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Improving World Wide Web educational uses promoting hypertext and standard general markup language content-based features

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Behind the characteristics that make use of the WWW easy and attractive lie the hypertext and standard markup languages (HTML–SGML), metalanguages for defining the syntax of markup languages. The fundamental principle that makes it possible to share information through the WWW with independence of environment, is based on the standard encoding of documents. Most current educational applications do not fully exploit the flexibility offered by what lies at the core of the WWW, the language HTML. A discussion of different taxonomies of educational uses of the WWW is followed by the presentation of an alternative taxonomy that aims to reflect the contribution of HTML. This is a double classification that distinguishes between the educational context, where the innovation brought by the WWW is mainly technological, and new contexts promoted by the WWW that could not exist without it. From this it is possible to envisage two lines of future work. First to analyse the educational possibilities offered by the current definition of HTML and to propose ways to use them in particular applications. Second, to provide the specifications and requirements to develop instructional tools to make use of the educational possibilities of the language. An example of the latter is provided by the developmental work being undertaken to provide language support as part of a Socrates–Lingua project. This has led to the conclusion that the present definition of HTML is insufficient for the organization of all the data required in educational applications. Instead an extended markup using SGML is recommended as the way forward for designers.

KEYWORDS: Distance learning; distance education; cognition; internet; language; pedagogy; research.

INTRODUCTION

The World Wide Web (WWW) is known as an Internet-based information system for access to hyperlinked multimedia documents. Initially, the WWW was designed as a researchers' tool for sharing information and producing documents in a collaborative/co-operative way over the world's largest computer network, the Internet (Berners-Lee, 1994). However, the WWW is now the fastest growing resource in the Internet. It is used by all kinds of users and for multiple purposes, e.g. academic, commercial and personal. Previously, other Internet resources, such as gopher or WAIS (which are mainly text-based applications), also allowed the user to share, access, and to search for information all over the Internet, but the use of these tools has been mainly restricted to universities and research centres, and today they have been completely overshadowed by the WWW.

The ease of use of the latest family of WWW browsers, e.g. NetScape or Internet Explorer, and the ability to integrate other previously existing resources seamlessly (such as ftp, gopher and E-mail) have contributed to make the WWW (and the Internet) extremely popular. A great deal of the WWW's attraction stems not only from its excellent userfriendly interface, but also because, from the user point of view, it offers some fascinating new features that have completely changed the scenario of Internet. First of all, WWW documents (WWW pages) can integrate information with links to any other (remote) document on the network. By selecting these links, you can easily access related pages, thus allowing the presentation of distributed information in a non-linear format. In the second place, this information can also include graphics, photographs, sound and even video clips with the text: the information is truly hypermedia! Also, the task of adding and maintaining our own WWW pages linked to related information produced by other people, or to general resources, i.e. catalogues and search engines, is relatively simple. Finally, WWW browsers are also including new communication facilities that simplify the on-line interaction between users.

With all these characteristics it is not difficult to understand why the WWW is growing exponentially and why it is used by all kinds of institutions and people in all types of activities: academic, commercial, entertainment, etc. All of them find advantages in the way the WWW can manipulate information, that is: simplicity of use, an attractive presentation, an easy way to *relate and disperse* information, low cost of creation and maintenance of the information nodes and, finally, facilities for interaction and communication. What may not be so evident to WWW users, is that most of the characteristics that make the WWW so flexible and attractive are possible because the WWW is based on a standard markup language, i.e. HTML. HTML was defined using a more complex standard, SGML, a metalanguage for defining the syntax of markup languages. That is, SGML is a standard set of rules for defining document types by their structures and for marking them up so machines can recognize and process documents by those structures (Colby and Jackson, 1996). The fundamental principle that makes it possible to share information with independence of the environment (software, hardware or communications protocols) is based on the use of a standard encoding of the documents. The structure, content and format of

a document are marked using a standard language, that later can be processed, interpreted and rendered by specific interpreters in all kinds of computer platforms. This encoding and later interpretation makes documents completely transportable and independent of any one environment. WWW browsers are environment specific interpreters of documents written using HTML. The most commonly used WWW browsers had been imposing a *de facto* operational semantics (rendering) of HTML, but now newer versions of HTML include formal support for style sheets, and the current HTML 3.2 includes the STYLE tag to ensure upward compatibility, so this tag can be used to provide 'in-line' style information. This evolution of HTML follows the line promoted by the standard document style semantics and specification language (DSSSL) used to specify the semantics (rendering) of SGML documents formally. Therefore our point is that it is the definition and interpretation, i.e. the syntax and semantics, of HTML that set the limits of what it is possible to do in the WWW, and SGML and DSSSL are the main tools we should use if we want to change those limits without losing WWW's flexibility.

