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Semantically Enchanced Personalised Adaptive E-Learning for General and Dyslexia Learners: An Ontology Based Approach

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ABSTRACT

E-learning plays an important role in providing required and well formed knowledge to a learner. The medium of e- learning has achieved advancement in various fields such as adaptive e-learning systems. The need for enhancing e-learning semantically can enhance the retrieval and adaptability of the learning curriculum. This paper provides a semantically enhanced module based e-learning for computer science programme on a learner-centric perspective. The learners are categorized based on their proficiency for providing personalized learning environment for users. Learning disorders on the platform of e-learning still require lots of research. Therefore, this paper also provides a personalized assessment theoretical model for alphabet learning with learning objects for children's who face dyslexia.

Keywords – **E-learning, personalized, Semantic, Ontology,**

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I. INTRODUCTION

The hypothesis of semantics takes into consideration the recognizable proof of the parts that different constituents have in an occasion: the practitioner of the activity, the recipient of the activity, the individual towards whom the activity is coordinated, the methods and reasons for an activity, and so forth. Through this paper, we propose to present semantic casings in e-Learning sites, with the conviction that learners may discover it less demanding to learn ideas in the event that they are offered in a semantically related way. So as to accomplish this, we propose a framework that, for each idea sought by the learners, offers a system of ideas, by dissecting the semantic relations which show up between ideas.

An ontology is an unequivocal detail of a conceptualization that alludes to the mutual comprehension of some area intrigue, which might be utilized as a bringing together structure to encourage learning sharing [1]. Ontologies permit key ideas and terms applicable to an offered space to be distinguished and characterized in a structure ready to express the information of an area or a portion of the truth/world. Its perceived ability to speak to information, to encourage thinking, utilize and trade learning between frameworks or learners adds to expand the computational insight of its framework. Therefore, ontologies can be utilized to help learning administration and to give some knowledge to e-Learning frameworks.

As e-Learning is widely applied, it's necessary and urgent to solve the problems in e-Learning applications, among them, learning resource sharing is one of the core problems. As web technology is to be mature and widely applied, learning resources can be realized a wide range of distributing and sharing through the Internet. At the same time, different learning management systems likewise provide the creation and distributing capacity for the learning resources.

In any case, these learning resource sharing stage still exist evident defects:

1. The resource sharing of web stages exists serious defects, for example, learning resources query and situating compares trouble; Resource access management area restricts the learning resources extensive partaking in a wide range.
2. The learning resources official with a wide range of learning management system have the remarkable difference in media designs, work definitions and stage consistency, hard to achieve the cross-stage sharing and interoperability.

The arrangement of these problems demanded a clear, consistent semantic expression. The concepts of semantic web and philosophy offer us the contemplations on taking care of e- learning resources development problems. These days, personalized learning systems are a key point in the field of web based learning as there is no settled learning way which is proper for all learners [2]. Yet, customary learning frameworks disregard these systems prerequisites and convey a similar learning substance to all learners.

This approach may not be compelling for learning with various foundations and capacities. Keeping in mind the end goal to outline a versatile learning content, we have to empower the conveyance of learning content as indicated

Volume: 10 Issue: 01 Pages: 3717-3723 (2018) ISSN: 0975-0290

by specific learner's needs. Besides, late advancements of semantic web advances have demonstrated a pattern of utilizing ontologies to advance adaptive learning which enables us to make particular client profiles and substance models.

Ontology is a formal, express determination of a conceptualization [3]. This depiction has prompted the accentuation that ontologies speak to theoretical clarification of the particular substance. They support educators on content creation or learners on getting to content in a learning guided way. Consequently, in this paper we propose an ontology-based knowledge modeling technique to designing an adaptive e- learning system in which learner's knowledge, abilities, learning styles and preferences are considered in the learning process. In this system, the ontological user profile is updated based on the abilities that learner's achieve. This approach additionally classifies the learning contents into fine levels of categories which are explicitly annotated utilizing descriptions from domain and content ontology..

