Filling out Learning Object Metadata Considering Cultural Contextualization

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Abstract— **This paper presents Cognitor, a common-sense aided framework for the Cog-Learn Pattern Language that aims to help content editors create and contextualize e-learning content through the generation of hyper documents that comprise pedagogical issues, producing learning objects (LO) compatible with the SCORM standard. Cog-Learn have been developed from Learning and Human-Computer Interaction (HCI) Theories. The goal of Cognitor is to allow for the design of digital learning material with better organization of the content that will be explored by learners, aiming to make easier the interaction with it, addressing HCI issues, as well as the interaction between learners and teachers, addressing Human-Human Interaction (HHI) issues. To reach that, it is important that the LO created in Cognitor be easy to reuse, helping creators to fill out the metadata aiming at addressing cultural issues related to the context in which the LO can be adopted and reused. For that, suggestions coming from a common sense knowledge base automatically appear in some SCORM metadata fields in order to help the task of filling out culturally contextualized metadata.**

Keywords— **Common Sense, Learning Object, Metadata, Learner's Context, E-learning, Learning Material, Patterns, Framework.**

I. INTRODUCTION

According to Anacleto *et al*. [7], the increasing use of computers in education has made teachers face some new challenges, since lots of them are not proficient in using computers and not used to the new educational approaches which computers made available, such as e-Learning, on-line Distance Learning and so forth. It happens especially to teachers in developing countries, the main focus of this research. It is necessary to think about several issues such as transposing learning material from the paper-based to the computer-based world and developing new teaching techniques to allow students, sometimes distant from teachers, to learn efficiently. Taking into account the facilities offered by the Internet, it is likely to think of producing learning content to be delivered on it. Therefore, it is important to provide tools to support the generation of web-based learning material, especially because teachers are not expected to know how to design hyper documents in order to elaborate the content they want to teach.

Producing on-line learning material can be a hard task for teachers with little experience in combining pedagogical issues, computer-mediated education and web page creation. This task becomes even more difficult when the need of accounting for the cultural context in which students are inserted into and how to reflect it in the learning process are considered [14]. Regarding the learning process, there are several learning theories on how learning takes place and how teachers should address it. Among those theories, the use of common sense knowledge to contextualize the learning process to the student's cultural reality [14][15] and the use of Conceptual Maps (CM) to organize the learning content which is presented to students [18] emerge as important practices that can help e-learning to be successful [5]. In this context, common sense knowledge can be defined as a non-specialized kind of knowledge that describes the culture of a social group in a specific era [18].

This paper presents Cognitor, a common-sense aided framework for the Cog-Learn Pattern Language that aims to help teachers create and contextualize e-learning content through the generation of hyper documents that comprises pedagogical issues, producing learning objects (LO) compatible with the SCORM standard [3]. Cog-Learn have been developed from Learning Theories such the ones previously mentioned and from Human-Computer Interaction (HCI) theories.

The main goal of Cognitor is to allow for the design of digital learning material with a better organization of the content that will be explored by students, aiming to make easier the interaction with it, addressing issues from Human-Computer Interaction (HCI) field of study, as well as the interaction between students and teachers, addressing issues from the Human-Human Interaction (HHI) field of study.

This paper is organized as follows: section 2 presents Cognitor; section 3 explains the theories used in the tool; section 4 shows a comparison between Cognitor and other web-based learning material authoring tools; section 5

describes how Cognitor fills out LOs metadata; finally, section 6 presents the conclusions and points some future works concerning the tool.

II. COGNITOR – A COMPUTATIONAL TOOL

Cognitor [21] is a computational tool developed to support teachers in their task of designing and editing quality learning content. Cognitor brings several advantages for teachers in the edition of on-line learning content. The tool was designed to help teachers put in practice pedagogical principles in the edition of learning content.

