Cognitive accessibility to information on the Web: insights from a system for teaching and learning Architecture through the Net

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Abstract. The question of accessibility to the Web takes on a special meaning in educational settings where access to information requires cognitive elaboration of the page contents. It is, therefore, a matter of "cognitive access" to the Web. The main efforts of the designers of Web Based Instruction (WBI) environments to encourage cognitive access are usually aimed at the organisation and presentation of Web documents and at specific cues which can improve the user's interaction, orientation and navigation through the pages.

However, it is possible to improve this high-level access to the information by supporting study activities through specific "Working tools" which can be implemented in the Web environment.

In this paper we report on the design solutions we have adopted to provide cognitive access to a WBI environment for university students studying Architecture and Town Planning. In particular, we introduce "Working tools" that can be used to support flexible and effective study activities. The adopted design solutions provide different classes of users (not only students) with different access facilities.

Finally, it should be noted that the methodologies of the design of WBI systems should deal with this kind of high level access and support it through specific solutions at interface and implementation levels.

1. INTRODUCTION

The Web is fast emerging as one of the most popular technologies for education. In fact, by considering at the Web as a rich hypermedia information system integrated with powerful communication tools[1] in the same learning environment [Ibrahim 95], we can identify several reasons to explain the instructional effectiveness of teaching and learning through the Web.

However, accessing a rich information environment -even if it is integrated with effective communication tools- is not a sufficient condition for expanding knowledge and stimulating learning. In fact, from a pedagogic point of view, learning requires "a deep understanding of the subject content" [Alexander 95] through a cognitive re-elaboration of the information [Colbourn 95]. Therefore cognitive access is one of the key issues for learning and should be regarded as one of the most important learner needs a Web site for education should satisfy.

Some design strategies can promote cognitive access to Web-based information. Research in this direction covers many aspects: from the hypertext organisation of the information for individual learning paths [Alexander 95, Oliver 96] to the use of multiple media sources; from the publishing formats to the design of interfaces to reduce the cognitive overload; from the required interaction [Jonassen 94] to the possibility of planning collaborative activities [Alexander 95]; and so forth.

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[1] inherited from the Internet, such as email, chatting, discussion groups and so on.

A further level of cognitive access may be conceived beyond the level provided by the solutions described above[2].

In this paper we report on the design strategies and specific "Working tools" we have adopted to improve cognitive access to a WBI system and to activate on-line courses based on it. The "Working tools" allow learners to handle and re-elaborate the information published on the web pages. In particular, but not exclusively, we have focused on the learning needs of university students on the subjects of Architecture and Town Planning. Actually, the system has been designed in such a way as to provide different classes of users with different access facilities.

For this reason, according to the type of the user, the system will adapt itself and grant some privileges rather than others; these privileges are related to the possibility of interacting with the system and the information it contains through the "Working tools" that permit learners to mimic some traditional study activities: taking notes, marking parts of texts, adding post-its, and so forth[3].

We have distinguished 5 categories of users and foreseen different access privileges for each of them[4]:

- system designers and on-line course tutors: they have all the privileges;
- teachers: they can control the progress of on-line courses, cooperate closely with the tutors but are not allowed to modify the system without the tutors' and designers' approval;
- students: they have the same privileges as the teachers, but they can access some tools only with permission from the tutors (e.g. the possibility of creating new information pages*);
- expert guests: they can modify substantial parts of the system (only in relation to the contents and the way they are linked). Furthermore, they can extend the system through the construction of new pages.
- guests: they are users who wish to consult the system without being entered for the on-line courses; they have very limited privileges.

Therefore, for each user access to the "Working tools" is dependent on the class s/he belongs to. It should be noted that the activities provided by these tools are absolutely independent of the learning domain, and their use is not mandatory (students with different learning strategies can decide whether to use them or not, or simply use a sub-set of them); in addition, these tools can be used at different levels of study: consequently they can be easily adopted in the design of general WBI applications.

2.   A WBI SYSTEM FOR ARCHITECTURE AND TOWN PLANNING

The system we have designed is an on-line interactive multimedia environment, planned to help the teaching in the Italian Faculty of Architecture and Civil Engineering by means of the institution of on-line courses based on subjects related, in particular, to the disciplines that deal with design, history, heritage and town planning. The information in the system concerns the city of Palermo and the design activities focus, in particular, on the sea front, in view of its future redevelopment.

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[2] At some extent, this idea is present in [Oliver 96], who explicitly states that it is essential to consider and plan activities that engage higher-order thinking and critical reflection. However, the author does not describe specific tools to promote this level of cognitive access.

