A METADATA MODEL FOR E-LEARNING COORDINATION THROUGH SEMANTIC WEB LANGUAGES

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ABSTRACT
This paper reports on a study aiming to develop a metadata model for e-learning coordination based on semantic web languages. A survey of e-learning modes are done initially in order to identify content such as phases, activities, data schema, rules and relations, etc. relevant for a coordination model. In this respect, the study looks into the mechanism of e-learning environment and the question of how e-learning can be classified in terms of activity coordination. A metadata model for coordination of e-learning is being sought which may be expressed using semantic web languages such as OWL + RDF. This is part of a project involving studies on several fronts regarding the application of semantic web initiative into e-learning; i.e. design and development of markup and annotation tools, relevant ontologies, intelligent agents, etc. The objective is eventually to build capability to semantically integrate and selectively retrieve e-content in implementing e-learning environments.

KEYWORDS
Semantic web, OWL, RDF, XML, markup, ontology, knowledge grid, semantic grid, information retrieval, intelligent agents, interfaces, markup tools, modeling e-learning, LMS, LTSC, LTSA, LOM, ADL, SCO, SCORM.

INTRODUCTION

There are numerous names for open, flexible and distributed learning activities, including ***E-Learning****, Web-Based Learning (WBL), Web-Based Instruction (WBI), Web-Based Training (WBT), Internet-Based Training (IBT), Distributed Learning (DL), Advanced Distributed Learning (ADL), Distance Education (DE), Distance Learning (DL), Online Learning (OL), Mobile Learning (or m-Learning) or Nomadic Learning, Remote Learning, Off-site Learning, a-Learning (anytime, anyplace, anywhere learning), and of late, terms like Instructional Technology, Learning Technologies, and Learning Management System,* etc. Precise definitions of such terms can be found in the literature (see, for example: [CDLP], [Moore-1996], [LTSC-1996], [Tsai-Machado] and [ACM-eLearn]). While we concede to that there is considerable difference among some of these in purpose, application, parties involved, tools used, etc., we tend to utter e-learning as an all-encompassing generic term. This is quite in line with our predisposition in this paper for we wish to consider e-learning in its generic form equally far away from any flavor of it.

Of specific interest, IEEE LTSC defines learning technologies as the development, deployment, maintenance, and interoperation of computer implementations of education and training components and systems. Instructional technology may be defined as being the systemic and systematic application of strategies and techniques derived from behavioral, cognitive, and constructivist theories of learning to the solution of instructional problems.

This paper reports on a study aiming to eventually develop a metadata model for e-learning coordination based on semantic web languages. We will show that e-learning requires a heavy dose of control and coordination where the findings of this study can be useful.

Information technology (IT) has always attracted attention from all quarters of interest; the education/training is no exception. Famous educationist Chris Dede recounts his recent initiative to utilize high tech IT gadgets in training projects in an interview [Morrison-2004]. Whereas we highly sympathize with such utilization of IT gadgetry to individual learner’s benefit, our interest lies in the softer side, that is, typically in effecting e-content and rendering it accessible through intelligent software agents.

Many e-learning models exist, some heuristic, others well-grounded on specific instructional design approaches. We will mention some here and our point of interest will be on control and coordination (C&C) aspects.

Salmon (2002) argues that the role of online teacher is evolving from that of conveying known information to one of facilitating exploration and generating new knowledge. Primarily this shift in the part played, but also the complexity of the technology employed, necessitates a highly elevated designation such as “e-moderator”. It is clear that the elevated role of e-moderator is mostly due to C&C it exercises.

The well-known creativity researcher Mihaly Csikszentmihalyi coined the term "flow" to mean a creative activity process that is both enjoyable and challenging that engulfs one to the extent of loosing track of time while doing it [Csikszentmihalyi-1990]. Likening the instructional design process to the flow concept and striving to create a flow-like environment for instructional design, Ceraulo (2003a) identifies seven characteristics for carrying it out highly effectively:

1. Focus goals
2. Eliminate distractions
3. Match student skills and course level
4. Create a supportive environment
5. Create order through rules
6. Let students express themselves, and
7. Provide timely and consistent feedback.

According to Ceraulo (2003b), similar characteristics apply in the case of online teaching. Of those, with respect to C&C, we would be reasonably interested in 3rd- 7th activities.

