Progressive Semiotic Enrichment

Designing Learning Content Metadata for Web 3.0

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Abstract: Web 3.0 allows learning content to be semantically annotated thus facilitating improved information retrieval, reuse and integration. This short paper presents a design pattern for progressively describing and annotating learning content components in Web 3.0 based on key concepts adopted from social semiotics. Furthermore, the paper exemplifies how this design pattern may be encoded using a structured data format such as RDFa Lite and a general-purpose vocabulary like schema.org. Finally, some potential benefits of this approach are briefly touched upon.

1 INTRODUCTION

As structured data formats such as Microdata and RDFa (Lite) and vocabularies like schema.org, ALOCOM, LRMI and SKOS are maturing and becoming widely available, learning content on the Web can now be described and annotated in greater detail thus facilitating increasingly sophisticated automatic information processing (retrieval, rendering, reuse and integration). In theory, embedded learning content objects like images, diagrams and videos can be unbundled and reused across disparate materials and contexts; content can be shown in different modes and forms and data sets about a specific concept, topic or event can be aggregated from different sources.

This potential is closely related to the introduction and application of HTML5, the latest version of the popular format, or markup language to be more precise, used in most existing web pages, including web-based learning materials. Besides enhanced functionality for handling multimedia, interactivity and content organization, HTML5 affords a set of mechanisms for embedding structured data to describe the semantic contents of web documents: what they are about, what their communicative purpose is, etc.

Mature and easy-to-use standards and technologies, of course, are not enough. To create reusable learning content and to build working e-learning solutions in Web 3.0, sound and viable design approaches need to be devised, implemented and tested. For instance, content developers need design patterns for structuring and semantically annotating content in ways that are meaningful, transparent, consistent and scalable.

In this short paper, a design pattern for describing and annotating embedded learning content components in Web 3.0 is proposed. A design pattern may be defined as a general solution to a recurring design problem.

The design pattern presented here may be said to be theory-driven in the sense that it draws on key concepts adopted from social semiotics, a theoretical framework for analyzing meaning and meaning making in multimodal materials. But it is also practice-oriented insofar as it may be applied as an integral part of a concrete web design and development methodology such as progressive enhancement (see below). The design pattern itself allows content developers to enrich learning objects with inline metadata detailing their semiotic characteristics, notably their medium, representation, genre and metafunctions. By employing such a design pattern, content developers may explicitly, and in a standardized manner, link documents to domains, or more abstractly, resources to reality.

In addition, the paper exemplifies how this design pattern may be encoded using a structured data format such as RDFa Lite and a general-purpose vocabulary like schema.org. Finally, some potential benefits of this approach are briefly hinted at.

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2 PROGRESSIVE ENHANCEMENT

These days, much web design and development (for learning) is based on the notion of progressive enhancement. The idea is that basic content and functionality should be available to all users irrespective of which browser (version) they are using, what hardware platform they employ or what assistive technology they may need (e.g. screen readers). In a word, basic content and functionality should be *accessible*. Content and functionality can then be progressively enhanced through presentation (typography and layout) or interactivity so that those having the newest browser (version) get a richer or an aesthetically more pleasing web experience (see for instance Allsopp, 2009 and Gustafson, 2011).

The ideal of progressive enhancement can be built directly into a HTML5 web document as shown in figure 1.

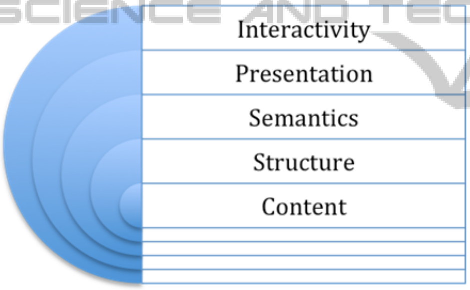

Figure 1: Progressive enhancement.

