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Using Taxonomies to Support the Macro Design Process for the Production of Web Based Trainings

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Abstract: Today, Web Based Training (WBT) starts to be widely used as a new way of teaching. Unfortunately, this mode of teaching imposes new requirements and constraints. It has made the creation of learning materials a complex and demanding task for the instructors because it takes much time and demands a multitude of skills, in particular technical skills that must be developed and continuously updated. Hence, we propose a collaborative authoring methodology based on division of labor as a way to produce WBTs where the processes of production are clearly separated to meet the existing and needed skills of persons involved in WBT production. This paper presents an efficient method to support instructor's guidance during the first phase of the WBT production called the Macro Design using the Rhetorical Structure Theory (RST) and taxonomies we developed.

Keywords: E-learning, Production of Web Based Training, Taxonomies, Collaborative Authoring, Knowledge Modelling, Semantic Design, Instructional design support tool.
Categories: H.4.0, H.5.4, I.6.5, K.3.1

1 Introduction

Since the integration of web technologies in teaching environments, education has undergone a shift in paradigm. An example of this shift is seen in Web Based Trainings (WBTs) that can be offered at any time and at any location as long as an Internet-enabled computer is available. However, this new mode of teaching has made the creation of learning materials a complex and demanding task for the instructors because it demands a multitude of skills, in particular technical skills that must be developed and continuously updated [Aqqal, 07]. In contrast, an instructor (at school or university as well as in a company) is a domain expert first and usually lacks technical skills needed for WBT authoring and media creation [Aqqal, 07]. Hence, one of the important requirements of an adequate approach to produce WBTs is that the technical efforts spent by the instructor in authoring and media creation should be reduced to a minimum. This helps instructors to refocus on instructional aspects rather

than technology [Helic, 02]. With this idea in mind, we have proposed a collaborative authoring methodology (figure 1) based on division of labor as a way to produce WBT where processes of the production are clearly separated to meet the existing and needed skills of persons involved in WBT production. WBT production should be done in three different levels of abstraction: the semantic, logical and physical levels handled respectively by three processes: the so called "Macro Design", the content modelling and the content authoring & media creation. In addition we define vertical to these processes a production management process in order to harmonize the collaboration between actors.

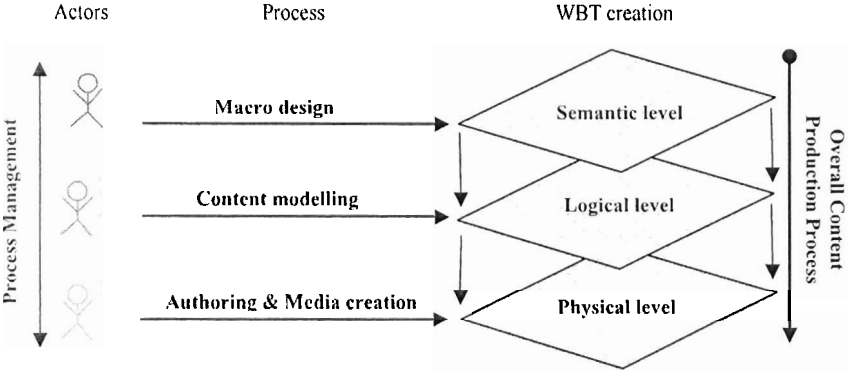

Figure 1: The proposed approach for the overall content production

The so called "Macro Design" will be explained in the next section in detail. We explore why taxonomies are necessary to support the creation of an abstract representation of WBTs. Section 3 describes the application of the Rhetorical Structure Theory (RST) as a mechanism to enhance the expressiveness of WBT design and to assist instructors when designing WBTs. We shortly introduce our developed taxonomies that enrich and extend the RST to meet our requirements. An example is given to illustrate our approach. The fourth section surveys related work and discusses the shortcomings regarding our requirements. Finally, we present some conclusions and remarks for further work in this area.

2 The Macro Design : Introduction & requirements

2.1 The need of the Macro Design for WBTs production

In contrast to existing ways of WBT production, we postulate a phase in addition to content modelling, authoring and media creation which is often neglected or not fully taken into account. This phase, temporarily called "the design thinking", covers instructor's ideas about what kind of WBT to produce, about a motive, reasons for a specific target group, and about a list of themes needed to be taught. The instructor defines implicitly cognitive boundaries of main concepts of his WBT and semantic relations among these concepts according to both knowledge and learner domains. The "design thinking" is done in the mind of the instructor only. Tool support starts in

the content modelling phase nowadays. Commonly WBT modelling uses the table of content paradigm. Such a table of content records the main concepts used in content authoring only. The relationships between the main concepts as well as the instructional impact can not been expressed in such a simplified model. We introduce, the "Macro Design" as an explicit modelling phase corresponding to the "design thinking" in order to record what instructors have in mind and to forward instructors ideas and intentions to all others involved in the WBT production, from the instructional level to the technical level [Aqqal, 07]. The capturing of such intentions aims to enhance the awareness and comprehension of the production context and will increase, as a metadata, consequently the chance to re-use parts of a produced WBT.