Khan (2003) introduces a "Framework for e-Learning" with eight dimensions:
1. Institution (admin, academic, student services),
2. Pedagogy (teaching and learning),
3. Technology (infrastructure),
4. Interface design,
5. Evaluation (assessment and evaluation),
6. Management (learning environment),
7. Resource support, and
8. Ethics.

Figure 1- A Framework for e-learning.

Figure 1 depicts these pictorially. Furthermore, each dimension has several indicative issues of focus. The purpose of the framework is to assist during steps of the e-learning design process. The framework with its concomitant checklist can be used to ensure that all relevant factors are taken into consideration during the design and development of e-learning. It is clearly a welcome contribution, as the scope and extent of e-learning expands rapidly, consequently projects will require complex team efforts. Existence of a mature framework and an extensive checklists stemming from it, help greatly to control and coordinate activities of parties involved. The complete list of dimensions and sub-dimensions may be accessed at URL http://www.bookstoread.com/framework/scroller.htm.

The above framework presents a model of "dimensions", that is to say, interest areas. The "E-Learning P3 Model" proposes a model embodying a process standpoint [Khan-2004]. Considering the people–process–product continuum in e-learning, it contributes greatly towards this study. Table 1 identifies 35 roles and their responsibility. It is judged that almost all of the roles involve C&C. That alone would justify our concern with C&C aspects in e-learning systems and solutions. Similarly McPherson and Nunes (2002) contains a few process oriented models.

Importance of coordination aspects in e-learning was substantiated by another study. Aiming at evolving a new instructional design model, Ling and partners set to determine most relevant scaffoldings in Web-based learning [Ling-2001]. They found that the support, learner's engagement, learner's participation, multimedia integration and learner interaction were the most influential in success. Clearly these are all related to coordination.

A consortium-led research program is working on a "Web-based heuristic advisory system for instructional designers" [Niegemann-2002]. The system will provide design options, connected costs and possible consequences for every level of design decisions. It will be more like a decision support system for instruction designers. To be able to construct such a system, one requires a good understanding of main categories of functional elements used in ID models and the main levels of design decisions. That will lead to a set of important control and cooperation relationships.

On the other hand, the Learning Federation hints on the future shape of education [TLF-2001]. By the year 2020, the next generation learning systems will draw from a "robust array of software tools". Software will provide intelligent and context sensitive support on all aspects of learning and teaching. This can only be possible through e-learning integrating with a semantic Web base. More on this issue later.

Riddy and Fill list the existence of "Integrated Environments for eLearning" among the prime critical success factors (CSF) [Riddy-Fill-2002]. Referred to are several "…examples of substantial initiatives that are developing and future-proofing educational environments, and provide pointers to some technological necessities for successful eLearning". These are the Open Knowledge Initiative's (OKI's) software architecture, MIT's Open CourseWare (OCW) Stella and UK eUniversities Worldwide's "next generation" eLearning system [PWC-2000] [Collier-2002].

These have been early projects each with its "particular" empirical foundation and resolution of practical matters. Findings of them have enriched important model studies by prominent research organizations in recent years. The major bodies involved have been the IEEE Learning Technology Standards Committee (LTSC), Aviation Industry CBT Committee (AICC), Instructional Management Project (IMS), EU 'ARIADNE' project, Advanced Distributed Learning (ADL) initiative of the US Department of Defense- SCORM (Shareable Courseware Object Reference Model) developments, and Microsoft Learning Resource Interchange (LRI) specification.

The work of these bodies has been far reaching. The LTSC has been developing definitions of all aspects of learning technology [LTSC]. It introduced the broad definition of 'learning objects' (LOs) concept together with related models. Likewise it has been producing relevant standards with much acceptance by others. For example, its Learning Technology System Architecture (LTSA) [LTSA-2001] standard was adopted by the ADL as bases for further improvement of the Content Aggregation Model (CAM) of the SCORM [SCORM-2003]. One year into subsequent development it was realized that "there's something missing" in SCORM: "the process of creating complex behaviors, such as remediation branching, wasn't supported well (or at all) in the current CAM specifications". So ADL had to build a "Navigation and Sequencing" part in cooperation with IMS and grafted it to SCORM.

This outcome is exactly due to lacking of what we have been pointing out as a must CSF, that is, C&C is required for purposes of environment integration. Sequencing of learning objects (LO's) without embedding sequence indication into them will allow shareable free standing LOs. Control over prescribed advancement of learner through courseware is a basic delivery requirement. Backtracking (for remedial purpose), reiterating (for coverage of further detail), synchronizing several learners at stages (say, before testing), temporary digression (say for deficiency training or info look up) with or without freezing the current state, etc. are also required.

