FleXml

An Integrated Distance Learning Tool to Improve Cognitive Flexibility

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Abstract. FleXml is an integrated distance learning tool grounded on
Cognitive Flexibility Theory principles. We emphasized the knowledge de-
construction process in FleXml. This web learning tool is based on XML,
XSL, DOM and ASPs. It has three types of users: the administrator, the
readers and the authors. It has two kinds of modules – author and reader
– that are explained in this paper as well as other functions and its archi-
tecture.

1 Introduction

There are several web tools available in the market for supporting distance and dis-
tributed learning. WebCT, TopClass, CourseInfo, Lotus LearningSpace, Toolbook
Librarian, IntraLearn and AulaNet are some examples of those. With these tools
it is easy for authors to make contents accessible online for their students. How-
ever, the structure of these contents is not influenced by any learning theory and
most often these tools are used to present in an electronic format course contents
developed for presential modes of teaching.

The web tool presented in this paper, FleXml, was designed accordingly to the
principles of Cognitive Flexibility Theory, developed by Rand Spiro [1][2][3][4].

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2   Theoretical Principles Applied to FleXml

Cognitive Flexibility Theory (CFT) focuses on complex (ill-structured) and advanced knowledge acquisition [1][2][3][4]. "Ill-structuredness means that there cannot be any recourse to homogeneity, to any single course of action across instances, whether it involves a single guiding principle, a single organizational scheme, or a single prototype case" [1, p. 186]. Spiro refers to three levels of learning: initial or introductory, advanced and expertise [2]. In the advanced level the learner "must *attain a deeper understanding of content material, reason with it and apply it flexibly in diverse contents*" [2, p. 375]. One of CFT aims is to develop cognitive flexibility that is a capacity that "involves the *selective* use of knowledge to *adaptively fit* the needs of understanding and decision making in a particular situation" [2, p. 378]. Moreover, as their authors claim, "the potential for maximally adaptive *knowledge assembly* depends on having available as full a representation of complexity to draw upon as possible" [idem].

CFT is case-based. A case may be a sequence of a movie, a chapter of a book, an event. A case has to be divided in parts, called mini-cases. "The mini-case (a segment drawn from a larger case) is the starting point for all instruction" [3, p. 181]. To analyse each mini-case it is necessary to identify the Themes. They are points of view, approaches, principles or concepts that help to understand the mini-cases.

CFT has two important and complementary processes to learn: the deconstruction process and the thematic criss-crossing that we are present on the following section.

2.1   Deconstruction Process

The deconstruction process focuses on the mini-case, which is deconstructed (analysed) according to the applied themes. The user has to read the thematic commentaries. Each *thematic commentary* explains how a general theme applies to a particular mini-case. Other information may also be presented about the mini-case, such as words explanation, an event, a person, some furniture, and so on, as well as pictures or some videos. This is everything that may help the learner to understand the mini-case.

2.2   Thematic Criss-crossing

The expression thematic criss-crossing is a result of the metaphor "criss-crossed landscape" inspired in the work of Ludwig Wittgenstein, *Philosophical Investigations* [3]. Landscape is used as a synonymous of knowledge and the understanding of a subject matter arises after criss-crossing it. "The same content material is covered in different ways, at different times" [2, p. 379]. The user faces a theme (or a

combination of themes) and is guided along mini-cases of different cases. "By criss-crossing topical/conceptual landscapes, highly interconnected, web-like knowledge structures are built that permit greater flexibility in the ways that knowledge can potentially be assembled for use in comprehension of problem solving" [3, p. 170].

Both processes contribute to develop cognitive flexibility, which we characterized previously.

Based on Carvalho work [5][6][7], we implemented on FleXml the process of deconstruction and we intend to use the facilities of the Forum to challenge the students to thematic criss-crossing the mini-cases to give the answer to the theme (or a combination of themes) proposed by their teacher. We think that with this strategy, students will have a more demanding and engaged learning.

