A Task Based Approach to Support Situated Learning for the Semantic Web

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Abstract. The task-based methodology to formalize a domain of knowledge is not new in knowledge engineering, and also in the field of the Semantic Web. This methodology has been used to describe the way learning resources are utilized; that is, to formally specify the meaning of a pedagogical strategy. In this paper we describe our position on the deployment of a task-oriented model for the purpose of characterizing domain knowledge. That is, we consider formal acquisition of what is usually referred to as the *content* of an eLearning application. We illustrate this model in describing the process of generating the issues relevant for the field of Semantic Web; with an aim to provide learners with an alternative access to a repository of learning resources. We propose that this model is more compliant with a conception of the learning process as fundamentally *situated* and *contextual* – as opposed to the classic instructionist paradigm that focuses on content delivery.

1. Pedagogical background and motivation

Learning is a complex and multifaceted activity; two broad types can be distinguished [1]: the "natural" learning and more artificial, "academic" learning. The former occurs in the everyday situations, and often corresponds to the acquisition of not only passive knowledge about a domain but also an active *knowing* [2]. The latter type of learning often occurs in formal education, in schools, and particularly in universities. Academic learning is essentially about abstractions; that is, it is not directly tied to reality. It mostly works with and refines various formal descriptions of what happens in the real world. Indeed, what teachers try to convey to learners are alternative accounts of everyday experiences, reusable descriptions of already known phenomena (for example in physics, *formulae*). Of course, these second-order descriptions are (not surprisingly) often hard to grasp in their abstract nature.

Recently, various frameworks attempted to theoretically redefine the learning process, in order to reconcile the 'user entity' with the 'knowledge entity' (usually treated as separated by the classic *instructionist* paradigm [3]). Examples such those in [2, 4] can be summarized under the heading of *situated cognition* [5]. Learning is always *framed* in a situation, where the problem and its context are defining each other [6]. It is actually correct to say that the solution is spelt out in terms of the context, and the problem is solved thanks to the entities a specific situation makes available. According to the authors, the situation *affords* a certain kind of knowledge production. This is true not only for the natural learning, but also for the academic learning. It is therefore crucial to contrive a setting for the learning (of both skills and abstractions) where what is taught does not appear in isolation (by definition), but in concomitance with the situation it originates from.

In this paper we present an early form of a model that offers a unique value to the educational designers; it reflects the *situated* style of the human cognition and the authentic activity through which learners create knowledge. We argue that through employing a task-based methodology to model the existing activities in a particular domain, we can provide a meaningful breakdown of the knowledge needed for teaching the domain *itself*. With respect to a widely known model introduced in [7], our approach proposes that beyond being used effectively to describe the *structure* (defined as the layout of a "set of learning materials in a learning course") and the *context* (defined as "the form the topic is presented") of the educational design, a task-based methodology can be also employed to represent the actual *content* of the course taught (namely, "what the learning material is about").

Next we briefly summarize the principles of task-based methodologies and relate them to the learning and learning ontology design in particular. In section 3 we instantiate the abstract task-centered model using the work we are pursuing in the domain of Semantic Web Studies, and discuss the value of this case. Finally, in section 4 we sum up our position and conclude the paper.

2. Task-oriented model

The task-based methodology is commonly used in many domains, including eLearning [8]. However, in [8] as well as in most eLearning applications tasks are employed to model the pedagogic structure of the resource or activity sequencing. For example, in [9] the notion of task is used to specify the right sequence of learning resources the application has to present, according to their instructional value and the author's learning design. This can be pedagogically sound but by focusing on the meta level of structuring a course it still does not sufficiently bridge the gap between a natural, situated learning and the artificial, academic one. In other words, although the authors recognize that the "process of learning is more complex than navigating between different pages and reading what is written on them", they do not try to frame the learning activity within the context of a problem-based situation. This is in fact what is required in the "natural" and most effective type of human learning.

We are instead using the task-based methodology to tie the objects of a specific domain to their effective usage, that is, to their *raison d'etre*. The core section of our position centers on the notion of 'usage semantics' – which can be distinguished from e.g. descriptive semantics of the knowledge acquisition methodologies. As we will exemplify in the following section, this representation relies on the recursive instantiation of the following concepts:

- A *problem* or *problematic situation*: this can be defined as an issue or situation that is so-far unresolved, from the perspective of a particular learner. A problem in this generic sense looks for a solution and/or for further specification [6].

- A *solution*: this can be seen as an outcome (or a set of multiple outcomes) that to some extent resolves the issue, the conflict or the situation identified by the learner as the problem.
- A *generated problem*: defined as a specific outcome of breaking down the problem at the input into several sub-problems – with respect to a particular approach. Different approaches afford the learner to perceive different sub-problems or the same sub-problems may emerge at different times. Two types of generated problems can be identified in our model:
  - An *in-domain sub-problem:* defined as a problem or a part thereof that according to a particular approach is amenable by the domain's methods, techniques and other conceptual apparatus.
  - An *out-domain sub-problem:* defined as a problem or a part thereof that has been considered to be amenable by methods and concepts of a different domain.
- Finally, an *approach*: this can be defined as a deliberately taken perspective on the situation in which the learner is and in which s/he perceives a problem. When used in a particular situation, an approach becomes the frame that allows further processing and analysis of the problem and the synthesis of the solution.

3. Case example: Semantic Web Studies

In the context of the KnowledgeWeb project, we are trying to re-operationalize a series of learning resources that have been deposited by their authors in the REASE repository[1]. One of the main drivers of our effort is to complement the existing topic-centered framework of REASE by more problem-centered learning. The core facility on REASE that allows semantic structuring and browsing is the topic ontology that hierarchically organizes the topics in the Semantic Web. The only meaningful usage of this conceptual model is to comprehend an elementary linking between resources that can be inferred through the abstract *is-a* relationship.