The first advantage of using the tool is related to the learning content organization. It can be said that one of the great challenges in editing LOs is to support teachers and students to organize the knowledge so that it can be transferred to other people. One of the ways to do it successfully is through the use of Conceptual Maps (CM). The theory on CMs was developed by Professor Joseph D. Novak from Cornell University, based on the concepts of subsunsors and meaningful learning presented by Ausubel in his Learning Theory [8][20]. In order to develop such theory, Novak performed several case studies with children in the USA, aiming to understand children's learning process and to verify the consistency of Ausubel's Learning Theory [3]. At the end, he proposed a technique for organizing content so that it can be effectively used for learning. Such technique is implemented in Cognitor, as it is presented further ahead in this section.

The second advantage is related to the reuse of LOs. The learning content produced through Cognitor can be reused in other learning contexts because it is designed as LO. In doing so, teachers can build a LO repository and have a great number of the most diverse LOs available for planning their classes, getting more flexibility for adapting the learning process to the pace and the interest of the students, toward the pedagogical goals they have previously defined.

Another advantage is related to the possibility of making the content available to be explored in different e-learning platforms. This is because LO created using Cognitor can be exported in both SCORM [3] and HTML formats. A LO exported in SCORM format, for instance, can be deployed in any Learning Management Systems (LMS) that supports it. Some examples of LMS which support SCORM are Moodle [19] and Blackboard [9]. On the other hand, a LO exported in HTML can be deployed in any Web server so that it can be explored within any web browser like Mozilla Firefox, Internet Explorer, Safari and so on. Exporting LO in SCORM or HTML do not require teachers more than a click on a button. Teachers do not need to know how to program in HTML or how to build a SCORM package in order to get their LO in these formats. All they need to do is to use the WYSIWYG (What You See Is What You Get) interface of Cognitor.

Besides those advantages, Cognitor also offers a computational representation for the Cog-Learn Pattern Language. Cog-Learn is an e-learning Pattern Language identified and formalized by specialists in the domain of

Design Patterns, during the performance of three case studies that made possible to verify that the use of a set of cognitive strategies combined with HCI and Pedagogical Patterns improves the usability of LOs written in hyper document format and contributes to improve the user's, i.e. the student's, satisfaction in using such hyper documents [22].

Therefore, by the use of Cognitor, teachers have the necessary support in designing digital learning material, which addresses important issues for promoting effective learning and achieving better involvement of the students with the learning process.

Figure 1 shows the main interface of Cognitor. As it can be observed, the tool is divided in six great areas, which are quickly described in the following.

- **A – Planning and Organization Area**: Using the options of this area, teachers can define a new organization (sequence of pages and topics) for the learning material, choose one previously defined or even change an existent organization. Cognitor also offers to teachers the possibility to use the common sense knowledge to build this organization.

- **B – Media Insertion and Content Publication Toolbars**: The media insertion and content publication toolbar allows the addition of media objects such as audio, video and images. Furthermore it makes possible to manipulate actions performed during the object creation/edition, such as *redo, undo, cut, past, copy, find* and *replace*. Teachers can also *save* their materials using the functionalities available in this tool and also export them in SCORM [3] or HTML format. More details about exporting the learning content are given further ahead in this section.
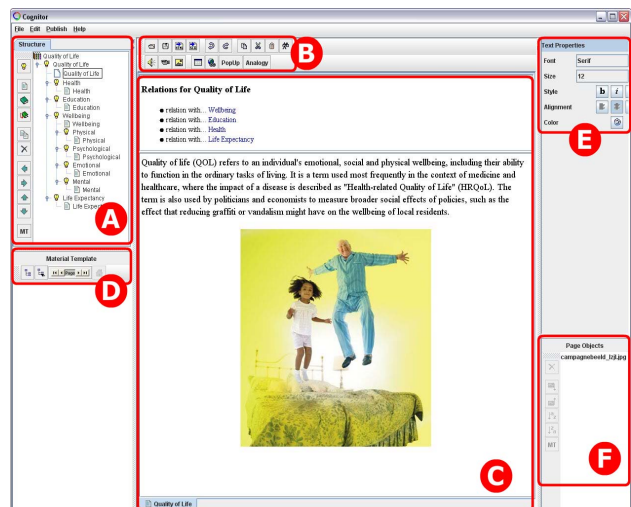

Figure 1. Cognitor Main Interface

- **C – Page Edition Area**: In this area, teachers can see the material which they are editing and also insert new media. There they can edit the body of the pages of the learning

content, typing the wished text or inserting several different media through the toolbar B.

