AN INTERFACE ENVIRONMENT FOR LEARNING OBJECT SEARCH AND PRE-VISUALISATION

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Abstract: Learning Objects – LOs – were devised in order to cut down on production costs and time, as well as to facilitate the distribution and reuse of didactic contents by means of a series of functions, such as reutilization, traceability, interoperability, durability and easy editing. Our main objective in the present paper is to propose an interface environment for LO search and pre-visualization. The distinctive feature of such environment is both the easy access to all search refinement functions available, thus allowing users to fulfil their search objectives without requiring much cognitive effort, and the well-structured LO pre-visualization. We started the project by defining a set of criteria to assess LO research and solutions, and one of such works was used as our starting point for the interface environment. Our theoretical foundation relies on HCI (Human-Computer Interaction), and the major outcome of the present project is a nonfunctional prototype (in storyboard) of the interface environment proposed, which in turn solves the majority of the problems we came across when revising the pertinent literature.

1 INTRODUCTION

The concept of LO (Learning Object) was devised in order to grant digital didactic units the following properties: reutilization, traceability, interoperability, durability and easy editing.

Our main objective in the present paper is to propose an interface environment for LO search and visualisation whose main purpose is (i) to allow users to take advantage of the entire search refinement potential available with the minimum cognitive effort, and (ii) to provide strong support in object pre-visualisation.

The scope of the present work does not comprehend an operational prototype, the definition of working directives or the necessary architecture of the search engine of the search interface environment proposed. Traceability is reached through two basic factors, i.e. a comprehensive metadata standard and a search tool equally comprehensive.

Great effort has been put into defining a metadata index pattern. Nevertheless, studies on LO visualisation and localisation simply complement studies on metadata indexing, or rely on empirical research.

2 METHODOLOGY

The first methodological step we took consisted of a revision of the relevant HCI (Human-Computer Interaction) literature, as well as literature concerning the production of digital didactic content, ontologies and teaching processes.

Once the literature had been revised, we carried out an in-depth analysis of works both on LO searching and pre-visualisation and on other interface solutions that might contribute to the development of the environment we propose. We used works concerning search tools in various multimedia collections, search interfaces by direct manipulation, by result filtering, among others.

Based upon this analysis we devised a set of assessment criteria as the first step towards the solution of the problem proposed. Each of the

solutions we studied was confronted with this set of criteria so as to determine which one would be the most appropriate and effective to work as the foundation for our solution.

Once all solutions had been analysed – taken in association with the literature and in the light of current HCI premises – we came up with a new solution for LO search and pre-visualisation.

Finally, we also devised Corel Draw® 12 and Adobe Photoshop® CS static images simulating different uses of the environment (storyboards) in order to complement the description of the solution proposed.

3 CONTEXT

Digital contents are one of the outcomes of technological evolution, particularly of the Internet. At first there were Content Management Systems (CMSs), and then as Instructional Design evolved and as the concept of learning object was introduced, the very first systems oriented towards the development and management of digital didactic objects came out, as well as other systems oriented towards learning management.

The main purpose of LOs is to contribute to didactic content access and sharing. LO conceptualisation has caused heated debate in the scientific community, and it has many different definitions.

(WILEY), with his pragmatic approach, defines LOs in a pragmatic way as "any digital resource that may be reused in order to support learning".

An LO repository (LOR) is a collection of learning objects (or of metadata describing leaning objects) managed through a technology which in turn allows users to request, find, post and submit these objects to the network (JONES). Normally one LOR is part of a Learning Content Management System (LCMS).

One LCMS is a system that supports generating, assembling, storing and posting tailor-made didactic contents. Its main purpose is to cut down on development time through its special tools, and to make LO reuse easier. An LCMS allows students to get the required content only, in a tailor-made way and in the appropriate amount and time.