Simply stated, the Macro Design could be summarized into answering explicitly the following:

1. Why to produce a WBT and for which audience?
2. What to produce (in term of knowledge)?
3. In which form to produce this WBT and why in this form?

In this paper, we principally focus on the third question. Here, our goal is to develop a mechanism supporting instructors to transform the intentions resulting from their design thinking into an explicit how-to-product specification given via small editing steps. The next section specifies main requirements the proposed approach should fulfil and introduces the need of taxonomies to support the Macro Design.

2.2 The requirements and the need of taxonomies for the Macro Design

Our goal is to build a tool supporting Macro Design without overhead for the instructor. To realize this, *Macro Design* has to meet some requirements; most importantly it has to be simple and intuitive. The tool should not impose a certain pedagogical model for the instructor to avoid any semantic mismatch conflict between instructor intentions and the model mapping his intentions. Secondly, guidelines are needed to determine how the instructor should express his intentions, how to supervise and progress the whole production process. This can be done via step-by-step guidance. Therefore, a semantic taxonomy is required as vocabulary for the representation of the WBT including "design thinking" data. Thus, the instructor will be supported in instructional design and the structuring & expression of his domain knowledge away from more technical content authoring and media creation (figure 2).

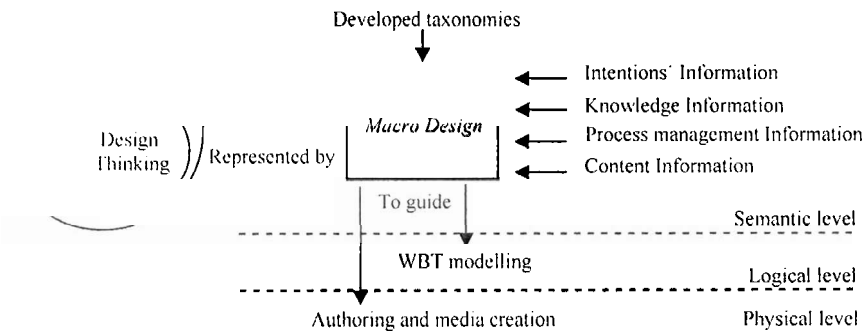

Figure 2: Using the Macro Design to support the WBT production

Semantic taxonomies in general are declarative classifications of different semantic elements in terms of a uniform vocabulary. We distinguish in our area of application at least two kinds of taxonomies: (1) taxonomy used for the representation of the WBT into aggregation of semantic parts called semantic units and (2) taxonomy of semantic relations among these elements and the way they are connected in the WBT to reflect the instructor's intentions and the knowledge mapping as well.

To suit our scenario of use, developed taxonomies have to support an instantiation by queries and should establish the correspondence between instantiated elements and the instructor's intentions. It should also reinforce a separation between the different production levels so that each level will be mastered before progressing to the next. Using taxonomies in this way for the WBT production provides many advantages over traditional authoring methodologies. Notably, an increased separation of design and authoring levels as well as an abstraction mechanism to support a step-by-step production via suggested proposals given to the instructor instead of free-to-write forms. Thus, the production is easy, fast, and deterministic. The next section introduces our developed taxonomies and their usage.

3 Towards an adaptation of Rhetorical Structure Theory (RST)

3.1 Introduction

The goal of each training apart from skill training is to transfer knowledge from a given domain to the learner. Formally, it can be expressed as follows: Web Based Trainings transfer knowledge from the WBT knowledge domain (the WBT domain) to the learner knowledge domain (the learner domain). Both WBT domain and learner domain are collections of concepts, where a concept is an independent unit of knowledge. For example, "how to insert an image into a Web page" could be a concept in WBT domain called "HTML introduction". In *Macro Design* both WBT domain and learner domain have to be described by the instructor.

3.2 Development of a taxonomy for semantic units

To get a WBT model representing the ideas of an instructor, the instructor has to be supported to determine the elementary units of the WBT first. Additionally, a general way describing semantic interrelationships among these units should be provided. Many related authoring approaches proposed hypotheses about what constitutes an elementary WBT unit. These hypotheses are based either on logical criteria (e.g. paragraph, section) or physical criteria (e.g. size, layout, image or page) [Aqqal, 07].