The origin of this lacking is actually stemming from LTSA. Figure 2 displays the hierarchic layers of LTSA where Layer 1 is at the top and Layer 5 at the bottom. There exists an interface between any two layers performing "filtration" function between "abstraction" from the layer above to "implementation" at the lower layer. A lot of C&C issues need be inserted at the interfaces, with the most of the rest going into the layer logic. What is not suitable or feasible for inclusion is left out. Instead, LTSA should have a dedicated C&C layer separate from the others. It is conjectured that, due to lasting relations with each layer, the C&C layer should be positioned perpendicular to others that is, in full contact with all the interfaces and layers at all times. This we depict in Figure 2.

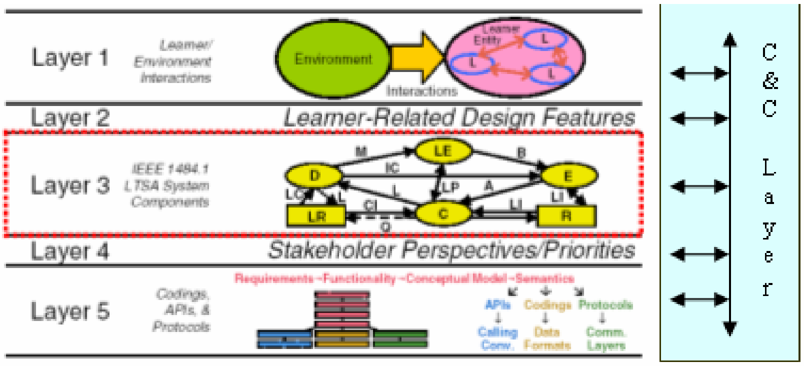

Figure 2. The IEEE LTSA layers [LTSA-2001]. The drawing on the right is not part of LTSA but being proposed by this paper.

In our proposal, each LTSA layer corresponds with the C&C Layer for all control and coordination issues. LTSA layers become processing plateaus for their designated specific functions. Layer interfaces similarly implement pass-through function calls to down-up layers where filtering is based on that specified by the C&C Layer. Consequently, LTSA becomes a generic architecture, that is, not involving inclinations towards any LMS scheme or kind of e-learning approach (ref. definitions in the introduction above).

At this juncture, there is an opportunity not to be missed: incorporation of semantic Web based approach (SWA) to LO design and development. This process may start with infusion of SWA into the design of the C&C Layer and into LTSA for which we will require an extensive metadata set to be gathered on C&C issues.

The standardization of LOs holds out the promise of re-usable learning materials. Increased use of metadata and XML to incorporate tags or labels within e-learning content will provide new structure to documents that software systems can interpret. Encoding the tags in a particular way, using the Resource Description Framework (RDF) allows the building a network of related information on the go. Combining these with ontology, to further define the relationships between objects, will lead to the "Semantic e-Learning" (after [Berners-Lee et al-2001]).

The real power of the Semantic Web will be realized by agents, software programs that can search the Web to find specified information. This could herald a new era of collaborative developments, enhancing tutors' abilities to work within e-learning environments and providing learners with what they want, when they want it. This would be quite in line with findings of a recent think-tank workshop organized by Computing Research Association on determining the "Grand Research Challenges in Information System". One of the five grand challenges is "Providing a teacher for every learner", that is, tutoring each individual in a tailored, learner-centered format to enable people to more fully realize their potential [CRA-2002].

CONCLUSION

There is need to involve semantic Web approach at all stages of e-learning [EU-IST-2004]. The semantic Web makes web resources understandable to software agents. By incorporating the meaning and context (semantics) of information, it brings structure to the web through capability to interpret its constituent resource. The concept of web services, where online transactional services are loosely coupled through common directories and exchange protocols, has also gained solid ground. Eventually, e-content will be rendered easier and friendlier to use and a better tool to serve all information needs. E-learning activities doubtless will draw benefit from being able to generate semantic metadata, to structure, filter, retrieve and maintain it in semantically so as to turn data into shareable knowledge. Thus, in the long-term, e-learning systems will use semantic Web-based knowledge systems as key parts of everyday learning cycles.

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