From an educational point of view and due to the increase of information available (and the WWW is a main contributor to this explosion of information) new ideas are breaking through, and educators are reconsidering traditional approaches to education in the new light provided by the information technology. Now, we live in a world richer in information and richer in information processing tools, in which lifelong learning is becoming a necessity. Driven by this information explosion, our expectations about what a student should learn are changing. The view that education is a mastery of a body of knowledge is becoming outdated. Instead, we recognize that students need more than ever to have already acquired skills, such as rapid comprehensive reading, critical thinking or qualitative reasoning, along with other abilities, such as the ability to find the information needed and the ability to work well with others (Twigg, 1994).

At present, there are still some technical problems (e.g. the limited capacity of the communication link, slow modems access), but these problems are not our main concern because these technologies are improving all the time. Many educators (Jonassen, 1995; Trentin, 1996; Wulf, 1996; Ibrahim and Franklin, 1995) consider that the information technology, and specifically the WWW, have to play a central role in those educational changes, driving the information explosion and making possible the construction of new learning environments. The key to the successful use of the WWW as an educational environment is a deeper understanding and clarification of its possibilities and possible roles in education. There is no doubt the benefits the WWW can bring to education: co-operative–collaborative work and the remote and equalitarian access to information are often mentioned as benefits of networking and Internet (Collis, 1995), but to share information is not to educate and having access to information does not imply learning. The real problem is how to deal with cognitive and pedagogic issues in the WWW. In part because the WWW was not originally designed as an instrument to educate people, problems like disorientation, lack of planning or guidance, and information overload can affect seriously the usefulness of the WWW as an educational tool (Buenaga *et al.*, 1995; Nunes and Fowell, 1996).

We think that most educational applications are not exploiting fully the flexibility offered by what is the core of the WWW, its language the HTML. In most educational applications the stress is only made on the (remote) interrelation of the documents, and on the use of the visual appeal of multimedia information (Ted Nelson said satirically that the WWW is like Hypercard 10 years later and across machines all over the world). However, WWW pages are not plain, but structured documents that contain mark codes, that cannot only be used to drive formatting commands or to establish remote (or local) connections but also as marks useful to organize pedagogical strategies and to promote good cognitive skills. The markup (or encoding) can identify portions of a document in ways that each computer can 'interpret' independently of distance, hardware and software. This encoding can be a means of making explicit different analyses of the content of a text, and to consider it only as a way to allow the formatting of a document is an oversimplification. We must consider the markup languages as a tool to organize, from a pedagogical viewpoint, the content of a document making it suitable for presenting information in a way that it can help the process of learning.

In the rest of this paper we will first present and analyse proposed taxonomies on educational uses of the WWW and educational applications. Then we will discuss markup languages and investigate how it will be possible to use HTML or its proposed extensions as an educational tool. Finally, we will present some conclusions and future work.

DISCUSSION

Classifications of WWW educational uses

Entering the Internet, from a computer at home or at a workplace, users can access a vast amount of library catalogues, course materials, journal indexes, reference books, journal articles, books, art exhibits, employment notices, discussion groups, business data, etc. Clearly, the availability of all this information offers us new opportunities in teaching and learning. Consequently, there has been a growing interest in studying the educational uses of the WWW. Hence to explore the potential role of the Web in education better, we will start analysing some of the proposed taxonomies on these educational uses. More general discussions about the roles of telematics and new hypermedia technology in education can be found in Jonassen, 1995; Kearsley *et al.*, 1995; Davis, 1995; Laurillard, 1995; Nunes and Fowell, 1996; Kerka, 1996.

In the first place, it is necessary to notice that today there are too many specific applications and research projects using the WWW in educational settings to be possible to do a comprehensive study, but we think that most of them can be analysed and described using the categories presented in this section. For instance, we think this is true for the works presented in *Computers and Education*, and *Internet World* special issues about education and the Internet.

