

Hyperbook: an on-line hypermedia editor and SCORM wrapper

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Abstract—Education sustained by Information and Communication Technologies needs adapted tools to support the teaching and learning process. Pedagogical theories must guide teaching contents development, and the tools used must attend specific requirements. This paper describes the Cognitive Flexibility Theory and the development of a tool to enable the on-line creation and edition of educational hypermedia according to the principles of this theory. Along with this tool development, the SCORM specifications were considered in order to make possible hypermedia exportation in the form of learning objects.

Index Terms— Learning systems, Hypertext systems, Multimedia systems, Educational technology.

I. INTRODUCTION

Online distance education requires special techniques and methods in order to support teaching and learning processes in scenarios different from face-to-face learning. Among these techniques and methods, there are those related to instructional design and materials development.

Learning materials can be organized into a hypermedia structure and its development can be done on-line in order to provide a more efficient response time when content adaptations are needed, enabling hypermedia customization on demand, exempting teachers from calling a technical expert just to add, edit or remove elements from the hypermedia.

Different learning and cognitive theories can drive the hypermedia organization. Among these approaches is the Cognitive Flexibility Theory (CFT), which basically tells us that learning content is more efficiently assimilated when accessed through different navigation paths.

In order to enable the building of this multiple navigation paths, the tools used on the on-line development of hypermedia must provide functionalities to assemble and deploy learning content with such characteristics.

Another relevant aspect of on-line distance education is content interoperability, spreading development costs while adopting materials in wider audiences. This is accomplished by standards adoption and allows content reuse in different situations, by using learning objects when designing the learning scenarios. Content interoperability is considered in the design of the online editor and on the hypermedia design; specifically, the

Shareable Content Reference Model (SCORM) is taken into account in order to provide content interoperability and reusability.

This paper starts describing the CFT in more detail and contextualizes it with a hypothetical hypermedia structure.

Next, the development of the online hypermedia editor, called Hyperbook, is described. It is used within the MOODLE, a Learning Contents Management System (LCMS), whose course structure is presented in order to demonstrate the context where Hyperbook is applied.

The Hyperbook development begins with the description of a more basic online editor, the Book module that founded the development the Hyperbook module.

An important functionality present on Hyperbook is the ability to export SCORM learning objects. The steps followed in the implementation of this exportation functionality are described and aspects of using SCORM and Hyperbook on an on-line course are also presented.

Practical issues related to the effects that SCORM adoption had over the tool design, content graphics aspects, and hypermedia organization and navigation are listed and commented. Some of them are about the misconsideration of certain SCORM specifications and the limitations that the hypermedia navigation design has when applied in SCORM learning objects.

Finally, conclusions about CFT, SCORM adoption and Hyperbook development processes are presented, and future work is indicated.

II. A TOOL FOR ONLINE HYPERMEDIA DEVELOPMENT

The Hyperbook is a tool based on the web that enables creation, structure, and publication of didactic contents. This tool is used in a LCMS and its target public consists of teachers and contents developers who need to elaborate material to support teaching and learning processes. This tool allows technologically naive teachers to transform their Hyperbooks into SCORM learning objects (Advanced Distributed Learning–SCORM, 2005) that can be used into others scenarios.

The Cognitive Flexibility Theory approached in the next item was chosen to guide the structure of the Hyperbook.

III. A TOOL FOR ONLINE HYPERMEDIA DEVELOPMENT

Linear learning models gave form to prior pedagogical theories to develop educational contents material. However, linear thinking contradicts the spatial structure of human memory. Dias (2000, p.146) states that the behaviorist learning theory followed the black box mind metaphor, especially with the programmed instruction that brings the decomposition principle of contents aiming at presentation and sequential control of learning.

Multidimensional approaches have been shown to be more adequate to explain the human cognition model. Lévy (1993, p. 40) believes human memory is structured in such a way that comprehension and retention is better when things are organized according to spatial relations.

Hypertexts and hypermedia, for him, can propose various access points and also become a kind of orientated instrument in the knowledge dominium (domain?) as they can present diagrams, network or conceptual maps possible of edition and displaying more dynamics. Lévy also argues that these new media may make it easier and quicker to master a knowledge dominium (domain) than classical audiovisual or printed material.

As a way of breaking with linear educational contents development, Cognitive Flexibility Theory seems to have adequate characteristics to support the learning model considered by Levy.

According to Spiro et al. (1987), this theory is based on existing knowledge, regrouped in a way to fulfill new situation needs: knowledge is acquired and represented by means that allow its flexible use.

Cognitive Flexibility Theory applied to education requires from learners the capacity to group knowledge about a certain domain, which involves different levels of cognitive effort. From the instructional point of view, detailing complex contents inter-relations and offering multiple perspectives of these, in such a way to be based in more than one representation schema, accomplishes this. (Jonassen, 1991 apud Bannan-Ritland; Dabbagh; Murphy, 2000).