ALOCoM (Verbert et al 2004), i.e. Abstract Learning Object Content Model, is an ontology that defines LO through its components. The ontology sorts out such components in three categories, as follows: Content Fragments (CF), Content Objects (CO) and Learning Object (LO). CFs are basic

elements, such as videos, sounds, texts, among others, which in turn cannot be subdivided. COs are the combination of two or more CFs, also including a navigation path. It is the navigation elements that are responsible for structuring CFs in COs. Unlike CFs, COs may contain other COs in their structure and thus may be of abstract constitution. Finally, LOs add a didactic purpose to one or more COs. Figure 1 portrays the ALOCoM model.
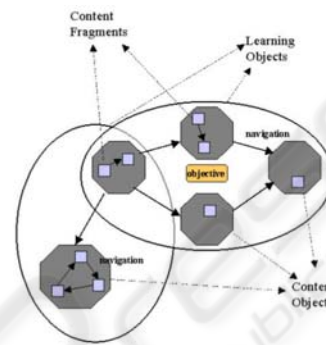

Figure 1: ALOCoM (Verbert et al 2004).

4 RELATED WORKS

So far, there have not been many efforts towards the improvement of the quality of LO search and pre-visualisation interfaces, which leads to rather complex LOR and LCMS search interfaces. The works presented in the following paragraphs have contributed greatly to this debate, helping us to come up with the solution presented here.

In this article (Klerkx et al 2004), they defend the use of Information Visualisation techniques, which basically refer to computer-supported visual representations of abstract data that cut down on users' cognitive efforts (CARD et al 1999), aiming at turning LO search into a more flexible, interactive process.

The following article (Klerkx et al 2005) complements the studies carried out in (Klerkx et al 2004) and brings forth a rather flexible environment for interface development using Information Visualisation techniques, particularly tree diagram representation. Through this environment the authors elaborated study cases with Ariadne LOR, as well as with the EdMedia LOR (see Figure 2), aiming at making LO search and localisation in base repositories easier.

Figure 2: Prototype interface (Klerkx et al 2005).

The following article (Klerkx et al 2006) complements the abovementioned studies. The authors present an interactive application for the visualisation of large repositories with small LO components (COs and CFs), which in turn were obtained by means of the disaggregation of full didactic contents. The study case they present refers to the ALOCoM repository, taking this very same ontology as its basis.

The main objective of the (Najjar 2005) research was to improve the usability of the Ariadne LOR search tool. Its authors came to the following conclusions: a) Simple and efficient search functions are essential for improving users' motivation and trust; b) Information organisation and structure must be oriented towards users' needs; c) Terminology must be accessible for users; d) Help tools must be improved so as to increase users' participation; e) The more refined search tools are, the better their performance.

In (Yee et al 2003), the authors bring forth a complete and creative solution for searching within an image collection. Their approach allows users to navigate through the conceptual dimensions that describe an image making use of hierarchic metadata and generating search samples dynamically. This way, not only does the interface provide successive search through clicks, avoiding thus complex syntax search, but it also allows users to get to know the structure of the image repository.

The (Wiza et al 2004) article presents a system for 3D-visualisation of Internet search results entitled Periscope. Three different interface visualisation levels are possible, as follows: **synthetic** interface, for displaying aggregate data; **analytic** interface, for displaying details of documents found; and **hybrid** interface, for displaying both aggregate data and details of documents.

5 OUR SOLUTION

After thoroughly analysing both the abovementioned related works and the existing tools, we chose the (Klerkx et al 2004) "tree diagram" as our starting point for devising an integrated solution for the problem of LO search and pre-visualisation.

Therefore, our solution follows the tree diagram principle; nevertheless, its main distinctive feature is the possibility of LO disaggregation into COs and CFs based upon the ALOCoM ontology (Verbert et al 2004). Other differences inherent to our solution shall be presented below.

5.1 Interface Environment: Visual Resources

Before describing the actual interface environment, we would like to present some visual resources of which we make use.

Colours: Colours play an essential role for our solution's communication coherence.

The colours ■ and ■ are used in LO search or classification. When the two blue symbols might merge, the two shades of blue are juxtaposed. The colours ■, ■ and ■ stand for the LO rights. ■ refers to LOs whose use and visualisation are unlimited; ■ stands for those whose use and visualisation are limited (such as paid LOs); and ■ refers to those whose visualisation is unlimited, but whose use is limited – such those under copyleft (GNU) or creative commons (CC). The choice of the colours ■ and ■, ■ and ■ follows (Klerkx et al 2004). The colour ■ refers to LO listing, and since its message is rather close to that of the colours ■ and ■, we opted for ■ because it is the colour right next to blue in the light spectrum. The colour ■ stands for LO disaggregation, and we chose it because it is a warm colour that contrasts with the other colours. The colours ■, ■ and ■ stand for LOs, COs and CFs, respectively. We opted for these colours because their message is close to the one of the colour ■; indeed, they are variants of ■ for their superior and inferior luminosity, representing thus different completeness levels. Finally, the colour ■ stands for unavailable symbols.