II. ONTOLOGIES FOR KNOWLEDGE REPRESENTATION IN E-LEARNING OF COMPUTER SCIENCE

A more precise search for learning assets, made conceivable by the unequivocal instructional capacity, prompts better reuse and less duplication, subsequently speedier writing of educational programs. By looking for instructionally appropriated learning material, learners can connect information holes all the more proficiently

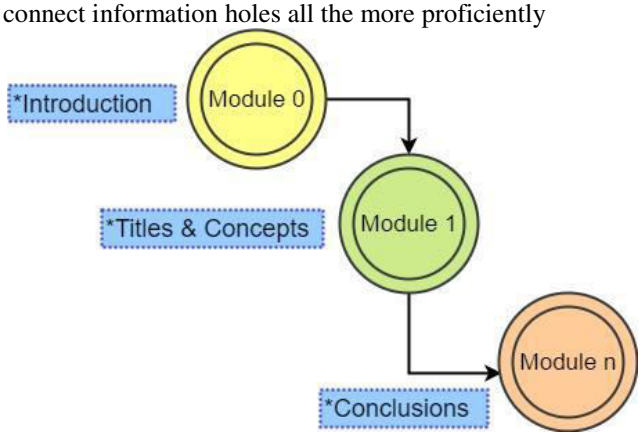

Fig 1. Learning - Domain Level: Subject Overview

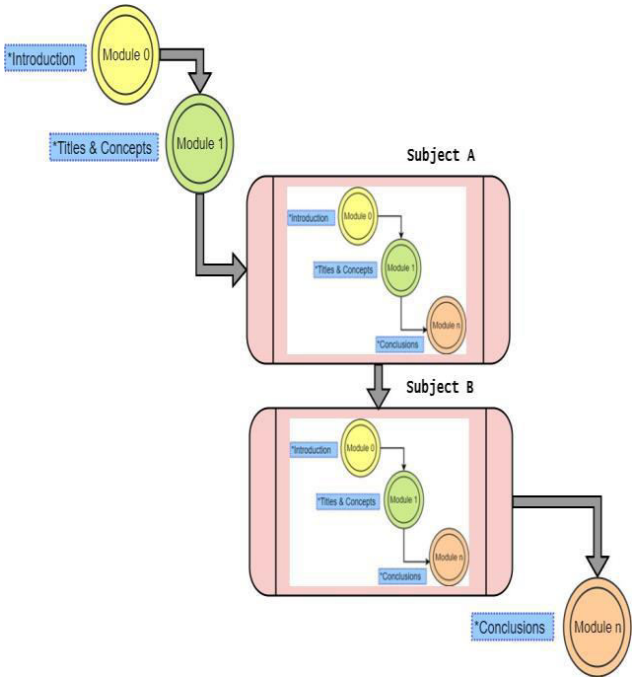

Fig 2. Learning - Programme Level: Conceptual Overview

An ontology can be utilized to speak to a learning (unequivocal) information base, encouraging the order of its components and along these lines thinking over it. To achieve this reason it is expected to see how to compose learning related information and change it inappropriate and moniker learning objects. Likewise, such related information ought to be composed to guarantee learning objects taking care of. Along these lines, the work of an ontology to speak to learning is a fitting objective.

As a sequence of these ideas, authors identified a methodology to help on the development of an e-Learning ontology. Such methodology is MENTOR, a methodology to support the development of a common reference ontology for a group of organizations sharing the same business domain [4]. This methodology has a light version focused on the building of ontologies from scratch. It is composed by two phases: one for the lexicon settlement and the second for the ontology building.

In the following it is presented a small example of its use. It starts by the definition of some basic terminology gathering and its definitions attribution (glossary building) through its representation in a thesaurus structure and finally its consequent ontology building. The concepts chosen to be presented here are directly related to elementary e-Learning elements or objects and structure, and represent the starting point to the lexicon definition of the ontology.

A leaning object is any group of materials that is structured in a meaningful way and is tied to an education objective. In the creation of a learning object, the author should consider how it relates to other existing learning objects and other educational materials available in the platform [5].

A learning course is an ordered process or succession of a number of lectures dealing with a subject overview on domain level (fig 1). It is conceived in a way that meets

Volume: 10 Issue: 01 Pages: 3717-3723 (2018) ISSN: 0975-0290

the specific desires and expectations of a determined target audience. A learning course is divided into several modules, according to the topics that are addressed. A learning module is a small piece of a learning course, essentially a lecture, with a very clear objective. Several modules of the same topic area can be grouped together to form a learning course as illustrated in Fig.