3 FleXml – An Web Platform to Improve Cognitive Flexibility

3.1 Architecture and Functionalities

The architecture of the platform takes into account two distinct interaction modules: author module and reader module. In the author module, the Authors build their Subject matters of study while in the reader module, Authors and Readers have access to these Subject matters. In the reader module, the Authors, besides being able to have access to the Subject matter, they have available a set of functionalities for managing and tracing the system usage done by the students.

3.2 FleXml: Author Module

The author module presents a set of functionalities that allow the uploading of the Subject matter of study supported by contents created outside the system or by relating texts inserted directly in diverse existing fields of forms. The activity of assembling the Subject matter of study can be taken in a collaborative way. That collaboration is promoted by the possibility of an Author of a Subject matter to give a co-author status to another person.

The files constituting the contents of a Subject matter of study can be placed either in a public area of the system or kept in a private mode, associated to a Subject matter of study.

When an Author decides to put a file in the public area that file becomes available for all other Authors and, this way, he/she promotes the reuse of this content.

The creation of contents to support the Subject matter of study can be done outside the system, using all the available tools. The documents supporting those contents must only be referred to the URLs corresponding to their localization. This functionality confers a great versatility to the FleXml.

3.3   FleXml: Reader Module

In the reader module, the user has a set of functionalities allowing diverse types of selection and browsing in the information repositories. The Reader must start by reading a general description of the selected Themes, to approach the Subject matter of study. Then, he/she chooses a Case and must proceed by studying all information available for each Mini-case. To proceed to the deconstruction of the Mini-case he/she must read the Thematic Commentaries and other available information that contributes to a better understanding of the Mini-case in analysis. Moreover, the user can still request Thematic Search, indicating the Theme or Themes and the Case or Cases that he/she wants to combine. As a result of that query, he can see a tree structure with the result of the selection, having access to the corresponding information.

Users have available a discussion forum, a chat system and an integrated notepad that allow them to share ideas and experiences, as well as to write, review and print their notes, taken during their study. Each work session of a reader is recorded in the system in terms to allow tracing the usage of the system, done by each student.

The teacher may see statistics of the total time accumulated for each student in each level of the tree of the Subject matter of study. All the functionalities described above should be used by the students as elements of self management. At the same time, using those functionalities, teachers can control the study process of their students. If necessary, it is possible for teachers to act, to correct their students in their learning process.

3.4   FleXml: Development and Used Technologies

When developing the FleXml platform we had in mind the following usability principles:

a) The use of the platform should be as intuitive as possible.
b) The interface should be consistent along the different components of the web platform. This way users do not have to spend too much time to learn how to use the tool.
c) The platform should have functionalities that allow the highest levels of autonomy for authors and learners.
d) The platform should have mechanisms to help the users in their difficulties. Those mechanisms were implemented through help messages presented in all the pages of the system interface, and a communication channel with the system administrator for critical situations.

Besides XML [8][9][10][11] for the structure and storage of the information, we used several XSL documents (Extensible Style Language) [8][9][10][11] to implement the