The taxonomy of WWW educational uses offered by Wulf (1996) could be represen-

tative of those classifications that take as a central feature the purpose of use, i.e. 'for what' are we using the WWW). In this way, Wulf identifies seven different uses of the Internet in education:

(1) Electronic mail: delivery of course materials, sending in assignments, getting/giving feedback and using it for an electronic discussion group course.
(2) Bulletin boards/newsgroups for discussion of special topics.
(3) Downloading of course material or tutorials.
(4) Interactive tutorials based on HTML.
(5) Real-time interactive conferencing using systems like Internet Relay Chat.
(6) 'Intranets' corporate WWW sites protected from outside access that distribute training for employees.
(7) Informatics: the use of on-line databases, library catalogues, gopher and WWW sites to acquire information and pursue research related to a topic.

Other classifications put the stress on the way educational applications take advantage of WWW main attributes like interconnectivity or its capacity to present and relate information. In this sense, Carvin (1997) identifies four different categories of educational applications:

(1) The WWW as tutor: i.e. HTML as a way to build and provide on-line tutorials, based on its capacity to present information clearly, attractively and practically.
(2) The WWW as publishing house, so teachers and students can create in-depth 'hyper-reports' with links leading to numerous subtopics and related network connections.
(3) The WWW as forum for discussion of ideas and virtual debate, for example using mailing lists (listserv).
(4) The WWW as navigator, or as a tool to search for information all over the Internet.

In contrast, other authors claim that the classification of educational use of computer networks has to be done by taking into account the degree of enhancement (added value) offered by this technology and not so much by its particular way of use. In this case, the main difference must be between contexts in which innovation brought to education by telematics is mainly a technological improvement, and new situations that could not take place without the network. Examples of the first case (of technological improvement) are the handling of intercommunications via electronic mail or the remote access and sharing of data and educational materials. An example of the second case (of new situations) is co-operative learning with on-line interaction in virtual classrooms. In this much more subtle way, Trentin (1996) identifies three types of different educational contexts:

(1) The enhanced communicational context: plain utilization of the network for communication. The enhancement is based not so much on specific approaches, but rather on using the network to provide a powerful tool for navigation through distributed information and for interpersonal communication.
(2) The enhanced distant educational environment: using computer networks in support of educational activities that can be conducted with or without the

network but which in this way are improved producing greater motivation and involvement.

(3) New learning environments: virtual learning centres or groups where learning activities are based on specific approaches, which are strictly dependent on the use of specific characteristics of the network and could not exist without it.

Approaches to an educational use of the WWW based on its language

An initial conclusion of our study is that most applications and research studies such as those previously mentioned take for granted that there will be a positive effect when using the WWW as an educational resource. However, the outcome of our own survey is that even if most of the projects dealing with the educational possibilities of the WWW come to mainly positive conclusions, these conclusions do not clearly state the unique characteristics that the WWW can bring to the educational activity. Moreover, in general the requirements of the new educational frameworks that the WWW could help to develop are not clearly established.

As we stated in the introduction, we consider that the key characteristic of the WWW is its markup language. It is HTML that makes it possible to convert a document into a hyperdocument that can contain appealing multimedia information, and can be accessed remotely by browsers. Therefore, we think that a taxonomy of WWW educational uses has to be done based on the contributions that HTML, or more generally any SGML defined language, could bring into education, together with improvements in communications technology. Thus we have tried to synthesize previous classifications into a comprehensive one. In the first place, we would also distinguish between the educational context where the innovation brought by the WWW is mainly technological and new contexts promoted by the WWW that could not exist without it (Ibrahim and Franklin, 1995).

(1) The WWW as a technological improvement enhancing human communication and human access/sharing of information.

- Enhancing human-to-human communication in a distance learning or educational context (e.g. E-mail and list-servers) such as, student–student, student–teacher and teacher–teacher.
- Enhancing human access to educational objects, e.g. downloading of courses and tutorials.
- Enhancing human access to informational objects in an educational context, e.g. databases, repositories.

(2) New situations based on specific characteristics of WWW's language that offer new kinds of learning situations to students.

- Interacting with WWW-based tutorials that could need/not need specialized viewers or browsers. A WWW-based tutorial that will not only use HTML tags for hypertext and hypermedia links, but will also use HTML tags to pedagogically structure documents.
- Interactive searching of information in the Internet. This means not only

can students and teachers use search engines, e.g. Infoseek or Lycos, but they can systematically make use of previous efforts of other users reflected in well organized personal or institutional pages.
- Personal or collaborative building of well structured WWW documents and/or WWW-based tutorials.
- Virtual classes in open and more authentic contexts that promote a meaningful learning (Jonassen, 1995). The WWW is not merely used as an information delivery medium, but rather as an organizer of thoughts and facilitator of knowledge construction.