[3] The psycho-pedagogic relevance of these activities is well known; nevertheless, the technological implementation of the Web, based on the http protocol and on the html markup language, has made it difficult to implement these solutions. However, the recent technological progress, which provides for more client-based solutions, makes it possible to implement most of these tools.

[4] It is not within the scope of this paper to report on privileges concerning the management of the on-line courses based on the system.

In order to provide cognitive access to the system and provide different access facilities to different kinds of users we have adopted specific design strategies. In particular, the system is organised in two big "work areas" respectively named "Analysis" and "Design" areas. The first one is "public", as far as simple access to information is concerned; however, some facilities to operate on pages and modify their content are granted -automatically or with permission- only to some classes of users. In particular a "Licence bar" allows the user to add new information to the hypertext, to modify any part of it and, eventually, to modify its structure by adding links between information nodes. This licence bar may only be partially accessible depending on the type of user (e.g. it is not accessible for guest users).

The "Design area", instead, can be considered to be much more "operative" because it allows a "system known user" to access a particular series of communication tools (i.e. chat line, mail box, videoconferencing) by means of which the user can actively take part in the on-line courses organised on subjects of Architecture and Town planning, according to the disciplinary areas involved.

In this context these tools can be considered as real didactic tools, essential in teaching and learning in the Web environment, as well as the "Shared Blackboard" or the "Virtual Gallery" that we have designed to promote the teaching and learning of Architecture through the Net. In particular, using these two specific tools, students have the opportunity to publish their projects ("Virtual Gallery") and correct them through the "Shared Blackboard" in which teachers can graphically suggest corrections or design solutions.

From a methodological point of view the possibility of extending the information network in the "Analysis area" can improve learning through the construction of knowledge for the students and, at the same time, allow the teachers and expert guests to enrich the content of the system. The privileges accorded to different classes of users prevent guests from arbitrarily adding information to the system and so modifying it and its content. Moreover the implementation of the "Design area" that mimics a "virtual laboratory" appears to be extremely interesting because it allows students, enrolled for different on-line courses, to develop projects from the same multimedia resources available on the Web, using specific interactive and communication tools integrated in the same work environment. By allowing access to different levels of study through the described structure of the system, we guarantee the use of the published material for non didactic aims, as well.

To facilitate cognitive access to the information of the system for all kinds of users we have adopted another design strategy that consists in the use of an animation based on an ideogram that chronologically represents the growth of the city of Palermo and that automatically activates a series of dated and "clickable icons" (that are represented by historical plans showing the modifications of the urban structure). These icons are a real access key to the information included in the system. Finally, we have designed some specific tools to support access to the content of the system. These tools have been made available through a "Working tools bar", which is introduced in the following section.

3.   THE "WORKING TOOLS BAR" TO IMPROVE COGNITIVE ACCESS TO THE INFORMATION

The "Working Tools Bar" allows users to:
1. carry out operations on the information pages (tools: Copy, Paste, Marker, Zoom, Post-it, Page-mark, Note-book, Kit bag);
2. interact with other users of the system (Chat-line, Mail Box);
3. search for information through the system (Search);
4. visualise the route followed during the work session (Iter);

5. enter the "Design area" of the system.

By using each tool to activate the different operations, it is possible to maximise the learning process of the users and, in particular, to facilitate the recognition of the phases of knowledge acquisition ("Iter").

Therefore, we focus on the tools which best sustain the user's attention at high level and develop his/her critical sense and his/her abilities to search for, extract and synthesize information in such that s/he can choices from the informative content. Specifically, we refer to the tools that allow the users to mimic traditional activities, through a series of stationery items like "Marker", "Post-it" and "Page-mark". These tools, together with the "Note-book" and the "Kit bag", enable the user to handle and manipulate the information in the web pages.

During first reading, the user can "mark" each page of the system s/he considers relevant to his/her studies by using the "Page-mark" tool; the user can navigate back to the marked pages through the "Iter" tool to study these pages in more detail.

The "post-it" tool allows the user to pin notes, reference-marks and other information to the margin of a page. The post-its, which are for the private use of the user who created them, can be seen only in the page they belong to; in addition, they remain "attached" to the pages from one on-line work session to another[5]. The tool "Iter" highlights the presence of post-its on the pages.

The "Marker" tool allows images or parts of the text on the pages to be highlighted. The selected parts remain highlighted all the time the user navigates through the system: in this way the user can decide whether and when to transform these selected parts into real informative documents by putting them into the "Kit bag" (explained below).