A Learning Programme is a significant long-term learning activity which comprises a set of learning courses and/or learning modules(Fig 2). It is a construct conceived for learning in specific fields focusing on a given audience and using a selected delivery approach. Reference learning programmes are those that are designed for reference target audiences (especially relevant within a given learning environment) and that serve as orientation for targeted learning execution [6].

A learning curriculum is the set of related instructional elements and content offers in a given field of study. It's designed to establish the underpinning that is used to frame the learning course elements. There could be several learning curriculum areas, and each usually has at least one subject defined with its direct contents of such area (Fig. 1).Nevertheless there are some learning concepts that are used by other areas, so it is usual to find subjects that exist in several learning curriculums. Such relations give some complexity to the classification of these learning elements [7].

A dynamic learning curriculum is a curriculum, which its associated learning subjects are modularized in the sense to be able to pick up a module from them if appropriate, to a specific learning programme (Figure 2). The Module 1 could come from a subject where all the other modules are not dynamic curriculum. The dynamic learning curriculum is therefore flexible, learner- centric and competency based. This conceptual framework holds instructional elements (modules and materials) by focusing on atomic competences and skills within established domains [7].

The main difference between a learning curriculum and a learning programme is that a learning programme is designed to develop specific skills, and the learning curriculum embraces all the fields of area of study. It is usual to find several learning programmes within a particular learning curriculum. There are various ways to organize and deliver the learning content, depending on the subject matter and the trainer preference.

Specifications and standards in e-learning enable different independent assets of learning to coexist for effective and better learning outcomes and also support properties like :

1) Interoperability, making it possible to work with other Learning Objects and with Learning Management Systems; 2) Reusability, allowing others the use of the objects created, even in different ways that firstly the object was designed for; 3) Accessibility, adding the information needed for quick and easy discovery so it can be found by other developer; and 4) Durability, by using the latest metadata standards so the lifespan long [8].

Many organizations like IMS, IEEE, ARIADNE, ADL, and AICC are making standards in the field of e-learning and most of the standards made by them are becoming the de facto standards in e-learning. These standards have been defined to structure learning by also providing metadata to represent its objects (e.g. multimedia content, instructional content, learning objectives, instructional software, learner profiles, etc.).

III. PERSONALIZED ASSESSMENT MODEL FOR E-LEARNING ON A LEARNER-CENTRIC PERSPECTIVE

Personalized e-learning has become even more advantageous. When the system presents the learning content as per learner preferences, then a personalization has been added to e-learning platform. For example, for the same content, there is a video lecture and audio lecture based on learner's choice.

One student learns through video and other through audio. There are various possible ways for the machine to learn what learner prefers for acquiring knowledge. These are:

i) Learning Style: There is various learning style model such as Felder-Silverman learning style model (FDSM), Dunn and Dunn model, Honey and Mumford model, etc. These models describe different ways of learning like visual, verbal, etc.

The famous learning style model is FDSM in which a learner has been categorized in four dimensions, i.e., active-reflective, visual-verbal, sensing-intuition and sequential-global

ii) Cognitive Traits: These cognitive traits describe how a learner perceives knowledge. They include reasoning ability of learner, their decision-making approach and learning skills This paper proposes a personalized approach where the focus lies on a learner-centric perspective of retrieving concepts from subjects according to learner's necessity.

The system defines any evaluating methodology such as questionnaire or quiz to conclude an opinion about the learner. This opinion then acts as an operator in tuning the necessary curriculum that could save the learner's time and also refines the e-learning modules to make it more personalized and adaptive.

Personalized Ontology construction is an iterative process and involves the following steps:

i) Design: Specifies the scope and purpose of the ontology with respect to personalized assessment of learners. Also reveals the relationship among classes and subclasses for traversing between concepts to aid them.

ii)Develop: Decides whether construction of ontology has to be done from scratch or to reuse an existing ontology so that it suits their expectation and also do not fail to address any concept.

iii) Integrate: Combine the developed ontology with the already existing one and reframe the graph structure every time when a learner shifts from one level to the other.