Carvalho (2000), by considering the CFT fundamentals, believes that mastering a certain content is like a landscape that should be crossed in several directions.

The CFT applied to a Case-based learning can illustrate the crossing views upon a certain content. A case consists of a situation in which some knowledge is applied, and this can be break down in mini-cases with small amounts of information. The element that will aid a learner to acquire plain knowledge of a certain domain is the navigation through different cases and mini-cases.

A simplified schema can be observed on a hypermedia for diseases case study. The learner navigation can take place in each case, accessing mini-cases, each one presenting a symptom associated with a specific disease, or can occur over mini-cases groupings, as in a group that shows certain symptoms that are present in different diseases. Thus, the analysis of different diseases is related

to cases, and the studies over each symptoms consists of the mini-cases. An educational hypermedia, based on CFT, for the case study of diseases should allow learners to explore the occurrence of a certain disease compound by different symptoms or to analyze the existence of a certain symptom associated to different diseases.

IV. MOODLE LCMS AND SCORM

The SCORM (Shareable Content Reference Model) has a great influence on the Hyperbook project. It defines contents organization characteristics and is part of the MOODLE.

MOODLE stands for Modular Object Oriented Dynamic Learning Environment, defined as Learning Contents Management Systems (Paulsen,2002), and supports the creation of learning scenarios using a web interface.

Such learning scenarios consist of courses organized by topics including activities and materials. Materials are modules that enable the use of questionnaires, wikis, forums, chats, and others. SCORM consists of one activity module, and in the latest MOODLE versions, it is also a course format.

The SCORM module enables the execution of learning objects elaborated according to the SCORM reference model. However, this MOODLE module does not allow the elaboration or edition of learning objects.

In order to allow the elaboration and publication of learning objects, the original Book module was adapted and transformed into a Hyperbook. Such adaptation occurred to facilitate more complex structured hypermedia development and is described in the following sections.

A. *The Book Module*

The MOODLE Book activity module enables teachers and developers to edit online contents.

The design of this module, according to this LCMS documentation, aims at a simple structure by allowing just two hierarchical levels: chapters and subchapters. The focus of this tool is on linear and less structured contents. For longer texts the author recommends the use of *pdf* files.

Interesting functionalities of this module consist of the possibility of importing HTML pages in order to enable online edition, and to automatically generate a printer version of the pages of the book.

Although the Book intends to generate low granularity contents, the Book structure does not support hierarchical levels, such as chapters, topics and sub-topics, presented in different web pages. Contextual elements are also not easily added, such as pages related to certain contents, or windows containing comments.

B. *The Hyperbook Module*

The structure of contents in hypermedia format seems more adequate to support learning due to the similarity with human thinking. However, such structure implies

organizing contents with links and using multimedia resources to help to represent the contents to be studied.

Aiming to offer better conditions to implement contents, the book MOODLE module was adapted to support hypermedia design demands, following the principles of Cognitive Flexibility Theory.

This adapted book module was named Hyperbook, as seen in the figure 1.

Area 1 in the figure highlights elements that enable navigation (in this example through Presentation, Contents, and Activities) and the management of navigation paths.

The user can find below the navigation paths a breadcrumb tracing the way the user has been through the Hyperbook (in this case just one level: Conteúdos > Literatura Contemporânea).

Area 2 lists the sub-chapters (second level) and allows altering their features such as name, order, and visibility. The plus signal allows the inclusion of new sub-chapters.

Contextual elements such as links, glossaries, comments and bibliographic references can be added using the icons presented in area 3. These element's contents are shown in a layer on the same web page.

Area 4 lists icons for adding, editing, removing, and navigating through the pages.

The links located at the lower left part of the figure 1 are for metadata register about the hypermedia and for converting it to a learning object in SCORM format.

Besides offering several structure levels, other requirements were identified in the development phase in the use of this tool. These requirements identified graphical and usability aspects. Layout, background colour, typographic type, size and colour, as well as the navigation scheme (sub-chapters list and breadcrumbs path) were planned towards achieving a higher level of usability. However, these characteristics may vary according to the users and LCM systems in use.

Ip et al (2003) proposes an extension of the SCORM data model to enable graphical personalization. However, this feature is not yet available and graphical aspects are important in learning objects elaboration.

The database design considered SCORM aspects in relation to the separation of chapters from its navigation structure, in such a way to allow a chapter to be present in different navigation paths.

The SCORM orientation related to avoid links among contents of two separate units⁴ was ignored. A hypermedia is composed of links and such orientation would impoverish contents.

As a consequence of not following such orientation, the LCMS cannot monitor learner navigation steps originated from links in chapter's content. The learning path can only be monitored when the access is issued from the navigation tree shown in figure 2.



