuss that affective state of learner plays major role in effectiveness of e-learning. [16] Dung and Florea concentrate on intelligent agents that can provide the learners with personal assistants to carry out learning activities according to their learning styles and knowledge level.

In Adaptive LMS, learner's interest, goals, and their prior knowledge in that subject are major concerns. In this kind of LMS, student centered approach is given more significance. The rationale behind adaptive LMS is that accommodating the individual differences of the learners (in terms of knowledge level, goals, learning style, cognitive abilities, etc.) is beneficial for the student, leading to an increased learning performance and/or learner satisfaction[1]. Student's behavior cannot be predicted in static way. Especially when he/she involves in on line learning, their behavior changes over time. Designing such kind of e-learning system is really challenging task and it is a need of current learner's community. Wolf C [10] has tested whether media experiences improves learner's performance or not. In his project iWeaver [10] he has done this research with multimedia students and found better results with low interest students. Melody Siadaty and Fattaneh Taghiyareh [11] used the Jackson's Learning Styles Profiler (LSP) [12] in order to model the learning styles of the learners. Jackson defined five learning styles: sensation

seeker, goal oriented achiever, emotionally intelligent achiever, deep learning achiever and conscientious achiever [1].

Our approach combines the Sabine Graf model and Jackson Learning Style Profiler where we implement the method and use semantics and knowledge base of Ontologies to derive the learning styles in LSP [1]. We prefer to use this model because a learner will fit into any one of these categories. Our SEALMS considers this as input and aims to provide proper workflow composition of e-learning services.

3.2. Automatic workflow composition:

Instruction technology can be defined as a combination of instruction design and instruction development. While scheming instruction design for web based LMS, we need to concentrate on sequencing of e-learning services to learners. The area of e-learning consists of a multiplicity of complex activities, such as content authoring or learner tracking and administration which interact with resources (including people such as learners and authors), with one another (some activities trigger others), and with the outside world (such as existing software systems) in a predefined way [13]. This section briefly explains about various workflow composition techniques used in real business applications.

Jihie Kim et al [5] specify AI planning techniques in which rich knowledge base is used for automatic composition. They have implemented an approach to interactive workflow composition that incorporates 1) knowledge-rich descriptions of the individual components and their constraints; 2) a formal algorithmic understanding of partial workflows, based on AI planning techniques. Using this approach, a system can analyze a partial workflow composed by the user, notify the user of issues to be resolved in the current workflow, and suggest to the user what actions could be taken next.

Jorge Cardoso and Amit Sheth [14] discuss about QoS model for work flow composition. They have brought a model that will allow for the discovery of Web services and for the composition of workflows based on operational requirements such as which includes their timeliness, quality of products delivered, cost of service, and reliability. They have recommended that a good management of quality leads to the creation of quality products and services, which in turn fulfills customer expectations and achieves customer satisfaction.

Xubo Fei and Shiyong Lu [15] uses data flow driven approach for composing scientific workflow. In this paper they have suggested a dataflow-based scientific workflow model that separates the declaration of the workflow interface from the definition of its functional body; a set of workflow constructs, including Map, Reduce, Tree, Loop, and Conditional which are fully compositional one with another, a dataflow based exception handling approach to support hierarchical exception propagation and user-defined exception handling are the unique features of this paper.

4. SEALMS FRAMEWORK

This framework in Figure 2. focuses on a cyclic model which includes continuous learning – feedback-update-learning cycle. It seamlessly integrates the following modules:

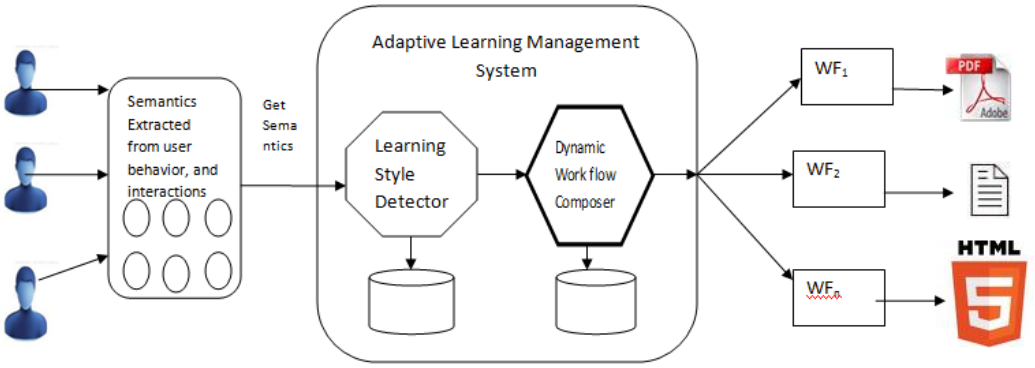

Figure 2. SEALMS-Framework

SEALMS framework can also be considered as QoS model which takes learners style as operational metric to decide the work flow of e-learning services. This framework has been divided into the following modules mentioned below.