Volume: 10 Issue: 01 Pages: 3717-3723 (2018) ISSN: 0975-0290

iv) Validate and Feedback: The completeness of the constructed ontology is verified with the help of automated tools or by seeking the opinion of the experts.

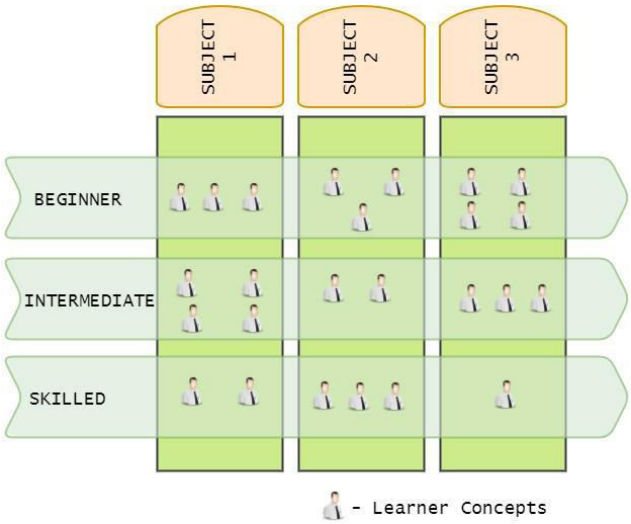

Fig 3. Learning Curriculum on learner-centric perspective

The above figure illustrates the personalized assessment pro- posed in the paper, the learners are categorized into Beginner, Intermediate and Skilled based on their proficiency.

This enables the author to cover all the subjects necessary for the learning programme with no degree of repeatability in concepts he is already familiar with. This enhances the E-learning system, over an ontology based approach as the level of the learner also acts as a class entity in the ontology to make information retrieval more accurate with relation to subclasses. The user model repository is queried frequently with regards to learner's abilities and preferred learning styles.

IV. ADAPTIVE E-LEARNING FOR LEARNER WITH DYSLEXIA DISABILITY

According to dyslexia association of India, "Dyslexia is a neurological condition that affects the ability of a child to read, write and spell. Dyslexic's find it difficult to visualize an alphabet properly. The alphabets appear to them in a swirled or distorted format. Hence, it is difficult for them to visualize the letters correctly. [11] give an e-learning architecture based on ontology for various disabilities which includes learning disorders.

A multimedia model has been defined to teach dyslexics with the help of computer science [12]. There are two frameworks for adaptive e-learning system for dyslexia. The first framework uses various dimensions and attributes. The framework has been validated using empirical approach [13].

Dyslexics can use e-learning systems using assistive technology[14]. The second framework is an open agent-based framework based on various models such as the model of teaching, the model of contextualization, authoring model and cognitive model. It has used reuse strategy [15].

Assistive technology has been used such as audio, video and speech recognition to aid dyslexic learning [16]. The course materials for dyslexia can be made using hardware and software [17].

The Semantic web-based educational system includes software agents, ontology and learning objects [18]. Also, research has proved that E-learning systems have high-quality resources as well as quality learning methods due to determinants like IT-infrastructure [19].

Collaborative e-learning systems can share resources between two institutes to provide better learning facilities [20]. Network dynamics for dyslexics has proved that remedial action for dyslexia should not focus on single processing methods instead it should be dynamic [21].

M-learning tools using customized multi-model method for dyslexics were made using cloud computing [22]. Based on research conducted in Dyslexia Association of Malaysia, It concludes that computer- based approach is more helpful for dyslexic students than paper- based approach. Also, result has shown that color and fonts for teaching a dyslexic is an important parameter [23].

This Paper gives a cognitive approach to help dyslexics in recognizing English alphabets based on their cognitive traits. There are three different cognitive dimensions for dyslexic [24]:

a. Multidimensional
b. Inferential
c. Hierarchal

The characteristics for multidimensional cognitive includes inclination towards complex structure and designing. Characteristics of inferential cognitive include determining similarities and differences among different domain concepts. And, the hierarchal characteristics include pattern understanding and recognition.