Figure 2. Contents navigation path of a learning object

Direct navigation effects among contents units were not verified in more complex data registers, such as learner's scoring when answering questionnaires or doing exercises of combination, for example.

V. SCORM PACKAGING

The Hyperbook module allows exportation of its contents to learning objects in SCORM format.

This functionality was not initially planned and was added on demand during development when database modelling became necessary.

The data exportation to files and to a SCORM package consisted of the following stages:

- Template files generation with the graphical aspects of the learning object definition;
- Contents recovery from data base according to SCORM required structure;
- Template and database retrieved content combined with the conversion of links to animations, images and other contextual resources in such a way to use relative references;
- Results were stocked in the file system also according to the specified structure required;

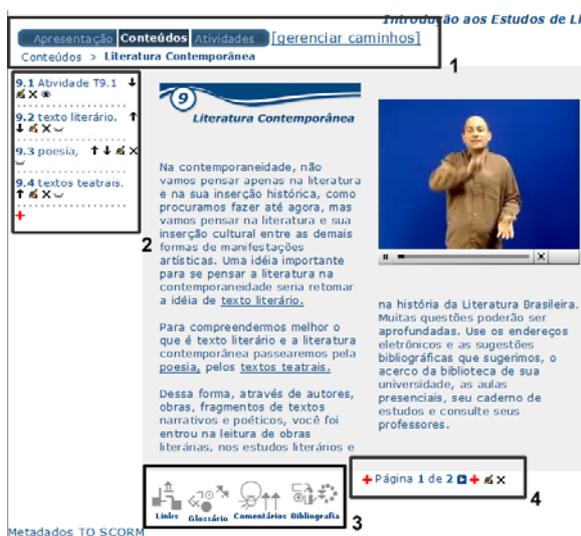


Figure 1. Graphical user interface of the Hyperbook

- Generation and recording of the file *imsmanifest.xml* that contains the metadata, navigation structure description and organization of the learning object;
- Compacting of the generated files and package of the learning object in a file with .zip extension;
- Copy of the created package to the files area of the MOODLE course.

VI. HYPERBOOK DEPLOYMENT

The Hyperbook deployment took place in contents for the deaf public of the Letras Libras distance learning program of the Federal University of Santa Catarina/Brazil. Such contents are composed of animations, images, contextual links, and texts with video translation in the Brazilian Signal Language.

This tool was used at the end of the contents edition process of the course, which involved a chain of authoring teachers, instructional designers, and graphical designers for the hypermedia layout and implementation.

The Hyperbook module was used in the contents online implementation phase and, also, in their publication into the LCMS. The SCORM module could be used in the publication phase but it would be necessary to optimize it in order to present the same navigation scheme designed in the Hyperbook. The difference can be observed comparing the Figures 1 and 2.

The SCORM module also avoids direct links among contents units. The different navigation paths are chosen from a separate window (Figure 3), altering graphics and usability aspects.

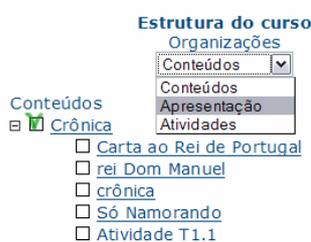


Figure 3. Choices of navigation path in the MOODLE SCORM module

VII. CONCLUSIONS

The Hyperbook allows online and collaborative development of the hypermedia of the Letras Libras course of the Federal University of Santa Catarina.

Cognitive Flexibility Theory gave the basis for the functionalities definition of the tool. However, the SCORM reference model has shown some limitations related to contents structure to attend hypermedia requisites for education.

The MOODLE enabled reuse of resources such as multimedia filters, database access functions and files manipulation, making quickly the new tool development. In this work, the MOODLE was considered a framework and the LCMS are its domain, due to the possibility to personalize elements such as modules, themes and

blocks, and to define the execution main logics. From this point of view it is important to analyse development costs of applications in relation to the efforts to learn the framework.

The possibility to transform the contents of the Letras LIBRAS course in learning objects offers the opportunity to reuse this material thus optimizing the production initial costs.

The current version of the Hyperbook does not allow a printed version, although it can be easily programmed by defining sequence rules of links and make descriptions of elements such as videos and animations.

The demand for personalizing the SCORM learning objects execution modules due to differences in the exhibition of the navigation paths between the Hyperbook and the MOODLE SCORM was identified. This difference of presentation refers to the scope of SCORM module over the graphic design domain.

As future work, the Hyperbook will be modified to enable students to edit it in a collaborative way, such as in the wiki tool, enabling them to build their knowledge more actively.

Another functionality to be developed is the importation of SCORM learning objects into the Hyperbook as a way to edit them, similarly to the way the MOODLE Book module enables the importation of HTML

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