- **D – Interaction Design Area:** In this area, the teacher can create a page template to apply on the material as a whole. The idea of configuring the class initial environment corresponds to solutions for common problems found in HCI analysis context which were formalized as Patterns and compose the Cog-Learn Pattern Language.

- **E - Media Properties:** This area permits teachers to change the properties (height, weight, colors, fonts, etc.) to adjust each type of media inserted in the Page Edition Area.

- **F - Object Control Area**: This area permits teachers to visualize the objects of a page, enabling the change of their order and allowing filling out of metadata related to each one. The metadata are important to describe the properties and behavior of each object inserted into a page and, in this way, they make possible to know, for instance, the objective of the insertion of a proper picture in the learning object and the data about the author of the picture.

Figure 2 shows the learning material generated in Cognitor, opened in an Internet browser. That artifact is related to the learning material presented in Figure 1.
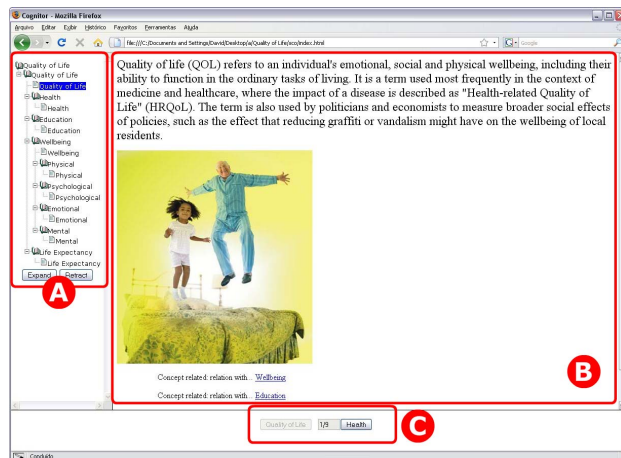

Figure 2.   Learning material generated in Cognitor

It can be observed in Figure 2 three great areas. Area **A** corresponds to the learning material navigational tree through which learners can explore the material in the same way that they interact with any hyper document on the web. This navigational tree is generated automatically by Cognitor. Teachers do not have to program any tag in HTML to have their pages generated as well as their navigational structure. Area **B** refers to the content to explain a specific concept. In the example, the text is related to the concept Quality of Life. Area **C** corresponds to another navigational item that can be included using Cognitor.

With just a click, the tool inserts in the learning material that sequential navigation item. Teachers can decide for one of the navigational structures present in Figure 2. For example, they can decide to deactivate the links of the navigational tree or even to hidden them if, for their pedagogical goals, it is better for the learners to explore the pages of the material sequentially. They can also do not make available the sequential navigation element.

III.   MEANINGFUL LEARNING, CMs, NOVAK AND COGNITOR

The students' *cognitive structure* is the hierarchical organization of the pieces of knowledge that they acquired before a specific session of learning process begins. The better the previous students' cognitive structure is, the easier the new pieces of knowledge will be integrated to it [8]. Ausubel call subsunsors the knowledge already well established in the students' cognitive structure. The subsunsors can be used as anchors for new pieces of knowledge presented during the learning process. Once a piece of knowledge is anchored to a subsunsor, meaning learning takes place [8].

Cases studies performed by Novak showed the importance of having the students' previous knowledge as starting point for a new session of learning. According to him, learning is related to the ability of making abstractions between concepts. However, he points out that even when considering the students previous knowledge, there is no guarantee that learning will happen, since it depends on other factors such as the students' motivation [20].