The Ontology for personalized e-learning systems for dyslexia has the domain of children's who face dyslexia. The system contains learner ontology and pedagogical ontology. The dyslearner class has subclasses name and cognitive. The cognitive subclass further divides into subclasses multidimensional, inferential and hierarchal. The Learning Resource class is also classified into multiLO, HierLO and InfiLO for multidimensional, hierarchal and inferential cognitive based, learning objects, respectively.

Dyslearner Class: This class modeled the concept of chil-dren's who face dyslexia. The name subclass of dyslearner class is used to hold instances of personal details of the dyslexic learner.

Learning_Resource Class: This class is used to model the concept of learning objects for personalized e-learning systems for dyslexia. The subclass multiLO, HierLO and InfiLO denote concepts of learning objects for multidimensional cognitive, hierarchal cognitive and inferential cognitive respectively. The subclass MultiLO is further classified into multityro, multimediocre and multivirtuoso which indicates, beginner, middle and expert level of the learner in the respective learning content. Similarly HierLO and InfiLO are further classified into

Volume: 10 Issue: 01 Pages: 3717-3723 (2018) ISSN: 0975-0290

subclasses for Hiertyro, Hiermediocre, HierVirtuoso and infityro, infimediocre, and infivirtuoso, respectively.

a) Object Properties and Data Properties: Object properties define relationships that exist among two resources. The object properties are, has, CogTreeX and inclines. The "has" property relates learner and cognitive.

The "inclines" property relates the class name to multidimensional, hierarchal and inferential. The CogTreeX (where X = {M,H,I}) property shows relationship between learner and the assessment page required for learner in cognitive path. The CogTreeX property also relates learner to learning_resource at last level of the cognitive path.

The data property 'age' has range type as integer values. The data properties MultiValue, HierValue and InfiValue, has 'name' class as its domain and used to store and retrieve inclination value of the learner in multidimensional, inferential and hierarchal cognitive, respectively.

The classification of learning objects in e-learning environment for dyslexia is based on pedagogical, reusability and complexity. The bidirectional relationship. indicates that a learner may switch from one cognitive dimension to another cognitive dimension.

Each learning objects have been categorized further into beginner, middle and expert level which connects in a bidirectional relationship indicating that learning content may change depending on learner's performance as discussed in the previous section.

Fig 4. a) The alphabet 'I' designed at beginner level (b) The alphabet 'I' designed at the middle level

These structures are k-dimensional figures where the value of k decreases with increase in learner's level of performance. These learning objects have characteristics of the learner cognitive. It will help the learner in understanding lines formation of alphabet 'I'.

V. CASE STUDY

A. Ontology for E-Learning in Computer Science Domain:

The main objective of this ontology is to create a knowledge base for Computer Science E-learning. It provides relevant results based on domain specific knowledge and improves both the precision and recall.

1. Create New Ontology for Subject Domain:

The major subjects that constitutes the computer science programme are noted. The possible concepts that has to be evolved with the subject is prepared. And an ontology comprising the above is created dynamically.

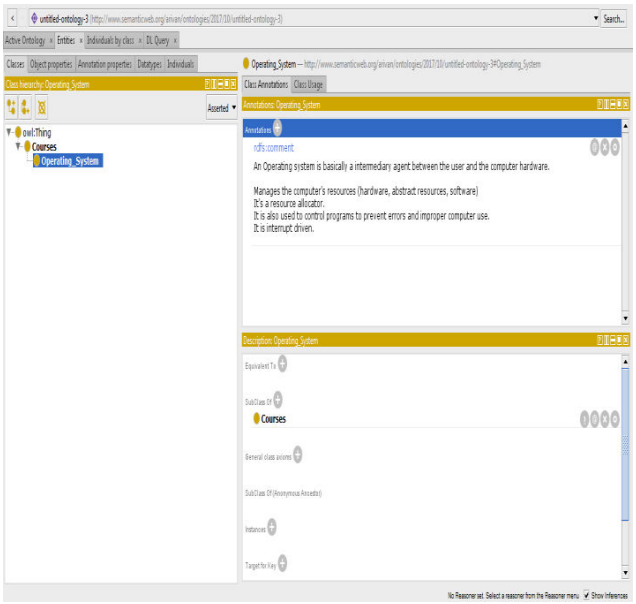

Fig 5. Case Study Illustration: Overview

2. Add a comment to ontology:

Using 'Active Ontology' Tab in the 'Ontology Annotations' view adds a comment, "This is the ontology that describes various sources of E-learning in computer science domain. The comments provide a self explanation for the structure of the ontology.