The core of the document is the *content*: text, images and multimedia objects. This content is organized into a transparent formal *structure* typically consisting of sections, subsections, headings, paragraphs and so on. These elements may then be encoded to signal their *semantics*. Further information can be added to specify what the *presentation* of the document parts is going to look like, while *interaction* elements finally provide a way for users to control and navigate the document. What is important here is the layered nature of the model: outer layers have inner layers within their scope. Interaction can be applied to presentation (e.g. a button for changing color or font-size), and semantics to structure (e.g. markup to signal that a certain paragraph is a procedure or a summary).

The construction of structure, semantics, presentation and interaction is normally done using technologies like HTML tags (structure), structured data formats like Microformats, Microdata or RDFa (semantics), CSS (presentation) and JavaScript (interaction) as shown in figure 2.

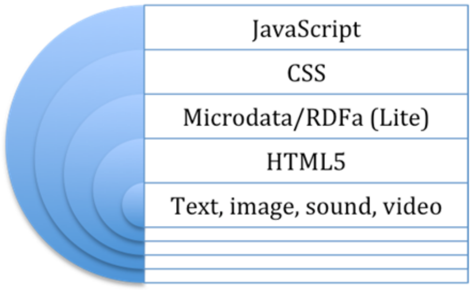

Figure 2: Technologies for progressive enhancement.

2.1 Semantic Enrichment

As for the semantic, or descriptive, layer, the key question is not only what semantic characteristics to capture and annotate, and at what level of detail, but also what model to adopt.

We propose a content metadata design pattern, which is loosely grounded in semiotic theory, more specifically social semiotics (see for instance Kress and Van Leeuwen, 2001; Van Leeuwen, 2005 and Bezemer and Kress, 2008). In social semiotics, the focus is on meaning and meaning making in multimodal contexts. From a social semiotic perspective, meaning is constructed through semiotic resources, interacting complexes of signs, in a variety of modes (writing, images, layout, gesture, etc.) and distributed through different media both electronic and physical. Signs are shaped through genres and can perform different communicative functions: they can construe reality (ideational meaning), create communicative coherence (textual meaning) or relate speakers/writers to addressees (interpersonal meaning).

The model proposed here presents a web-based learning object as a semiotic resource having (at least) four central facets: medium, representation, genre and metafunctions. The model is depicted in figure 3:

Medium may be perceived as the channel, or frame, through which the content is communicated or distributed. So, a medium may be a blog posting, a wiki page or a social medium like FaceBook.

Representation refers to an object's multimodal representation. Is it a written text, an image, a video object or a combination or modes?

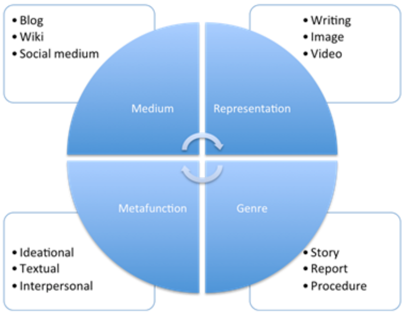

Figure 3: Learning objects as semiotic resources.

A *genre* is a goal-oriented semantic configuration or template "for getting things done" communicatively in a certain culture (see Martin and Rose, 2008 and Vorvilas et al., 2011). Examples of genres are stories, procedures and reports (broadly descriptions of entities). Such genres may combine to form macrogenres, typical of larger units of educational material (e.g. textbooks).

Metafunctions are the semantic elements that can be identified in an object. *Ideational meaning* is what the object is about (persons, places, events and concepts), *textual meaning* is what makes the object (more or less) cohesive and coherent, internally and externally, and *interpersonal meaning* is meaning associated with the relationship between the creator or designer of the object and his or her audience.

The upper part of the learning object model in figure 3 has mainly to do with the form of the resource (signifier) while the lower part relates to its content or meaning (signified). The arrows indicate the "natural progression" in analysis from a concrete communication channel to more or less elusive meanings.

The four semiotic categories may themselves be progressively refined. For instance, a learning content component might not only be categorized as an image but also as a diagram or even a concept map. And a specific instance of a genre like procedure could be subtyped as a food recipe or an installation guide.