From the case studies results, Novak developed the technique of Conceptual Maps (CM) to organize concepts that could be used as subsunsors, so that the students' cognitive strategy could be stimulated [3]. In the CMs, the structure is build hierarchically, having the more abstract concepts in the top and the deeper concepts, i.e. concepts representing more specific knowledge, in the bottom. This is called progressive differentiation [8].

According to Novak's theory, presenting the concepts in a well organized structure makes easier for students to create new anchors between the new knowledge and the knowledge in their cognitive structure. The better the quality of tests, the more likely the students assimilate the content of the material [8][20]. Therefore, Cognitor aims to help teachers compose CMs with subsunsors from common sense knowledge collected from people with the same profile of the target group in an attempt of supporting Novak's theory. In this way, concepts closer to the students' cognitive structure could be presented during the learning process to promote meaningful learning. It is worth pointing out that common sense knowledge is not taught, but used for introducing new pieces of knowledge that can even contradict the common sense, since it is known that common sense knowledge can have some misunderstandings that need to be clarified during a learning process.

In Cognitor, teachers can use the implementation of the Cog-Learn Knowledge View Pattern [21] for planning and automatic generating the learning material navigational structure according to the technique of CM proposed by Novak. For that purpose, teachers should (i) enter into the system the concepts which they want to approach in their learning material

and organize them hierarchically; (ii) name the natural relations between concepts, i.e. the relations mapped from the hierarchy previously defined; and (iii) establish and name any other relation between concepts, which they consider important to the content understanding and exploration (See [6] for more information on the process of generating a CM in Cognitor, using the Knowledge View Pattern).

When the teacher use the Knowledge View Pattern implementation, Cognitor offers the common sense support to provide him with information about the facts that are considered common sense in the domain that s/he is thinking of. So the teacher can complete the concept list based on that information, decreasing the time on planning the material organization.

Figure 3 depicts the first step of Cognitor Knowledge View Pattern tool, in which teachers are supposed to enter into the system the concepts which they want to approach in the content. In the example, the teacher entered the concept "Health", and the system suggested in the box on the right concepts such as "ill person", "place", "medicine" and so forth. Teachers can select one of the suggestion from common sense knowledge and click on the "<< Include" button, select a concept in the list of concepts on the right and perform a search in the common sense knowledge base for related concepts through the "Search >>" button, or even add another concept that is not in the common sense concepts suggestion list.
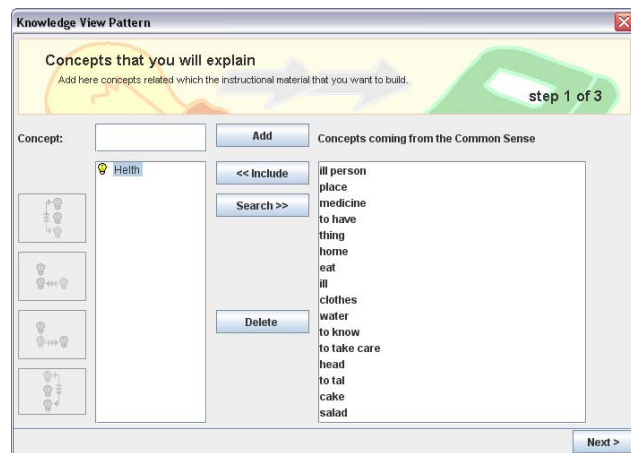

Figure 3.   Knowledge View Pattern - First Step

In this way, teachers can compose a CM contextualized to the cultural reality of the students and prepare LO that can promote meaningful learning.

IV.   COMPARISON BETWEEN COGNITOR AND OTHER LEARNING MATERIAL EDITORS

Being aware of the importance of knowing other tools which have the same purpose of Cognitor, the web was searched for tools which aim to support teachers to produce learning material in hyper document format and each of them was compared. The comparison was based on the features that W3C recommends web page authoring tools have [24]. The support in creating CMs to be used as the learning material navigation structure, and creating LOs, through the insertion of metadata, was also considered. Table 1 presents the relation of the features found in each authoring tool analyzed.