3. Create Subclasses for Subject and Concepts:

With 'Add subclass' button in the 'Classes' tab creates Access Type, Document,, Generic Concept, Learners Profile etc as sub- classes of 'Thing'. Repeat same process to create Facilitator, Learner as subclasses of Actor. Author, Manager, Presenter, and Teacher as subclasses of Facilitator. Concept, Course, Knowledge element as subclasses of Generic Concept as shown in Fig.

4. Add individuals to a class:

Add individuals to a class using 'Add individual' button in 'individual members list view'. Ex: D1, D2, D3, D4, D5, D10, D11, D12 etc as individuals of Document for concept notes and assignment questions.

5. Add OWL Properties

With 'Add Object Property' button of the 'Object Properties' tab create Object Properties like ConsistsOf Documents, ConsistutedOf, Creates, dependsOn, relatedTo, Implies, subtopic Of etc.

Volume: 10 Issue: 01 Pages: 3717-3723 (2018) ISSN: 0975-0290

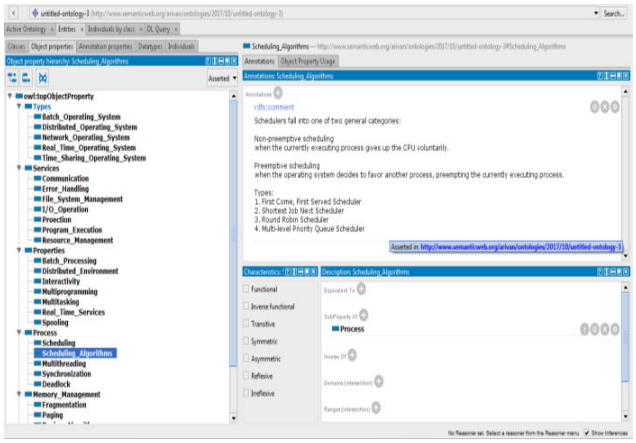

Fig 6. Case Study Illustration: Properties.

6. Invoke a Reasoner*:*

Invoke Reasoner to check asserted class hierarchy and the inferred class hierarchy. The asserted class hierarchy matches with the inferred hierarchy and no inconsistencies so nothing is displayed in the 'Class hierarchy' view.

7. Executing DL Query:

Ontology can be tested in the query search engine of the Protégé tool for the given query. Query1: Reference Material and has Resource Type some (Proceeding or journal) Result: Search engine displays list of documents those have resource type of proceeding or journal.

8. Represent ontology graph:

The graph shows semantic relationships between classes and instances of E-learning Domain .

VI. CONCLUSION

OWL which has more expressive power has been chosen to develop ontology. The proposed system is an effort to provide personalized assessment in an E-learning domain. Our experi- mental results show that the learner's context can be effectively used for improving the performance of learner and also efficiency of the learning system. This paper presents an ontology-based approach to develop a personalized e-learning which creates adaptive content based on learner's abilities, learning style, level of knowledge and preferences. In the approach, ontology is used to represent the content, learner and domain models. The learner model describes learner's characteristics required to deliver tailored content. The domain model consists of some classes and properties to define domain topics and semantic relationships between them. The content model describes the structure of courses and their components. The system recognizes changes in the learner's level of knowledge as they progress. Accordingly, the learner model is updated based on learner's progress and the passage from one stage of learning process to the next stage is determined based on the updated learner's profile. Several problems, among which we may highlight the size and heterogeneity of the content or the need for simple ways of interaction with users, keep this line of research open to further improvements. The paper also discusses a theoretical approach of designing a e-learning system that provides learning content to improve the understanding of structures of alphabets for dyslexics. But still for the evaluation of this system, we have to reach to special education schools for dyslexia, which is taken up as a potential future direction of the work. Also practically, it requires preparation of more learning objects; and feedback system which would help in conducting large experiments.

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Volume: 10 Issue: 01 Pages: 3717-3723 (2018) ISSN: 0975-0290

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