Icons: As we show in Figure 3, the interface icons may be classified as action (ação) and identification (identificação) icons.

Figure 3: Interface icons.

The action icons are colourful, and their colours refer to the action they perform. Since ▨ stands for disaggregation and ▨ stands for listing, the icons conform to the same pattern. The action icon "Close/Remove" (✕) conforms to the operational system of the interface users.

The identification icons are not colourful and are used in the disaggregation interface for making CF identification easier. Each CF type has a different iconic representation. Such icons may be displayed alone or together with another icon that represents a CF pre-visualisation in a smaller scale, in the case of images, or a frame, in the case of videos. The division between discrete and continuous CFs respects the classification presented by (Verbert et al 2004). The icons for discrete CFs stand for static objects, such as a text or a graph, among others. The continuous ones stand for moving objects.

5.2 User Help

The main purpose of user help is to provide strategic information so that the entire potential of the environment can be explored. This sort of help is particularly relevant for intellectual tools such as this one. Such help consists of two complementary parts, which provide insights on the application from two different points of view.

Structural help, "What's the potential of the environment?", describes the use of the application from the point of view of the benefits it brings to the actual activity of didactic content elaboration and manipulation. **Procedural help**, "How...?", describes the procedure for achieving the objectives of real life activity through the functionality provided by the application.

5.3 Initial Search Interface

The initial interface display is a preview of the full repository and follows the work of (Klerkx et al

2004), as shown in Figure 4. The blue portions stand for LO areas and subareas of knowledge, whereas the green, red and yellow portions stand for the respective LO right limitation level. The numbers at the top of the screen are the actual number of LOs included in each one of them. The area taken up by these portions is actually proportional to the number of objects it comprises. By "clicking" one of the blue, green, yellow or red portions, users are taken to one level "above" or "below" the current level. The initial display also includes a window for information filter selection, as well as one for the selection of the field which will be used as basis for interface result mapping/display.
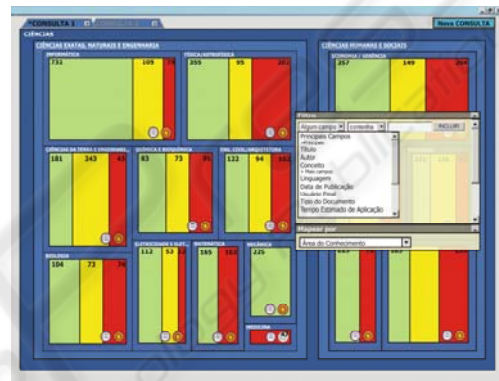
Figure 4: Initial interface display.

5.4 Viewing LOs in List

Listing was always an available option in (Klerkx et al 2004). According to both (Klerkx et al 2004) and (Yee et al 2003), list search is far more time consuming than visual search. This is why in our solution we include listing as an optional feature which should be the last search option users resort to (Yee et al 2003), and the lists should always have a minimal number of options (Klerkx et al 2004).

Figure 5: LO listing within searched elements.

If there are no other classifications, or if users click ⊜ (see Figure 4), a list within the quadrangular area is displayed (see Figure 5). In (Klerkx et al 2004), the rectangular areas containing a large number of LOs can get illegible. Therefore, we opted for including the scrolling function in our solution so as to avoid this problem. When displaying LO listings, the frame of the rectangular area is coloured ■ to represent the list.

5.5 Filter

When a form comprises many filtering fields it may become voluminous and take up unnecessary interface space. One solution for this problem is a filter with a few entry possibilities, making it possible to narrow or broaden the search. The filter tool consists of three or four fields to be filled out, as follows: search field, operation field, value field and the Boolean operators AND and OR. By using the filter one can establish conditions that, when applied to the search, lead to immediate results.

Figure 6: Filter tool.

