Multi-dimensional Learning on the Semantic Web

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ABSTRACT

The Semantic Web effort is to evolve the web into a web of knowledge, of meaning, and its potential in education and learning cannot be overstated. The World Wide Web (WWW) has proved to be a great leveler for education - nowadays a school in Calcutta has the access to same course materials as one in Cambridge or Canberra. The immense popularity of initiatives like Wikipedia [1] or MIT's OpenCourseWare [2] is testament to the effectiveness and reach of online education. However, current web technologies have a long way to go in fulfilling the varied and unique requirements of interactive education in a virtual space. The idea of the Semantic Web is to evolve the web into a much smarter medium, which can revolutionize online education in amazing new ways.

In this paper, the paradigms of *multi-dimensional* learning and *iterative browsing* are presented to demonstrate the usefulness of the Semantic Web platform in online education and learning. 'Proofs-of-concept' along these ideas are being actively developed.

Categories and Subject Descriptors

I.2.4 Knowledge Representation Formalisms and Methods – *representation languages, semantic networks.*
I.2.7 Natural Language Processing.
I.2.11 Distributed Artificial Intelligence

Keywords
Semantic Web, Information Retrieval, Text Mining and e-learning.

INTRODUCTION
The web is the largest repository of knowledge known to humanity, and its potential for e-learning can be significantly enhanced with the advent of the Semantic Web. The Semantic Web aims to create a universal medium of knowledge by publishing knowledge in a manner processable by machines. It is therefore possible to digest information from various sources and domains and present in a multi-dimensional format to the learner. The phrase multi-dimensional means the different aspects along which a given information-set can be queried and navigated. A multi-dimensional learning system provides the assignment of multiple classifications to an object, allowing navigation of related information through several paths [3]. Elements may include attributes such as geographical, temporal or the physical form.

For example, if a student were to be studying the history of World War 2 – s/he might be interested in approaching this subject matter from various dimensions. These dimensions might be: "Soviet Front", "North African Campaign", and "The Pacific War". Similarly, the student might also be interested in other dimensions such as "Events of 1939-41", "Events of 1942-44", "Events of 1944-45", or to query it from a military equation standpoint: "German Forces Vs. Allied Forces", or "Nazi Forces Vs. Soviet Forces" and so on. For example, a student studying the history of World War II would likely follow a hierarchical pedagogy similar to one shown in Fig.1.

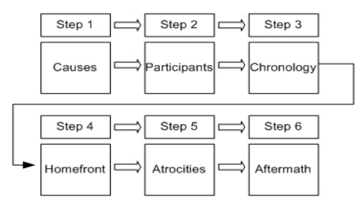

Figure 1: Typical Hierarchical Model for learning ("WW2 History"). [Adapted from Wikipedia.org]

Typically this is a taxonomy designed by the author of the text-book, or the teacher teaching the course, and is usually fairly rigid and inflexible. However, human learning is a very iterative, interactive process of negotiation, questioning and debate. This is best achieved when an individual approaches a subject matter in a manner that best suits his/her unique learning requirements. By making knowledge accessible across various dimensions, the Semantic Web aims to provide a completely new learning experience, so that online education is an exploratory, interactive process of *successive approximation* to a goal, as opposed to the current method of force-feeding based on a pre-defined hierarchy.

Fig.2 illustrates the model of multi-dimensional learning that lets student learn a subject along a dimension of their choosing. A student might for example choose a temporal dimension ("events of 1939-41"), followed by a geographic dimension of learning ("Burma Campaign"). Approaching learning in this manner is an extremely powerful manner of letting students approach the subject-matter

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by identifying the gaps (dimensions) in their knowledge, and iteratively learning the concepts.

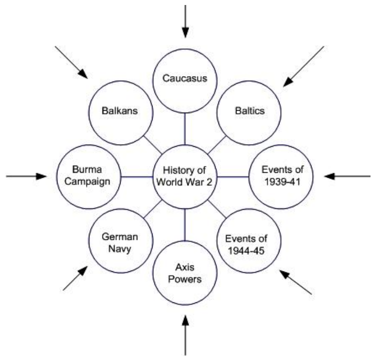

Figure 2: Multi-dimensional Model of Learning

MULTI-DIMENSIONAL LEARNING

The Semantic Web makes the multi-dimensional earning process possible through the presence of metadata. Metadata is literally data describing data, by using these annotations the student can dynamically construct dimensions from structured, semi-structured and unstructured corpora and query it along any dimension. *Dimensions* are Concepts and Meta-Concepts generated from corpora of domain knowledge using text-mining algorithms. The dimensions form frameworks for the student to "walk-through" in a sequence or combination of their choosing. These dimensions can also be Concepts in an Ontology that lets the learner a complex subject, or even a combination of subjects from multiple perspectives.

A **faceted browsing** paradigm is used to navigate the dimensions generated. Faceted browsing has been used to great effect in many e-commerce sites e.g. IBM Notebook Finder [4] or sites with vast amounts of research information e.g. Forrester Research's archive [5]. By presenting the dimensions as facets, the user can navigate the information easily and seamlessly and follow the path of learning that best suits his/her individual needs.

Source Dimensions

Dimensions are typically Meta-Concepts (Concepts describing Concepts) but can sometimes be Concepts as well. Meta-Concepts usually describe a collection of Concepts, for example the Meta-Concept "Events of 1939-41" might describe the set of Concepts: "Attack on Poland", "Invasion of France", "Pearl Harbor" etc. on a *temporal* dimension. The user can approach the subject using one or more of the source dimensions.

Target Dimensions

This research extends the idea of facets to refining the resultset as well. Most faceted browsing paradigms have been limited to the filtering criteria and only applied to refine the results – which currently are little more than a listing of documents. This still leaves the user with a plethora of results to sift through. The proposed model lets the learner customize the results to view it only along the required dimensions.

Iterative Browsing

Human learning is an iterative process of learning questioning and reinforcing concepts, and this paradigm can and should be extended to the Semantic Web for online education to reach its full potential. Through this research the author presents the idea of iterative browsing which allows the student to approach a subject from multiple source dimensions – starting with an overview level, progressing to greater depths (target dimensions.

CONCLUSIONS

The advent of the Semantic Web holds great promise for e-learning and online education. While e-learning has exploded globally, and its popularity is growing by leaps and bounds – yet it is still hamstrung by serious issues of a lack of interactivity and personalization. The cookie-cutter approach of e-learning on the World Wide Web (WWW) is disappointing because e-learning on the web has turned out to be little more than just another medium of material delivery.

The Semantic Web promises to change that by enabling a new and effective medium of iterative, multi-dimensional learning. The power of such learning holds an exciting future for online education. Prototypes along the ideas presented here are being developed in support of the author's research.

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REFERENCES

[1] Wikipedia – The Free Encyclopedia, available at <http://www.wikipedia.org>

[2] MIT OpenCourseWare, Massachusetts Institute of Technology, available at: < http://ocw.mit.edu/>

[3] Instone, K., "Faceted Browsing - How User Interfaces Represent and Benefit from a Faceted Classification System", available at: <http://user-experience.org/uefiles/facetedbrowse/>

[4] Lenovo (IBM) Note book Finder, available at: <http://www.ibm.com/products/finder/us/finders?sid=1&N=200004&Ne=200000&lst=off&trac=1T10FN01A&ca=nbfinder&me=W&met=inli&re=home>

[5] Forrester Research, Archive Search available at: <http://www.forrester.com/findresearch>