As it can be observed, only 34% of the tools which claim to be web-like learning material authoring tools have their own editor. It means that only 34% of those tools are really authoring tools, since the others do not support content generation or edition. Those tools which do not have their own editor work as content organizer and aggregator, i.e. teachers can define which learning objects should be available in the learning material however they cannot edit the content of the learning objects in the tool. The learning objects should be generated in other tools and then added and organized in the tool as a sequence of learning objects which will be published as learning material.

Another important issue that can be verified in Table 1 is that all the analyzed tools support the edition of CM. The CM tool works as a support for teachers to organize the learning objects which are part of the learning material and to define the navigational logic which is going to be used to explore the learning content. Previous studies have already shown the usefulness of using CM as the learning material navigation index to achieve good results in the learning process, since it is an artifact based on Learning Theories [20][22].

TABLE I.   COMPARISON AMONG LEARNING MATERIAL AUTHORING TOOLS

	Cognitor [6]	Compendium [12]	CMapTools [11]	Conzilla [13]	Inspiration [17]	Vue [23]
Own Editor	Yes	No	No	No	Yes	No
Add Resources	Yes	Yes	Yes	No	Yes	Yes
Export Html	Yes	Yes	Yes	No	Yes	Yes
Collaborative	No	No	Yes	No	Yes	No
Concept Map	Yes	Yes	Yes	Yes	Yes	Yes
Aid Creation of Concepts	Yes	No	Yes	No	Yes	No
Metadata	Yes	No	No	Yes	No	Yes
Common sense support	Yes	No	No	No	No	No

Notwithstanding, the support to generate CMs present in the tools, only 50% of them give teachers support in selecting the concepts which are going to be approached in the material. This feature is very important to make easier teachers' job of organizing the learning material, since they bring out related concepts, so that teachers do not forget important topics which should be approached in the learning material. This feature makes the CM edition more effective since teachers are likely to remember faster the concepts for their CMs. CMap Tools [11] and Inspiration [17] use their own dictionaries to retrieve and suggest related concepts to teachers as they insert a new concept in the CM they are elaborating. Cognitor uses the common sense knowledge base of the Brazilian Open Mind Common Sense Project (OMCS-Br) [4].

Finally, only 33% of the tools allow inserting metadata to the LOs edited in the tool or added to the learning material, i.e. inserting data which describe the LOs in the learning material

and the learning material itself. This is another important feature which web-based authoring tools should comply with, especially to allow learning objects to be stored in and, after that, retrieved from a learning object repository. This is special important to collaborative development of learning material.

It can be concluded, therefore, that Cognitor complies with the majority of the features established by W3C for web page authoring tools, as well as features considered important in learning material tools such as the support to create CMs [11][12] the help in selecting concepts for the CM under development, and the description of the LOs through metadata [6][13][23].

V. FILLING OUT LO METADATA

As said, the Cognitor is capable of insert metadata in the LOs created in it. These metadata take into consideration IEEE LOM [16] standard; SCORM also uses it [10].

Nowadays, some metadata fields, such as: "Title", "Keyword" and "Description" are already filled out semi-automatically [10]. "Title" is filled out with the name of the LO under edition; "Keyword" is composed of words that appear often in the text; and "Description" is formed from concept map relations created during step 2 and 3 of the knowledge structure assistant. But, new fields can be filled out at the same way using common sense knowledge. Figure 4 shows some metadata being edited. Those metadata correspond to the page related to the "Helth" subject. Figure 5 illustrates the window that helps teachers to fill out the "Keyword" field. Notice that common sense knowledge could be used for supporting the teacher.