As shown in Figure 6-1, the first selection box is responsible for indicating the field in which the filtering shall take place. We have derived the first few options from (Najjar 2005), and they correspond to the most frequently used metadata (title – "titulo" –, author – "autor" – and concept – "conceito"). These options are entitled "Main" ("Principais"), whereas the advanced search fields (language – "linguagem" –, publication date – "data de publicação" –, among others) are entitled "More fields" ("Mais campos").

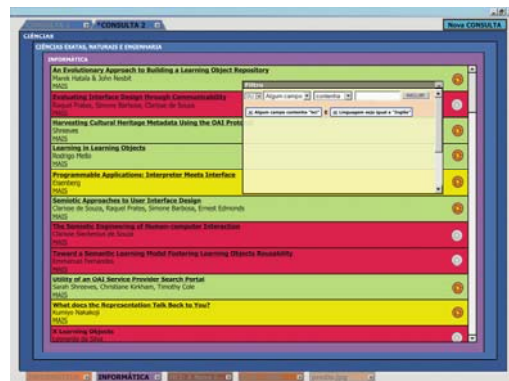The next step is then to select the operation ("operação") ("containing" – "contenha" –, or ending in – "termine com" –, "the same as" – "seja igual a") that shall be applied to the search (as shown in Figure 6-2). We derived these operations

from the "PHP My Admin®" system (PHPMYADMIN).

Once these two first options have been selected, users must then fill out the third field, i.e. the information they wish to be filtered. The value of this entry is contextualised within the field of the metadata to be filtered and can be of limited entry or textual. Figure 6-3 brings an example where the entry is textual (field filled out with the "HCI" value – "IHC" –, field "Title" – "Título"), while Figures 6-4 and 6-5 bring examples where the entry is limited through selection boxes (the fields "Language" - "Linguagem" – and "Publication Date" - "Data de Publicação" -, filled out with "Portuguese" – "Português" – and "15/08/2007", respectively).

Once these three first fields have been filled out and users have clicked the INCLUDE ("Incluir") button, the first clause is then inserted in the filter, and the search interface displays a new field, i.e. AND/OR ("E/OU"), as shown in Figure 6-3.

Finally, this AND/OR field must be filled out. By choosing the option "OR", a new line with the chosen clause is added to the filter preceded by a line containing the word "OR" – "OU" – (see Figure 6-6). If the chosen option is "AND" – "E" –, this clause is added right next to the last clause of the filter, preceded by the word "AND" – "E" – (see Figure 6-4).

This structure here described reproduces the sentence building process of a natural language (Portuguese), from right to left, originating alternatives in columns. One such model allows for clauses to be removed from the search filter. In order to do so, users must "click" ☒ right before the clause in question. Once a clause is removed, it is taken away from the filter interface and the search interface is then affected by the remaining filter. We derived these options of clause addition and removal from (Yee et al 2003).

5.6 LO, CO and CF Search

We derived the idea of visualising disaggregated LOs from (Klerkx et al 2006), whereas the concepts concerning disaggregated LOs used in the present solution come from the ALOCoM ontology (Verbert et al 2004).

The icon ✹ (present in Figures 4 and 5) stands for the disaggregation of LOs. We have chosen the explosion icon to represent this exploded view, a metaphor we propose for the disaggregation. During disaggregation, a new secondary tab coloured orange is displayed and labelled either with the name of the level or with the name of the LO in question.

When visualising disaggregated LOs there is a filtering tool analogous to the one presented for LO search – only now with metadata information on COs and CFs.

Results may be grouped by LO, CO or CF. Each result grouping has its own specific display, as we shall describe in the following sections.

5.6.1 Disaggregated LOs grouped by LO

Figure 7: Disaggregated LO grouped by LO.

In the interface where disaggregated LOs are grouped by LO are displayed the main metadata on the LOs and COs it comprises. COs are displayed as CF groupings ordered by inherent navigation and distributed through broken lines which in turn represent the boundaries of the CFs. CO ordering is also done by navigation in their respective LOs. One example of this is shown in Figure 7.