This double classification tries to state the singular role of the markup language in the WWW. In the applications comprised in (1) the HTML language is used to integrate different operations in a simpler and friendly interface. These operations can be done using other Internet tools like ftp, E-mail, IRC or telnet, but the applications comprised in (2) are based on an educational use of the information handling capabilities offered by HTML. For example, in a WWW tutorial it is as simple to access a local/remote document as to organize the content of a document using logical tags.

Nevertheless, we think that today most educational applications do not take full advantage of the possibilities offered by HTML. The role of the WWW seems to be restricted to hypertextbook type applications where the predominant model continues to focus on the production of information resources and much less on the learning processes in which the student must be engaged. Possible reasons for the present situation are:

(1) Current HTML definition has been determined by taking into account mostly the needs of the net's publishing industry requirements, i.e. markup for tables, styles, forms, etc.
(2) There has not been a substantial development of tools, browsers and editors, specifically adapted to educational tasks.

Therefore, we can envision two main lines for future work and research in order to transform the WWW into a more powerful educational medium:

- First, to analyse the educational possibilities offered by the current definition of the HTML language and to propose ways to use them in particular applications. At the same time, it is necessary to identify the limits of the present standard as a base to suggest new SGML defined extensions to be included in future standards.
- Second, to provide the specifications and requirements to develop help and instructional tools that make use of the educational possibilities of the language. Here we identify two possibilities:

  (1) tools that help to create WWW pages specifically created with a pedagogical purpose, and
  (2) tools that process specific and/or generic WWW pages with educational purposes.

Finally, we have no doubts about the benefits and potential of the WWW in educational institutions, and specifically in those providing distance education. Perhaps

more than any other previous media, the WWW can help to overcome the barriers of time and space in teaching and learning (Kerka, 1996). But it is also necessary to notice that the educational value of the WWW is also limited. The WWW will not be the solution to every educational problem. Therefore, it would be positive to identify clearly the situations where the WWW could be used to solve specific educational difficulties.

The HTML language as a tool to organize and structure information with educational purposes

As previously stated, we think that most educational applications are not exploiting fully the possibilities offered by HTML. WWW pages are structured documents that contain mark codes, that cannot only be used to format documents for on-line presentation but also as a way to promote good cognitive skills in the learners.

The WWW is written largely in HTML, which is one application of the SGML. The explosive growth of the WWW applications demands richer and larger sets of markup features in HTML, and SGML is a proven tool with capacity to introduce new concepts in information handling and exchange of information at all levels of complexity (Sperberg-McQueen and Goldstein, 1994). Newer revisions of HTML will include greater numbers of SGML features. As the WWW continues to grow, SGML will likely become the standard for more markup languages on the Internet (Colby and Jackson, 1996).

Introduction to markup languages: HTML and SGML

SGML is a metalanguage that can be used for encoding the logical structure, the content and the presentation of any type of document. The goal of SGML is to standardize the definition of device-independent, system-independent methods of representing the structure and intent of a document, so the accessibility and reusability of information stored within documents can be maximized. Since 1987, SGML has been widely adopted by government, industry and academic groups worldwide.

SGML is not a set of standardized codes but a language that can be used to define precisely the elements to which a particular kind of document must conform. This definition starts with an SGML declaration that states mandatory and optional features used in the rest of the definition. This declaration is followed by the document type declaration (DTD), which is the formal collection of element, attribute and entity declarations that describe what markup to expect in these kinds of documents. Finally there is the document instance, that is the document itself with the actual markup. The real benefit of this flow is that a computer program, an SGML parser-translator, can process the declaration and learn its rules, then process the DTD and learn the rules of the markup, and then process the document and determine if the document meets the rules and take the prescribed actions. This way an SGML document can be processed by different programs and with different purposes;

each program can apply different processing instructions to those parts of the document instance that are considered relevant.

Some of the possibilities of SGML are already being used in projects like the Text Encoding Initiative (TEI) and the International Committee for Accessible Document Design (ICADD) (SGML Open, 1996; Ide and Véronis, 1996). ICADD leverages an SGML tagged document to produce multiple textbook versions from the same source document, giving print-disabled students access to the information (through Braille, large print, voice synthesis and electronic browsing). TEI is an international effort to standardize encoding of all kinds of text in any language (mainly literary and historical texts). TEI encoded documents give researchers and students an efficient way to utilize the information contained in these texts. As these and other new initiatives evolve, more information can be handled more efficiently giving educators and students a way to manage the voluminous quantities of available information.