When the user logs out from the system, the information on the highlighted parts will be automatically lost, if not transferred into the "Kit bag", since they are retained only during single on-line sessions.

One of the most effective tools to help the users navigate through the information is the "Iter" tool: it shows the list of pages visited by the user during the work session. Unlike the "history" tool available in commercial browsers, the "Iter" tool keeps track of the operation performed by the user on the pages through the three tools described above. In particular, next to the name of every page, there are symbols to indicate the operation carried out by the user, so s/he may locate the information he considered important and return there directly.

The "Note-book" tool works like a real note-book enabling the user to write down reflections, critical notes, and so on; for this reason it represents a collection of writing and drawing sheets. The user can access the Note-book even after the end of an on-line work session[6]. Furthermore, the "Note-book" gives the user a choice of which virtual sheets to use: in particular, it is possible to choose between opaque and transparent sheets. This feature exhibits a high

Page Name	PM	M	Pit
Palermo 1861	✓		
La Cala			
Castellammare	✓		
Palermo 1939			
Il Concorso del '39			✓
Porta Felice			
La "Strada Colonna"	✓	✓	
Il Borgo Santa Lucia			
Il Molo trapezioidale			
Il R. Arsenale Borbonico	✓		
Palermo 1884			
Il Piano Giarrusso			✓

The "Iter" window

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[5] they are implemented on the client side.
[6] it is implemented on the client side, similarly to the "Post-it" tool.

level of adaptability to the different needs of the users and specifically of students[7].

The "Kit bag" tool represents a kind of catalogue that the users carries with them during navigation through the system, and where they store pieces of information collected on this way around; furthermore, users carry the "Kit bag" with them in the "Design area". The information stored in the "Kit bag" can be consulted and studied in more detail off-line when the user is not connected to the net, thus reducing the connection time.

The links on the pages stored in the "Kit bag" can be "really active" or "virtually active", depending on the location of the link destinations. If the information indicated by a link is itself stored in the "Kit bag", then the link is immediately activable (really active); otherwise, when the user moves the cursor onto a link indicating information in the server, then the cursor modifies its state (by changing its shape), and a message advises the user that s/he needs to connect to the Net. In such a way, the user can decide him/herself whether to activate the connection or to give up, and whether s/he should be notified the next time s/he tries to follow a "virtually active" link.

It should be noted that the pieces of information in the "Kit bag" retain the reference to their original web page; therefore, it is possible for the user to go back to this page, and choose links to other parts of the system.

The user interaction with the "Kit bag" tool is extremely easy and rapid: once the tool has been selected, the user picks out the "objects" (parts of text, images, movies) to be directly stored in the "Kit bag". As far as the parts of text are concerned, it would be sufficient to drag the "Kit bag" cursor onto the section of text to be saved; however, if the user has previously marked parts of texts with the appropriate tool, these parts will be treated as single objects: by clicking on every part of them, they will be inserted in the "Kit bag". Finally, at the log out, the user will be allowed to automatically include all the marked objects in the system in the "Kit bag".

It should be noted that some of the described activities can already be performed by using features of the browsers and of the most popular operating systems. However, these solutions are unsatisfactory because the mechanisms are not integrated into a single environment, they are usually separated from the learning context (the informative content of the Web pages), and require a cognitive overload on the part of the learner.

4. CONCLUSIONS

The Web can open up interaction between students and knowledge. However, in order to exploit this opportunity, it is extremely important to consider design aspects that can help to create learning conditions and tools which support cognitive access to the information.

In this paper, we have illustrated the design strategies we have adopted to improve cognitive access to a WBI environment for university students on the subjects of Architecture and Town Planning. Specifically, we have reported on the "Working tools" included in the system.

The result of including these tools in a WBI environment is expected to be very high, since they add the benefits of effective study activities to the instructional effectiveness of the Web, thus providing very important cognitive access to the information. Actually, by planning study activities in the Web, we can improve accessibility to the Web in the educational field. Consequently, the methodologies to develop WBI environments should include facilities for cognitive access activities at design, interface and implementation levels.

Finally, it should be noted that the reported design strategies, and specifically the tools to handle and re-elaborate the information, provide different classes of users with different access

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[7] For example, the transparent type may be laid over photos or drawings on the different pages of the system, so that the user can trace some parts of them. This can be useful, for example, in producing working sketches to be used for the design activities.

facilities, thus making it easier "to read" the Web in all the contexts where cognitive access to the information is required.

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