interface between the system and the users. Embedded in XSL documents, it was used some code JavaScript [12] to allow the improvement of some aesthetic aspects and/or the functionalities of the pages that the users interact with. As an example, we can relate the situation that occurs when the user selects diverse elements from one "combobox" and those elements will constitute the criteria for the information selection in a XML tree. In this case, that script is necessary to promote the concatenation of those elements in a single string. The data collected in the forms that these diverse documents implement are sent to the ASPs (Active Server Pages) [13] via HTTP (Hypertext Transfer Protocol). Those ASPs are used for some data processing, and they invoke DOM methods (Document Object Model) [14] that, in the XML documents, are responsible for the insertion, update, removal or selection of the information. In the cases in which the user receives in its browser a reply, some XSL documents are used again to promote the presentation of this information in the adequate format.
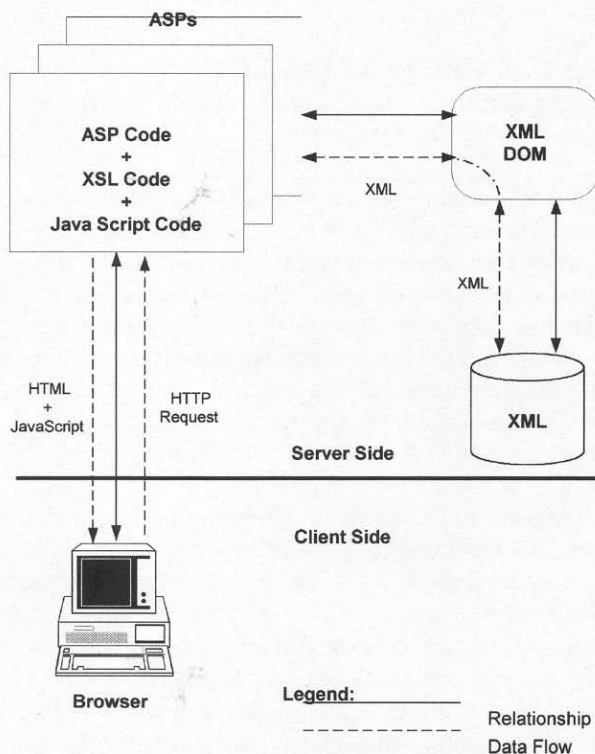
Fig. 1. *Relationship between technological components used in FleXml*

Figure 1 represents the levels of relationship of the diverse technological components used in the development of the platform. That relationship is represented by full lines. At the same time, the dashed lines represent the different flows of data passed between those technological components.

3.5   Organization and Storage of the Information – Why XML?

As an alternative to the XML, we could use a relational database of low cost and generalized use, for example, the Microsoft Access. It was possible to develop the same platform with this technology. There were, however, two factors that influenced the choice of the XML:

a) On one hand, the fact of being a more current technology, constituting a standard one in the development of software for the Web;
b) On the other hand, a certain intuition that this would be the best choice to guarantee a better performance. It was necessary to demonstrate this last aspect.

The fact that the tool has not been used in real situations, with many Authors and Readers accessing simultaneously to the information repositories, took us to carry out the following test

a) A Microsoft Access database with a single table and 10 records was created.
b) We created an equivalent XML structure, with the same information.
c) Two similar ASPs have been written to execute 2000 times one same set of operations and to measure and present the execution time. One of the ASPs interacted with the database while the other carried out the same operations on the XML structure. The operations consisted of selecting a record of the database or a XML tree node, to simulate the execution of some processing on the record or the tree node and, finally, to update the record or the node in the respective structures of data.

The results were conclusive. When the ASP that manipulated the database was invoked by the user, the time necessary to receive the result was about 16 seconds while in the other case the time the user had to wait until receiving this information was about 2 seconds!

One of the main reasons for this big difference of time is the operation of the update of database records and the XML tree nodes. In the case of the ASP that manipulates the database, it is evident that the operations of the record selection and update involves the transference of information from the disc to the central memory and from central memory to the disc. In the other case, that update is made in the central memory. We must recall that all XML tree is loaded there!

Thus, in the case of the manipulation of database, we have an access to the server disc for opening the database, 2000 accesses for records selection, 2000 accesses for records update and a final access to close the database. We had a total of 4002 accesses. In XML version, we only have 2 accesses. One for loading the tree to the central memory and another one, at the end, to store the tree with the information on the disc.

There is, however, another question to be answered. Attending the mechanism of XML document manipulation, in central memory, how will behave the system if we have 20 Subject matters of study with about 20 Readers for each Subject matter, generating thousands of information records? At that time, several XML documents that support the functioning of the platform, will occupy a space in the central memory that will be prohibitive. The following phase of the project that originated the development of the FleXml will consist on making available the platform to a large number of Authors.