So, a learning content object might be described along the following lines:

- Medium: Blog posting > tweet
- Representation: Image > diagram > concept map
- Genre: Report > classifying report
- Metafunction: Ideational meaning > concepts (birds > birds of prey > eagles, hawks, vultures)

That is to say, this bundle of metadata designates a concept map published in a tweet on Twitter and giving a classificational description of a set of concepts, namely birds of prey.

Another object might have these characteristics:

- Medium: Wiki page
- Representation: Writing
- Genre: History > historical recount
- Metafunction: Ideational meaning > events (Battle of the Little Bighorn), persons (Custer, Crazy Horse), places (Little Bighorn River); textual meaning > external link > elaboration

Here a piece of writing in a wiki page gives a historical recount of the Battle of the Little Bighorn involving certain persons and places and containing a link to an external resource providing additional information on the event.

In other words, this semiotic descriptive model may be conceived of as a kind of extensible facetted classification in which any learning component may belong to several types and subtypes or be viewed from several perspectives.

Now, further information may be attached to these four main facets. For instance, didactical metadata may be added to the learning object as a representation to indicate degree of interactivity, learning style, etc. Ideational meanings may be expanded: events may be located in place and time, persons may be described or depicted and places may be encoded with geospatial coordinates.

Also, the metadata may describe nested structures, as it were. For instance, in a concept map classifying birds of prey, there might be images attached to the various types of bird. These images may themselves be subjected to semantic description and annotation.

Semiotic metadata should not be seen as an alternative to more traditional metadata schemes such as Dublin Core, LOM or SCORM (e.g. Robertson, 2011) but rather as an extension. They make it possible, it is believed, to tie a learning resource more closely to its domain and to specify in greater detail what communicative intentions it seeks to realize. Moreover, as argued below, they may also have a role to play as part of the actual learning design of the resource in which they are embedded.

2.2 Encoding

It is beyond the scope of this short paper to discuss the many possibilities of representing semiotic metadata as embedded semantic markup in HTML5 documents using structured data formats such as Microdata and RDFa (Lite). The following example, however, suggests one simple approach. It makes use of RDFa Lite syntax and the schema.org vocabulary:

```
<!DOCTYPE HTML>
<html>
<body vocab="http://schema.org">
<article typeof="Article
CreativeWork/Medium/Wikipage
CreativeWork/Representation/Writing
CreativeWork/Genre/Report/DescriptiveRe
port">
<div
property="about/metafunction/ideational
Meaning" typeof="Person/General">
<h1 property="name">General Custer</h1>
<p>George Armstrong Custer(December 5,
1839 – June 25, 1876) was a United
States Army officer and cavalry
commander in the <span
property="performerIn"
typeof="Event"><span
property="name">American Civil
War</span></span> and the Indian Wars.
Raised in Michigan and Ohio, Custer was
admitted to West Point in 1858, where
he graduated last in his class.
However, with the outbreak of the Civil
War, all potential officers were
needed, and Custer was called to serve
with the Union Army.</p>
<img property="image"
src="http://upload.wikimedia.org/wikipe
dia/commons/thumb/8/83/Custer_Portrait_
Restored.jpg/250px-
Custer_Portrait_Restored.jpg" />
</div>
</article>
</body>
</html>
```

This snippet of text copied from Wikipedia is marked up with common HTML5 elements such as <body>, <article>, <p>, <h1> and <img> to indicate structural components like paragraph, heading and image. These elements contain semantic markup based on schema.org classes and properties. They formally state that this is an *article* about a *person* whose *name* is Custer who was a *performer in* an *event* whose *name* was the American civil war and that it is indeed his image that is included in the text.

The schema.org vocabulary allows content developers to extend and customize its categories and properties. For instance, in the representation above it is specified that Custer was not only a person but in fact also a general (`typeof="Person/General"`).

And it is this extension mechanism we have employed to include semiotic metadata. To indicate the medium, representation and genre of the resource we have extended, or specialized, the schema.org category of *Creative Work* and to signal ideational meanings in this text, we have extended the *about* property. (Search engines like Google's do not know about these extended notions of *general*, *medium* and *ideational meaning* and so on, of course, but they will still be able to act on the core categories and properties like *person* and *about*).