This ontology, however useful in organizing a dynamic repository, carries little pedagogical value. Simply, when one wants to understand notion of 'OWL semantics' it is not sufficient to know that this belongs to the category of (say) 'Logical Foundations of the Semantic Web'. Ontology designed to catalogue resources does not reflect the usage semantics of various notions the learner may want to acquire, such as how does 'OWL semantics' work, what does it afford, what are its limits, where can it be applied, etc.

As showed in Figure 1, we take an existing application developed at KMi, Magpie [10], and try to frame it using our model based on the *problem-approach-solution* framework. The basic question that drives this kind of contextualization has this form: "If there is X, what does solve or tries to solve it?" For example, the problem a tool such as Magpie (and in general, any other semantic browser) addresses is the dispersion of potential learning resources on the Web and their recollection on the fly

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[1] KnowledgeWeb is available online at http://knowledgeweb.semanticweb.org; REASE is one of the outcomes of the project's educational area, it stands for Repository of the European Association for the Semantic Web Education, and is available at http://rease.semanticweb.org

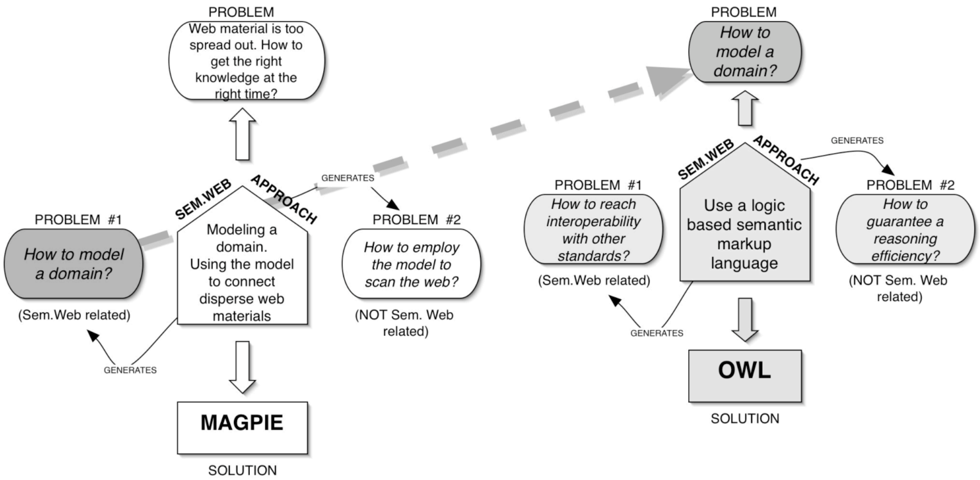

Figure 1. Specific model conceptualizing the domain of Semantic Web Studies starting by situating one particular problem into a set of sub-problems and a technological solution

depending on the learner's context of usage. We define the Semantic Web approach to frame this problem as comprising a model of the relevant domain knowledge, relying on ontology and performing a web search with that ontology as a filter. The problem is thus broken down into (at least) two broad sub-problems: (i) how to model a domain and (ii) how to implement an information extraction technique using an ontology. The first one is considered again as a problem relevant to the Semantic Web studies domain (so it will iteratively move to the upper box generating a new instantiation of the model). The second one is a "border" problem, outside the scope of our teaching (again, this scoping depends on how the approach has been chosen). Eventually, the purpose of the iterations is to identify all these "border" problems, which of course can be linked to the problematic issues arising in or tackled by other domains [11]. In the same figure we can see how the generated problem is further developed through another instantiation of the model, which frames the OWL language instead.

It is important to notice how the formulation of the approach drives the whole characterization of problems as Semantic Web related or not. This choice is of course totally arbitrary and subject to criticism. But since the overall aim of this framework is to dissect a domain for teaching purposes, and not to define or acquire once and for all the essence of the Semantic Web (or any other domain), we do not discuss this choice any deeper in this paper. As a teacher inevitably has to take a specific set of assumptions in order to explain and explore with his/her students an object domain, we also have defined the Semantic Web approach in a specific way in order to shed light on related "teaching materials". Our focus is therefore not on producing an ontology that *defines* classes and sub-classes, but on carving out the relations between entities in the domain. An interesting outcome would be, for example, the usage of a hierarchical classification (such as the one in REASE) *within* the model: since Magpie is classified as a semantic browser, also other similar applications can be retrieved as examples of solutions to the same problem. In other words, if Magpie is presented to learners in the context of the problem of remote and disconnected web materials, automatically another semantic browser can be treated as relevant since it also fits in the actual context. On the other hand, these other 'solutions' may shed new light on the existing problem. Only through the explicit recognition of this network of an object usage, the domain knowledge can be treated as a truly situated cognition.

5. Conclusions

In this paper we have sketched a task- and problem-centered model for organizing learning materials, with respect to their content. Existing research focuses on formalizing the learning design through tasks and subtasks specification. We acknowledged how this research, although useful for some purposes, remains at the level of structuring the course presentation. In contrast, the characterization of the content through the usage of conceptual primitives in specific tasks and activities helps to capture both a dynamic nature of the domain and a learner's immersion in conceptualizing it. This view is compliant with a known pedagogic paradigm that interprets learning as a process of situated cognition. In this way, knowledge chunks and their conceptual abstractions are not considered isolated, but in the context specified by their *Problem-Approach-Solution* space. We have also introduced an early and ongoing work aiming at instantiating this generic model for the situations involving teaching the students to practice the Semantic Web. An example from the field describes our methodology and gives a glimpse of the future direction of this research.

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