5.6.2 Disaggregated LOs grouped by CO
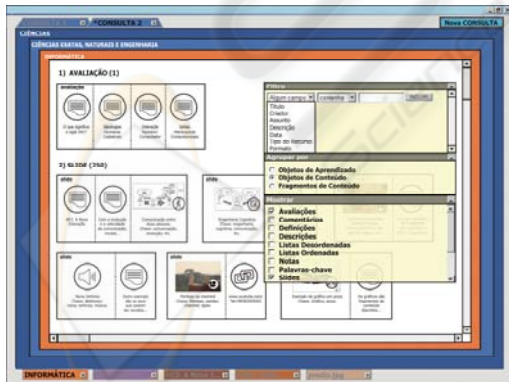
Figure 8: CO list grouped by type.

In CO grouping, on the other hand, there are only COs and lists of CO types (see figure 8). Results are grouped according to these types (Verbert et al 2004), which display, additionally, the number of

results in each of the groupings. CO display follows the pattern shown in Figure 7, but it also has the additional assistance of the filter component "Show" ("Mostrar"), through which one can select only two CO types so as to make CO localisation easier within the repository.

5.6.3 Disaggregated LOs grouped by CF

Finally, in CF grouping (see Figure 9), besides the listing of CF types and the number of elements comprised by each of these sets, the pre-visualisation of these fragments – together with their titles and key words – is displayed as well.

Figure 9: Disaggregated LO grouped by CF.

The interface takes advantage of the communicative potential of such fragments so as to make the search process easier on users. For instance, a picture is displayed by means of a smaller-scale version of the original including an informative icon explaining that that image is actually a picture (rather than a video, for example). At this point, neither the metadata nor the structure of both LOs and COs are displayed. Similarly to CO grouping, only the CF types chosen by users are displayed.

5.7 LO, CO e CF Pre-visualisation

In the solution we propose, one can visualise both LOs or COs and CFs the moment one interacts with the icons and links displayed on the disaggregation screen or on the LO listing screen. The screens corresponding to LO, CO or CF pre-visualisation are divided into two frames. The one on the left-hand side comprises the metadata of the visualised element (LO, CO or CF). Together with the metadata is the information concerning element reuse, indicating how many times it has been used in the repository. By "clicking" this information, a list

of the LOs that use this element is displayed. In the right-hand frame is the pre-visualisation of the element selected.

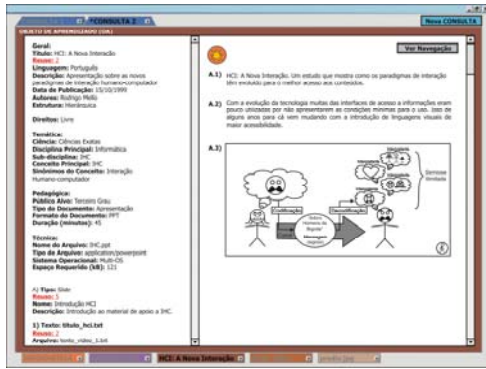### 5.7.1 LO Pre-visualisation

Figure 10: Overview of LO content and metadata.

The LO pre-visualisation screens (see Figure 10) become accessible when users "click" the title of an LO (Figure 7), for instance. To the left are the LO metadata and the number of times it has been used. To the right is the full LO, containing all its components (COs, CFs) ordered by the navigation defined for such elements. Users may also disaggregate this LO by clicking the ✷ icon, which will then lead them to a new tab.

5.7.2 CO Pre- visualisation
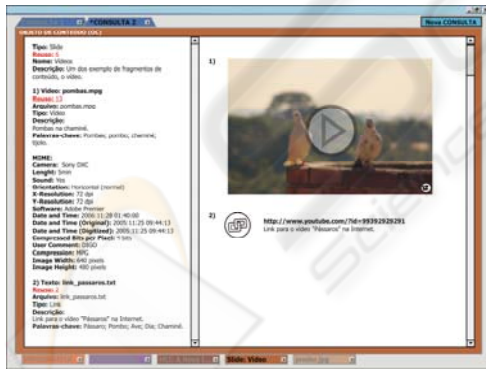
Figure 11: Overview of a CO and its metadata.

CO visualisation (see Figure 11) becomes available when users "click" the rectangular area that delimits the CO representation area (except for the area of the icons representing CFs) in the screens shown in Figures 7 and 9. In the left-hand area are the CO metadata and their reuse. In the right-hand area are the metadata on each of the CFs that make up the