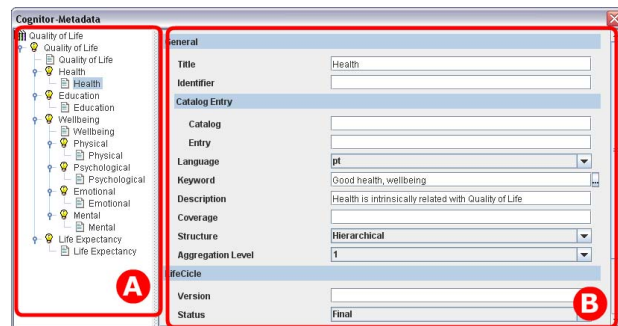Figure 4.   Cognitor's metadata editor inteface

The window that allows the user to fill out the metadata related to a LO, presented in Figure 4, is composed of two areas: Area **A** shows the material CM, while area **B** shows the metadata fields that can be edited.

Figure 5, showed in the following, presents the window that supports the user to compose the "Keyword" field of the metadata editor. To open it, the user should click on the button next to the "Keyword" field (showed in Figure 4). Some suggestions are presented to the user in the format of a list (**A**); these suggestions are extracted from the text inserted in the page whose metadata are being edited. The user can click on the "Search >>" button to search in the common sense knowledge base for concepts related to the word selected in list **A**. The results of the search are displayed in list B. User can

also type suggestions in the "Create Suggestion" field, showed in **C**.
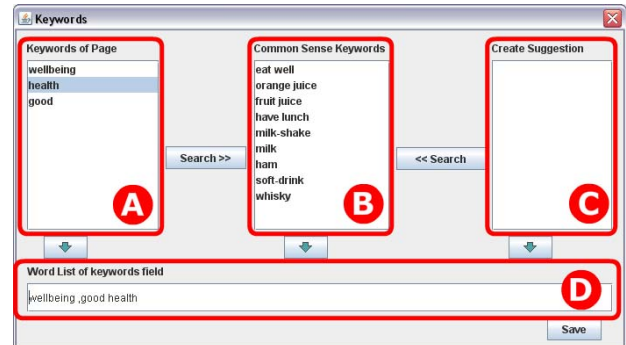

Figure 5.   Cognitor's keyword composer

As it is done with the suggestions from list **A**, the user can also search for concepts related to her/his suggestion in the common sense knowledge base. To do that, s/he should select the suggestion provided and click on the "<< Search" button. Again, list **B** will show the search results.

Finally, to build the keywords list, the user should select an item in list **A**, **B** or **C** and after that click on one of the add-buttons available bellow the selection lists, which are depicted as arrows pointing down. Doing this, the selected word is copied to the field in Figure 5 area **D**. When the user finishes composing the keywords list, s/he must click on the "Save" button.

VI. CONCLUSION

This paper presented Cognitor as a tool to support teachers from developing countries in transposing the challenges brought by the new approaches made available by the use of computers in education. As it was mentioned before, it is necessary that teachers think of suiting their learning activities and material to e-Learning and, for that purpose, it is important to offer tools to help them with their tasks.

The proposal of Cognitor is that teachers who have little experience in producing web-based learning material can easily develop their learning material to be published on the web or in digital media, having the support of common sense knowledge and an e-Learning Pattern Language for reaching pedagogical issues in the content generated, such as culture sensitivity [1][2], which is especially important to teachers who work in extensive countries like Brazil, and who consequently deal with learners from different regions and cultures.

Nowadays, the most important challenge in the development of Cognitor is to build a better mechanism to help teachers to fill out metadata allowing the LOs created by them to be stored, retrieved and reused.

As future works it is proposed to work on the usability problems brought out during the usability tests presented in [7], to port the tool to a web environment, to improve the metadata filling out mechanism, to make the editor a collaborative authoring tool, an important feature in the current knowledge society which values the group work, to create a LO repository

to store the LOs created by the users of Cognitor and to perform new usability tests to keep the tool improving towards the use efficiency, efficacy and satisfaction.

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