For our scenario of use, we developed an initial taxonomy where we distinguish 8 types of WBT Units and their instances to fit the *Macro Design* adequately (table 1). Our segmentation of WBT documents is rather grounded on semantic basis, where fragmentation and modularization of WBT units is determined by the existence of a certain meaning or didactic function in each unit. This unit, called "a semantic unit", should be stand alone and didactically well-recognized. For instance, an illustration composed of an image and its description in paragraph format will be not considered as two units but only as one. This way of modelling fulfils our requirements. It leads

to a separation between the different production's levels. If so, the instructor has the ability to abstractly define desired content in form of a set of semantic units.

Semantic Unit	Semantic Rule	Examples of instances
Principal unit	Concept presentation	Definition (concept, theory, etc.)
Alternative unit	Concept restatement / unit's reformulation	Summary, abstract, preview
Illustration unit	Concept illustration	Simulation, elaboration, example
Activity unit	An activity description	According to the learning design
Assessment unit	Measure and evaluation of grasped knowledge	Test, exam, quiz, evaluation
Reference unit	To refer or designate a used concept or unit	Metadata, glossary, references, bibliography
Supplement unit	Supplement, information about a concept/unit	FAQ, Help, Read more, index
Connection unit	Join units to bridge semantic transitions	Background, planning, motivation, table of content

Table 1: The developed taxonomies of the semantic units in the WBT

This taxonomy categorizes in a matrix typical semantic units and their instances needed for WBT production. It also assures a minimal associative linking between a given semantic unit and its "typical" logical formatting since those semantic units are composed of logical units and seem to respect certain aggregation likelihood.

3.3 Using RST to support the Macro Design

So far, our intent was to generate a plausible taxonomy of a WBT's units to allow the *Macro Design*. To preserve our prior concepts we have adopted the Rhetorical Structure Theory (RST) as an additional mechanism to support the *Macro Design*. The RST is used, in our context, as a navigational model to contextualize and freeze the instructor's intentions beyond a simple hierarchical structuring of sections. RST [Mann, 87] is a framework for analyzing discourse structure and speech statements by positing hierarchical relations between spans of text. These relations are defined functionally, in terms of what their intended effect on the reader is.

RST has been chosen because it has many features meeting our requirements. First, RST is a natural and neutral mechanism for semantic modelling that specifies a rigorous set of annotation guidelines without imposing any prior model for the conception. Secondly, RST respects perfectly our developed semantic taxonomy and its requirements. It assumes that a text is divided semantically into autonomous units according to speaker intentions. These units are related by named rhetorical relations

and structured into two kinds (a nucleus and a satellite) that reflect their importance according to the speaker's intention. We also suppose that WBT segmenting (implicit or explicit) and relations between segmented elements reflect instructor intentions.

Finally, since the discourse generation and WBT production are two analogue processes, the taxonomy of semantic relations developed already by the RST community [RST, 07] is seen to be relevant for our scenario of use. This taxonomy of relations should be extended beyond the application area it was originally designed for. The extended taxonomy should be significant enough in converting the WBT structuring into a way to explore the instructor's intentions.

3.4 An RST based Macro Design Component as part of production tool

To implement a RST based tool to support the *Macro Design* we had to adapt RST formalism to our scenario of use. This RST based modelling will be implemented in a tool and allow the instructor to express his Macro Design (didactic modelling, domain knowledge modelling and WBT segmenting) for the ongoing production process. To understand, we simplify briefly in the figure 3 an example of design via RST from a given learner and WBT domains to an abstract representation of the WBT.