CO. There is also where the pre-visualisation of the CFs that make up the CO takes place.
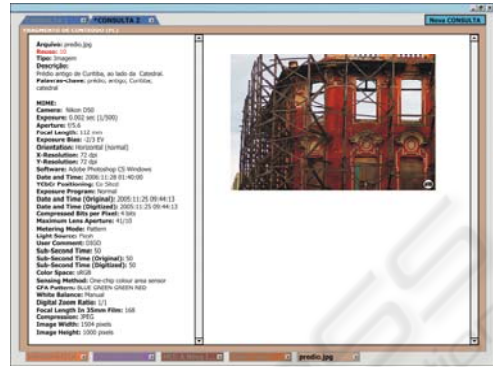
5.7.3 CF Pre- visualisation

Figure 12: Overview of a CF and its metadata.

Similarly to the other cases, on the left-hand side are the metadata indexing the fragment, whereas on the right-hand side is the pre-visualisation of the fragment. Users may access such CF pre-visualisation by "clicking" one of the icons that represent CFs (see Figures 7 and 9). If the fragment is an image, graph or photo, the fragment is displayed together with an icon representing the type of fragment in question. If it is a text or link, the very content of the text or link is displayed. If it is an animation, video, sound or song, the interface displays the necessary commands to reproduce or execute them.

5.8 Pre-assessment

Due to the non-operational nature of the tool we proposed, and aiming at testing this same tool by getting potential users to work with it, we elaborated an experiment based on the following basis.

As a first task, we will ask students to read the technical description of the environment proposed. After that, we will ask them to carry out two tasks by using the technical description they will have just read.

The first of such tasks involve the entire potentiality of the tool, but specified in such way as to have the students carry out the search steps in a different order from the one presented in the technical description of the application.

The second task required great skill and comprehensive knowledge of the main potentiality of the tool. We intend to ask students to searching for all materials available on a certain topic as if there were going to prepare a new course on that

topic. Nevertheless, we did not specify the necessary steps, making it a rather generic, free activity.

Both tasks involve hypothetical data, different from those used in the examples presented in the technical description of the application.

We will also ask the participants to take note of all and every difficulty they come across while carrying out the tasks, as well as of the sequence of operations performed and the expected solutions within the application.

When analysing the results, we will take into consideration whether both tasks have been successfully fulfilled or not. For the second, generic task, we will also take into consideration the use of the entire potentiality of the tool.

We will now apply this experiment to a sample of 7 Masters Students (potential users of this kind of application) as a test to be applied to a larger universe in a near future. Our hypothesis are that the tool is self-explanatory when it comes to the accomplishment of each individual task. However, its potentiality may be underexploited, because of the lack of strategic help, which in turn should describe - in a more precise way - the distinctive aspects of the environment when used in the real world, i.e. in the search for materials oriented towards the elaboration of didactic content.

6 CONCLUSIONS AND FUTURE WORKS

In the present work we listed and looked into a number of solutions available for building a proposal of an environment (on storyboard) based upon current HCI premises and concepts. The results we achieved solve most of the problems we came across whilst revising the literature on this sort of environment. The main advances and achievements of the environment we propose are the following: the pre-visualisation of the semantic structure of the content by taking advantage of the communicative potential of LO content and its components; the possibility of synthetic visualisation (at LO level) and analytical visualisation (at CO and CF levels) of search results; and the visualisation of results according to different attributes/mappings.

When giving continuity to the present work, we will applied an experiment to a sample of 7 Masters Students as a first test. Our hypothesis are that the tool is self-explanatory when it comes to the accomplishment of each individual task. However,

its potentiality may be underexploited, because of the lack of strategic help.

After the concept of the environment an the experiment, the next step is to apply the improvements needed to the conceptual environment and apply again the pre-assessment to a larger universe of potential users.

Other pertinent future works may approach the incorporation of new search capacities to the information filtering tool (Cardoso 2000); the improvement of result ordering, such as through the ranking of the results displayed (Ochoa et al 2006); the help during the process of cooperative search among repository users, including cooperative and dynamic indexing as well as the possibility of taking notes about the use of reused objects as inputs to the new decisions and their possible reutilisation; among others.

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