3.6   Conceptual Structure

The structure of a Subject matter of study is basically a tree that has its root in the identification of the Subject matter and ramifies in Themes and Cases and these, in Mini-cases. The Mini-cases, in turn, are associated to the Themes whose occurrence is explained through Thematic Commentaries. The diagram of figure 2 constitutes a representation of this structure, based on the Cognitive Flexibility Theory principles.
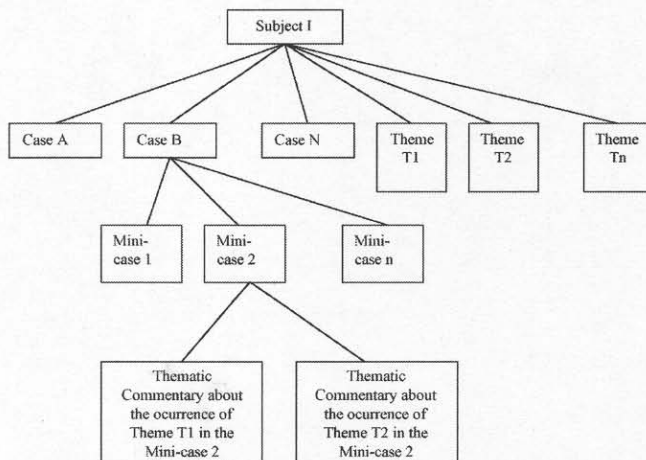

Fig. 2. *Tree structure corresponding to a Subject matter of study*

The platform deals with the existence of three types of entities or profiles of user: the administrator of the system, the Authors and the Readers. In this document we will use indistinctly the terms Author, teacher or instructor to assign the responsible entity for making available the content, and Reader or student to assign the user that will explore the Subject matter of study, constructing his/her knowledge by exploring the documents and negotiating his/her knowledge with his/her colleagues and the teacher through the "chat" and the "forum". These two functionalities of synchronous and asynchronous communication also integrate this platform and constitute the basis to develop a collaborative learning.

3.7 Users-Platform Interaction

The Authors and Readers interaction with the platform is represented in Figure 3. This figure depicts the main documents and manipulated records, and the type of operations done by readers and authors in their interactions with the system.
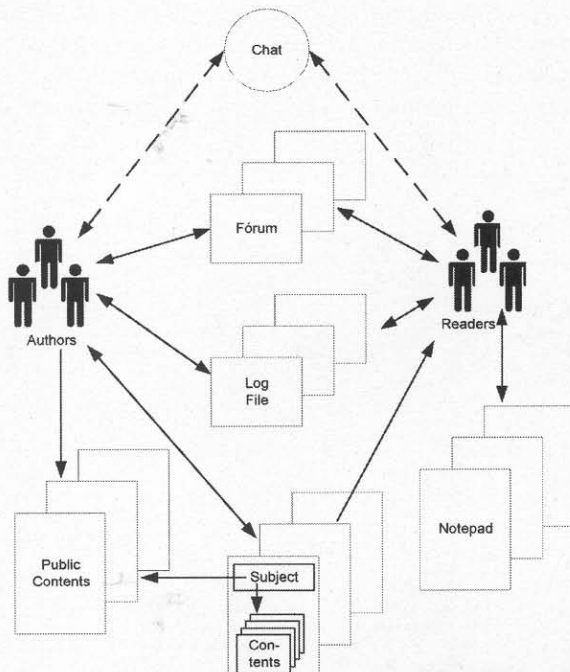
Fig. 3. *Authors and Readers interaction in the FleXml Web platform*

These operations are basically of three types: storage and consultation of information, and communication between the users through the subsystems "discussion forum" and "chat".

The Author or the Authors of the Subject matter may choose to put contents in private or public areas; they trace the system usage done by each Reader, and stimulate the discussion in the forum. There, they should present complex questions that motivate the Readers to review the relevant Mini cases (through the search engine if they want). Readers are invited to think about the complex questions (presented in the forum) and to restructure the knowledge to solve the presented situation.

Readers have access to cases (mini-cases and thematic commentaries, and complementary information if available) and themes of the Subject matter of study. Moreover, they may have access to a Notepad which can be organized according to their interests of study and learning style. They can verify what they had already covered of the Subject matter of study, consulting the automatic register of system usage (Log File). One expects that the Readers collaborate in a proposal of solution for the questions posted in the Forum by the Author. Through the "chat" they can discuss ideas with their colleagues and, perhaps, with their teacher.

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