Input module: This module is based on the technique which uses mix of both collaborative and automatic concepts where the behavior, interactions and attitude of the learners are tracked 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 (games kind) for that relevant subject learning. For example, user may be asked to list out certain keywords which are relevant to the subject.

Semantics Acquisition Module: From the user input Ontologies constructed and stored. Here the context ontology, learning object related ontologies such as i) Learner Ontology ii) Learner Style Ontology iii) Domain Ontology iv) Pedagogical Ontology v) Adaptation ontology vi) Workflow ontology are constructed. This module does not involve users. This module automatically detects available learning objects and takes the ontologies for that subject specified by the user.

Knowledge Extraction/Learners Style Detector Module: Ontologies obtained from knowledge acquisition module and profile/historical details of the learner are used to determine the kind of learner in other words learning preference of the learner is detected. [17] Sabine Graf approach is to be extended where learner's interaction and their behavior related ontologies stored in knowledge base and extracted 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. Ontology reasoners are involved to perform different operations such as union, intersection, merge and refinement on ontologies can be performed to find out the learning style of the e-learner [18].

Work flow composer module: Web services are independent entities. Achieving inter operability among heterogeneous web services is challenging task. The standards that are used for building independent, portable, inter operable web services are WSDL, SOAP and UDDI. But WSDL uses syntactical description of the web service. Workflow which is an abstraction of business process composed of one or more web services sequenced to resolve the business request. Syntactical nature of WSDL doesn't allow the composition or orchestration of these services statically or in other way with user intervention. Automatic composition can be achieved

with Web Ontology language OWL-S in building semantic web services. Profile, grounding and process ontology are used to compose the services dynamically. The planner or composer in this is responsible for this workflow plan generation. There are several Heuristic approaches available. The one which we find suitable for dynamic composition is A* search algorithm. A* is one of the many search algorithms that takes an input, evaluates a number of possible paths and returns a solution. This algorithm is similar to greedy best first algorithm which takes history of nodes traversed. Semantic web based E-learning services which provide different learning objects as a sequence will be identified for the learners preference. The composer which takes learning styles ontologies and learning Object ontologies use variant A* algorithm to determine the best workflow.

Execution module: Realizes the work flow sequence obtained in composing module. Messaging happens to communicate among various entities in the sequence. Correct sequence of services executed and sequence will be provided to the Learners

5. IMPLEMENTATION

This conceptual framework is under implementation in Jena Framework which is meant for creating semantic web application**.** The evaluation of this framework is to be conducted for various real time data. The results, findings and comparative study on various other ALMS will be carried out after the completion of the project.

6. CONCLUSION

Personalization is a vision of Web 3.0 which next generation web. Instruction design is an area which is still not given significance as far as semantic web concerned. Achieving this goal in e-learning services is challenging one. In this paper we try to provide the theoretical aspects of combining two- three areas of our interest and bridge the gap between these fields. We are currently trying to implement the same. The conceptual framework SEALMS combines learning style detection, ontology operations and knowledge management for reasoning and dynamic composition of e-learning services using planning algorithm to provide the benefits listed below

- Meaningful workflow for dynamic learners whose behavior changes over time.
- Collaborating with people with similar experience
- enforces continuous learning
- Supports categories of learners styles
- Provides guidelines to Instruction designers to move toward with most appropriate design for their student community

In this framework, we consider e-learning services into major consideration. But this approach can be applied to various business domains where dynamic composition is compulsory.

REFERENCES

[1] Popescu, E., Badica, C.,& Moraret, L. "Accommodating Learning Styles in an Adaptive Educational System," Informatica , vol. 34 2010, no. Computational Linguistics and its Applications, p. 451–462, March 2010.

[2] Boticario, J G.,Santos, O C., Van Rosmalen P., "Issues in Developing Standard-based Adaptive Learning Management Systems," in EADTU 2005 Working Conference: Towards Lisbon 2010: Collaboration for Innovative in Lifelong Open and Flexible Learning, Italy, 2005.