The web language, HTML, is an SGML application and as such its syntax is defined by the combination of the SGML declaration and the document type definition or DTD. Actually, the current HTML definition in force, HTML 3.2, places further constraints, inexpressible in the DTD, on the permitted syntax. Although HTML is moving toward the larger feature set of SGML, consequently more SGML tools are starting to appear for the average users. For example, there is an SGML WWW browser that works alongside a standard browser, e.g. Netscape, (Colby and Jackson, 1996). When you encounter an SGML WWW page, the program activates and enables you to browse it as easily as an HTML page.

Therefore, HTML has the potential of being a really smart use of SGML, taking advantage of SGML's flexibility without giving up a common backbone structure that any browser can readily interpret (Severson, 1995). Moreover, it is precisely this combination of simplicity and extensibility that will capacitate the WWW to be viable for new educational applications.

An example: teaching text comprehension of a second language

Included in the SOCRATES–LINGUA European Union project, our group is working on the Galatea project with other European universities under the Stendhal-Grenoble III University leadership. This project is aimed at developing a set of multimedia tutorials for the written and oral comprehension of the Romance languages (Fig. 1). The pedagogical and cognitive strategies included in the set of multimedia tutorials being developed by our group are based on previous work on text comprehension done by members of the group (López, 1994; Fernández-Valmayor and Fernández, 1992) and also take into account the ideas of other authors (Schank and Abelson, 1977; Kintsch and Van Dijk, 1978; Adam, 1992; Grosz *et al.*, 1995).

We can take our work in this project as an example to describe the different roles that the WWW can play in an educational application. The pedagogic scenario used in the tutorials we are producing is based on the selection of approximately 20 different documents written in French and in a sequence of activities that students can do with these texts to improve their level of comprehension of the written text. The

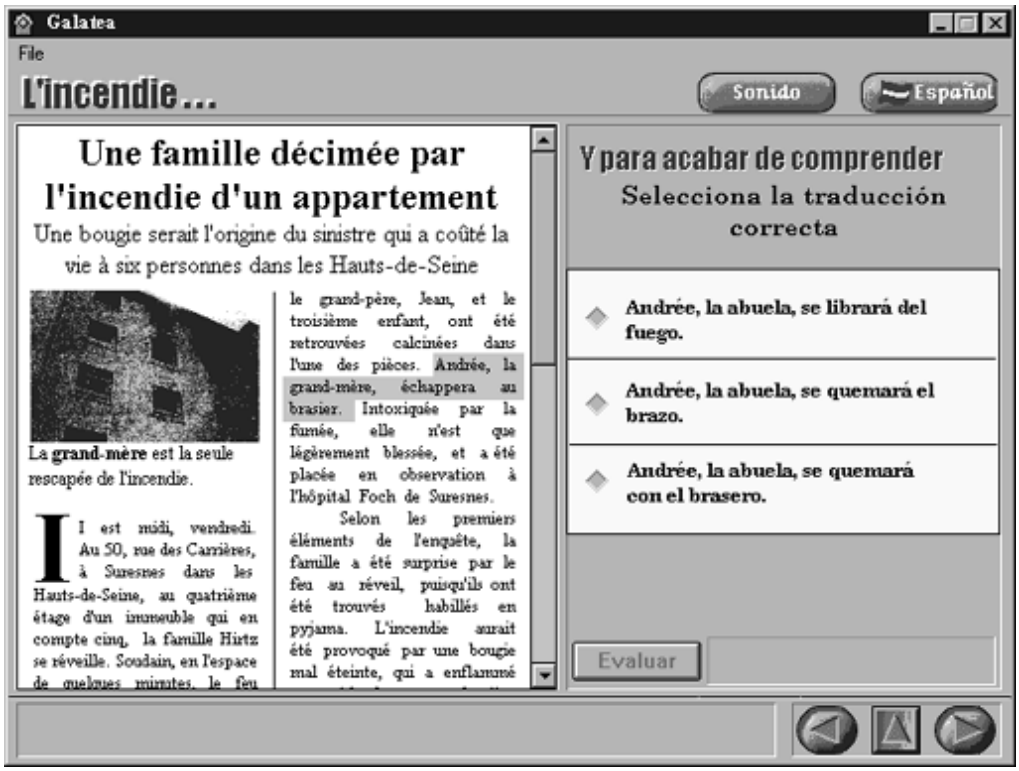

Figure 1. Screen of the current multimedia application for teaching French text comprehension