In figure 4 a semantic/semiotic representation of the resource is shown when fed to an RDFa processor (http://rdfa.info/play).

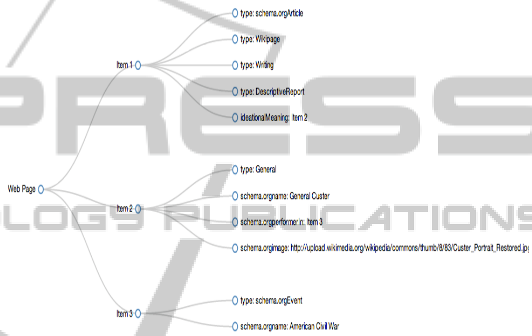

Figure 4: Semiotic representation of sample text.

For the sake of simplicity, only one vocabulary is instantiated in the Custer example. But structured data formats like Microdata and RDFa (Lite) actually allow several schemas to be mixed in an HTML5 document. For instance, in a longer document we might have included categories and properties from the FOAF vocabulary ("Friend of a friend") to specify General Custer's relations to other historical persons or referred to the Dublin Core vocabulary to add details about the document as a digital resource. And if the text had contained any hypertext links, we might have pointed to classes in the Salt Rhetorical Ontology to specify their communicative function.

3 BENEFITS AND WIDER PERSPECTIVES

What, then, are the benefits of marking up semiotic resources, complexes of meaningful signs, in learning materials? It may be argued that gains may be achieved in the following areas:

Firstly, the quality of information retrieval will no doubt be enhanced. It will eventually be possible to formulate more precise queries in search engines. Queries like "Find a concept map in English classifiying birds of prey and containing pictures of them" are no longer but a futuristic dream. (Google's Knowledge Graph is evidence of this trend).

Secondly, linking content components across web sites may be done in more explicit and principled ways. A hyperlink may denote an ideational relation between two domain entities (person A *is the brother of* person B) or a textual, or communicative, relationship (paragraph A *is a summary* of section B). And if global identiers are used, this is effectively tantamount to exposing, or attaching, learning objects to the Web of Data using linked data (see Heath and Bizer, 2011).

Thirdly, the reuse of embedded content components is also likely to become easier as these will be "unbundled" to a greater extent.

Fourthly, embedded semiotic annotation may provide an additional affordance, which has to do with the *learning potential* of learning objects, rather than just their retrieval, linking or reuse. The reason is that such metadata may be construed, and utilized, as what we may call *semiotic enzymes,* hidden elements enabling learning designs to be (dynamically) altered in various ways to cater for different user preferences, learning styles, rendering devices, etc. (see Johnsen, 2012). As an example, inline semiotic markup may be used to actively support one or more of Mayer's principles of multimedia learning (Mayer, 2009), in particular his "principle of signalling", i.e. the guideline advocating the use of conceptual structure markers in learning materials. Embedded semiotic tags could be used, say, as source data for dynamically creating graphic organizers, spatial arrangements intended to visually map the conceptual or narrative structure of a piece of text and hence facilitate its comprehension (see Stull and Mayer, 2007).

And since semiotic encoding can be done using standards like Microdata and RDFa (Lite), reusable style sheets, templates or widgets processing these semiotic metadata can be developed and shared on a global scale, especially for widely used categories like events, persons and places. For example, a college professor publishing a history textbook on the web might link the document to an external widget creating a visual timeline based on the events mentioned in the text. Or a learner might download a browser plug-in to flag all occurrences of concepts of interest when surfing the web.

This affordance opens a whole set of opportunities that could, for lack of a better term, be called "Learning Content Design as a Service" (LCDaaS). The idea itself is simple: content providers like professors and teachers will only have to concentrate on constructing structured materials ("basic content") but will be able to link these materials to (dynamic) designs and in this way create richer and more engaging learning resources. And users will have a greater say in deciding what design options they want for the materials they study (visual support, interactivity, etc.).

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