[3] J. Keefe, "Learning Style: Overview," NASSP's Student Learning Styles: Diagnosing and Prescribing Programs, National Association of Secondary School Principles., pp. 1-17, 1979.

[4] Lytras, M., Sicilia, M., "Knowledge society a manifesto for knowledge and learning. Int. J. Knowledge and Learning 1(1), 1–11 (2005)

[5] J. Kim, M. Spraragen and a. Y. Gil, "An Intelligent Assistant for Interactive Workflow Composition," in Proceedings of the 9th international conference on Intelligent user interfaces IUI 04, Island of Madeira, Portugal, 2004.

[6] E. Kanninen, "Learning styles and e-learning," Tampere, 2008.

[7] Graf, S., Viola, S R., and Kinshuk, "Automatic Student Modelling for Detecting Learning Style Preferences in Learning Management Systems.," in In Proceedings of the Iadis International Conference on Cognition and Exploratory Learning in Digital Age, Algarve, Portugal, 2007.

[8] Bousbiaa, N., Jean-Marc L., Issam, R., Ballaa, A. "How to determine the Learners' Learning Styles in e-Learning Situation?," in Proceedings of The 16th International Conference on, 2008.

[9] F. A. Khan, E. R. Weippl and A. M. & Tjoa, "Integrated Appraoch for the Detection of Learning Styles & Affective States," in In G. Siemens & C. Fulford (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2009, Honolulu, Hawaii, June 2009.

[10] Wolf, C., "Construction of an Adaptive E-learning Environment to Address Learning Styles and an Investigation of the Effect of Media Choice" RMIT University January 2007

[11] Siadaty, M., Taghiyareh, F. "PALS2: Pedagogically Adaptive Learning System based on Learning Styles," in Seventh IEEE International Conference on Advanced Learning Technologies (ICALT), Niigata, Japan, 2008

[12] Jackson. C. [Online]. Available: http://www.cymeon.com.

[13] Westerkamp, P., "E-Learning as a Web Service," in 7th International Conference on Database Engineering and Applications (IDEAS), IEEE Computer Society Press, Hong Kong, China, 2003.

[14] J. Cardoso and Sheth. A., "Semantic e-Workflow Composition," Journal of Intelligent Information Systems (JIIS), vol. 2003. 21(3) , pp. 191-225. , 2003.

[15] X. Fei and S. Lu., "A Data flow Based Scientific Workflow CompositioN framework," IEEE Transactions on Services Computing, vol. 5, no. 1, pp. 45-58, Jan-March 2012 2012.

[16] P. Q. Dung and A. M. Florea, "A literature-based method to automatically detect learning styles in learning management systems," in WIMS' 12 Proceedings of the 2nd International Conference on Web Intelligence, Mining and Semantics , Craiova, Romania, 2012.

[17] S. Graf, "Adaptivity in Learning Management Systems Focussing on Learning Styles," Austria, 2007. Ph.D thesis

[18] Farida Begam, M. and Ganapathy, G, "Knowledge Engineering Approach for constructing Ontology for e-Learning Services," in International Conference on Advanced Computer Science and Information System (ICACSIS 2011), IEEE explore Digital Library., Jakarta, Indonesia, 2011.

Authors

M. Farida Begam received her Bachelor of Engineering in Computer Science and Engineering from Bharathidasan University, India in 1998 and Master of Technology in National Institute of Technology, Trichy, India in 2006 and she worked as a Technical Evangelist in Infosys Technologies, India and now she is working as Senior Lecturer in the Department of Information Technology, Manipal University, Dubai Campus, U.A.E. She is currently pursuing Ph.D., in Bharathidasan University, India in the field of Semantic Web based E-learning. She is also CCNA Certified Instructor. Her research interests include Web technologies, Semantic Web, Computer Networks, Operating systems and Security.

Gopinath Ganapathy PhD is the Head, School of Computer Science Engineering and Applications, Bharathidasan University, India. He did his under graduation and post-graduation in Computer Science and Applications in 1986 and 1988 respectively from Bharathidasan University, India. He obtained his PhD degree, in Computer Science in 1996, from Madurai Kamaraj University, India. Received Young Scientist Fellow Award for the year 1994 and eventually did the research work at IIT Madras. He published around 20 papers. He is a member of IEEE, ACM, CSI, and ISTE. He was a Consultant for 8.5 years in the international firms in the USA and the UK, including IBM, Lucent Technologies (Bell Labs) and Toyota. His research interests include Semantic Web, NLP, Ontology, and Text Mining.