main goal is to promote the general understanding of the content of the document even if some words or paragraphs are initially incomprehensible. There is also a set of general purpose tools that students can freely use: a general dictionary, a contextual dictionary, a grammar and a sound tool to hear the texts. The general learning strategy is to relate the information contained in the document to information already known by the student (Ausubel, 1963). For instance, an exercise can ask the learner questions aimed at the correct classification of the text based on easily recognizable external characteristics, e.g. a journalistic text, an advertising text or a fiction text. Other exercises take into account the chronological script: the typical sequence of events implied by the subject matter of the document, e.g. the sequence of events in a fire, or sets of words belonging to the same semantic family, e.g. words related to a fire. The student not only has the assistance of general purpose tools, like a dictionary or a grammar, but also specific tools related to the specific examples appearing in the texts.

This kind of tutorial could be considered as a finished product that can be distributed over the network for remote execution, or for download and local execution. But now we are starting to take what we think is a more potentially interesting approach. An approach that tries to make full use of the capacities offered by the

WWW, as we have described in previous sections. In this approach we provide the documents with all the markup information necessary to implement an educational strategy similar to those used in our tutorial. The particular actions used to present the information will be the responsibility of the local browser who interprets those documents.

Now we are working on the creation of an educational DTD for the written and oral comprehension of languages. This content-oriented DTD will specify the elements needed to implement the pedagogic strategy used in our tutorial currently developed with a traditional multimedia product (i.e. Authorware). Most of the markup needed to define our pedagogical strategy is done through the SGML declaration ⟨! ELEMENT ⟩: used to define the tags to mark up the elements and subelements of our tutorial, and ⟨! ATTLIST ⟩: used to connect attributes to elements, define the possible attribute values and give them default values. In our tutorial we have a DTD with five basic elements that represent five different, but complementary, points of view about the comprehension of a text (Fig. 2). These basic elements can be considered in sequence or each one standalone. For example, one of these basic elements, called QDC, contains the subelements representing the text information about characters, place and time. The attribute connection to elements and subelements not

Figure 2. Application screen with different points of view about the comprehension of a text

only allow us to define the possible values for the identified items, but also includes complementary information about the relationships between them. A similar approach is described in (Karjalainen, 1997) where a DTD for distance education is proposed.

Defining the markup of documents also facilitates the creation of new educational applications because the presentation strategies of the information can be changed or adapted locally. In addition, this approach can also simplify the automatic creation of a comprehensive content summary of a WWW document based on its marked information. We also envision that this approach can simplify the sharing and reuse of documents and even the collaborative construction of repositories to be used in text comprehension.

CONCLUSIONS

There is no doubt that a powerful communication resource like Internet can provide new incentives and unprecedented opportunities for innovation in the field of education. The crux of the matter is to define innovative methods for designing, planning and conducting network actions in which innovation lies not just in the mere presence of a new technology but rather in revising certain teaching processes or in creating new ones based on the new technology (Trentin, 1996).

The WWW is accepted internationally because of its ease of use, capabilities for presentation/communication and cross-compatibility. Future changes in HTML standards will make it even more powerful. It would be desirable if the future HTML standard were more flexible (in the SGML way) and able to include new features that could be used in education beyond those that are interesting to publishers, e.g. better tables or layouts.

An initial conclusion of our work is that the present definition of HTML is insufficient to markup and organize all the data contained in the documents that are relevant to our application. Thus we are now working on an extended markup using SGML. But in many of the current WWW browsers, any markup not recognized as a supported HTML element is ignored. So these new extensions could only be interpreted with new browsers specifically designed for educational purposes or with new add-on programs (specialized parsers) for standard browsers (Sperberg-McQueen and Goldstein, 1994).

The next step of this research will be to produce WWW applications for text comprehension. At present, we are working on the final completion of the (local) multimedia educational modules for second language text comprehension (French). Currently in these modules we are using specific markup that we are translating to SGML format, and we want to produce an educational DTD for the written and oral comprehension of languages. In the future these tags will also be extended and used for a contextual dictionary. This dictionary will consider not only the definition of words and text segments, but also its features (morphologic, syntactic and semantic) and even its use in specific text examples.

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