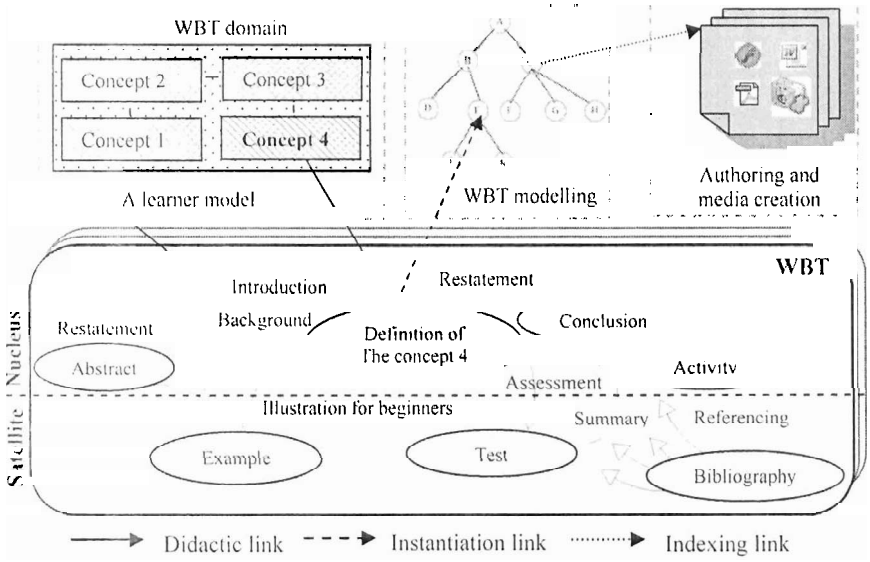

Figure 3: Using RST and taxonomies to support the Macro Design

In this example, the WBT semantic modelling shows only WBT segmenting into didactic elements and rhetorical relations among them to express some of the instructor's intentions. Here, the first thing which has to be considered is what the concepts that our WBT domain should include are, and what the concepts known by the learner (i.e. Learner domain) are. This specification will be quite easy since we have adopted a neutral and simple way of knowledge modelling. The second step is to map those concepts to certain semantic units which serve as abstract containers of

knowledge. All information which is needed about each semantic unit has to be defined explicitly such its mapping to given concepts, its semantic features or rules (e.g. nucleus/satellite), its intentional relations with other units and authoring properties if required. This specification is based on the RST framework and on our developed taxonomies. Later on, the resulting representation of the WBT when it is completed should be instantiated into a specific WBT model so that the last step to do is to enable this model by authoring and creating needed media. The modelling and authoring of WBTs must fulfill the representation and requirements given by the instructor and should be done via iterations by the process management [Aqqal, 07].

4 Related Work

Over the past years, many approaches (in academia and industry) were purposed to support the WBT production by tools [Pernin, 06] [Aqqal, 07]. However, few suppose that the WBT production is done in a collaborative way supporting different roles and skills. Hence, using existing tools for a collaborative way of working will be quite fuzzy. In particular, these tools fail usually to support Macro Design as stated in the previous section [Aqqal, 07]. Unlike our requirements, the traditional way of WBT design focuses on a flat structuring of WBT toward developing a modular view to fulfil existing technical standards requirements [Verbert, 06]. Indeed, these standards (e.g. LOM, SCORM Content Aggregation Model) have been generally limited to the modelling of object-oriented schemas because they have put significant effort into developing mechanisms to manage the reuse of materials located in a repository in form of learning objects not necessarily semantically annotated [Aqqal, 07].

In addition, there are a number of taxonomies and ontology based models that conceptualize learning resources and their mapping to the knowledge domain. Verbert and Duval [Verbert, 06] [Zouaq, 06] studied six content models and showed that they could be mapped on their abstract model called ALOCoM [ALOCoM, 05]. So far, ALOCOM refers only to slide presentations as materials to be authored [Bergsträßer, 06]. Similar approaches are found in [Bergsträßer, 06] and [Zouaq, 06]. Unfortunately, these approaches are based either on repurposing or retrieving existing resources and do not go beyond the traditional way of WBT authoring.

On the didactic level, Bloom's Taxonomy [Bloom, 56] is a relevant taxonomy to expresses educational objectives and serves as a sort of checklist to answer the first two questions listed in the section 2.1 rather than to follow all semantic connections of a WBT in terms of intentions, degree of modularity and the authoring process. IMS Learning Design (IMS-LD) [IMS, 07] considers that the focus of learning is the activity and not the content [Aqqal, 07] [Pernin, 06]. Thus, by being so abstract, generic and constructivist oriented, IMS-LD does not meet all our requirements.

5 Conclusions and further research directions

In this paper we presented a novel conceptual contribution to the Web Based Training creation. We motivated a collaborative production as way to meet instructors' skills for an efficient WBT production. The proposed methodology points out the so called "Macro Design" as an independent task to be supported. The Macro Design is

innovative in two ways. First, it extends the existing way of content design by supporting instructors in expliciting their intentions and instructional data that are often not captured. Second, it demonstrates the possibility to use the Rhetorical Structure Theory (RST) as a communicative mechanism to give an explicit perception of the expected content. Hence, we have developed taxonomies that are RST adapted and fit the Macro Design requirements. We will continue to further refine these taxonomies to fully suit our scenario of use.

As proof of concept, we plan to implement an extension of The ResourceCenter tool [Aqqal, 07] to support the Macro Design by addition of a Macro Design component up on this tool and to support the processes management. ResourceCenter was chosen because it constitutes an open source, browser based and instructor-friendly tool. Moreover, it supports the content modeling and authoring separately and implements already some required functionalities that we need for the collaborative production. One area of interest is the evaluation of the Macro Design concepts on the computer-communication networks domain of knowledge to be web trained but our methodology can easily be reapplied on other knowledge domains as well.

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