TAXONOMY OF EDUCATIONAL WEBSITES - A TOOL FOR SUPPORTING RESEARCH, DEVELOPMENT AND IMPLEMENTATION OF WEB-BASED LEARNING

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RUNNING HEAD: TAXONOMY OF WEBSITES

Abstract

While many educators believe in the unprecedented opportunities offered by the Internet to enhance education, others are intimidated by its somewhat chaotic and unstructured nature. To enhance our understanding of Web-Based Learning (WBL) it is important to identify current educational uses of the Web, to survey the variety of technological and didactic means used for building educational Websites, and to detect how Websites as learning environments may differ from previous computer-based instruction tools. We present a classification scheme of educational Websites which comprises over 100 variables characterizing an educational Website according to four main dimensions: basic descriptive information (e.g., target population, site developers, language), pedagogical and educational considerations (e.g., instructional model, instructional means, cognitive demand), knowledge attributes (e.g., representational structure and means, navigation tools) and communication features (e.g., distant learning modes, synchronic/asynchronic activities, links configuration). This taxonomy of educational Websites may assist the developer in the implementation of the technology according to educational needs and constraints, will provide the practitioner with a tool for mindful selection and evaluation of instructional sites, and offer the researcher a conceptual framework for the formulation and study of relevant research questions.

Introduction

The World Wide Web (WWW) - a huge, interlinked and complex network of information is one of the defining components of our knowledge-based society. Its rapid evolvement is constantly and profoundly affecting the way people use information, communicate and learn. Web-Based Learning (WBL) - the usage of the Web as an arena for learning - has captured the imagination and interest of educators worldwide. A clear manifestation of this trend is the growing number of experimental projects focusing on the integration of WWW activities within teaching and learning processes (Berenfeld, 1996; Berge & Collins, 1998). The Internet can be said to have five major educational roles:

- Information provider: Information manipulation functions (e.g., generating, transmitting, storing, processing, retrieving of information) are at the heart of educational transactions. The access to on-line libraries, data-bases, journals, museums, and other public information repositories on the Internet, may therefor qualitatively affect education.
- Communication facilitator: Computer-Mediated Communication (CMC) constitutes a powerful interaction means (e.g., e-mail, group conferencing, IRCs) allowing students to communicate with peers, teachers, and experts and also conduct collaborative work (Berge, 1995; Harasim et al. 1995).
- Creation environment: A considerable number of user-friendly tools for the creation of Web-deliverable materials is currently available. These tools support students' creativity and initiative, allowing them to generate and publish their own Web units without mediators and with minimal technical assistance.
- Teacher Resource Center: A large number of educational resources is available on the Web, from plain raw materials which may serve as building blocks for lesson plans, to complete learning units and curricular solutions. Teachers face a broad scope of

options, from adopting and adapting existing materials to generating and contributing new Web-materials on their own.

- Instruction Delivery: Numerous Websites provide educational activities and courses for all grade levels in a large number of subjects (Hackbarth, 1997; Khan, 1997). The conception of the Web as learning environment is gaining more and more adherents, and is instantiated in varied forms, e.g., distance learning courses and even degrees, collaborative learning projects, virtual environments for complementary and informal education.

It seems clear that these functions of the Internet are going to affect education. There is a debate however, whether the technology will help solving the fundamental problems of education or create new ones, and whether it will improve the quality of learning (Owston, 1997). Skeptical voices have been heard recently, who suggest that the capabilities of the Web are simply extensions of existing software capabilities, and that the advantages of using the Web are merely a matter of efficiency and scope rather than unique affordances that could fundamentally alter relationships among learners, teachers and curriculum (Windschitl, 1998). While many educators believe in the unprecedented opportunities and potential offered by the Internet to enhance education, others are intimidated by its somewhat chaotic and unstructured nature. The unlimited freedom, the overwhelming amount of information and the possibility for anyone to take part in the creation of knowledge, become a barrier in fulfilling the perceived potential.

The educational community has experienced many ups and downs in its attempt to create coexistence and synergism with the evolving information technologies. This community has to take into account that the Internet, thirty years after it was created and four years into its massive commercialization, is still unstable and rapidly changing. Its major effect on the life of societies and individuals is yet ahead of us, and its influence on the educational system is yet to be explored (Dede, 1997).

It is therefore important to identify current trends and modalities in the educational use of the Web, to survey the variety of technological and didactic means used for building educational Websites, and detect the features by which Websites as learning environments distinguish themselves from previous computer-based instruction tools.

In this paper we report on such a research effort, aimed to develop a classification scheme or taxonomy of educational Websites. We believe that such a taxonomy can serve as valuable tool for supporting research, development, and implementation of Web-based learning.

Related work

Although a detailed survey of classification frameworks of technology-based instruction is beyond the scope of this paper, we will succinctly refer to the research that form the foundation of our proposed taxonomy.

Classification tools of technology-based learning environments were proposed and implemented from the early days of the "previous generation" (namely personal-computer-based) era of educational tools, for different purposes, e.g., development (Coburn et al., 1982; Venezky & Osin, 1991), evaluation (Blease, 1986; Shuell & Schueckler, 1989), or selection and implementation (Truet & Gillespie, 1984; Sloane et al., 1989).

With the emergence of new technologies and new kinds of learning environments, there was an expansion of existing classification schemes to express the way the new features could be translated in learning-relevant forms. For example, the rise of the hypertext/hypermedia/multimedia era led to the creation of categorizations, for research or development purposes, of key features such as knowledge representation structures or navigation tools (e.g., Churcher, 1989; Jacques et al., 1993).

Nowadays, attempts to classify Web-based learning are being made from varied perspectives. It is commonly accepted that many of the features of pre-Web computer-based

learning environments found their evolutionary path into the new technology (e.g., traditional tutoring modes, friendly interface features, hyperlinked information-bases). But another frequent claim is that particular efforts should be made to identify the added educational value of the new technology: whether such added value exists at all and how it is manifested in new didactic situations and solutions. In search for this added value recent research efforts focus on specific qualities of Web technology. Let us consider some examples.

One classification perspective emphasizes different models of instructional process implemented in Websites. Harasim et al. (1993), for example, describe seven instructional modalities which are either expert based (electure, ask-an-expert, mentorship, tutor-support) or student based (access to information, peer interaction, structured group activity). Both Berge (1995) and Collins (1995) suggest a set of fourteen instructional modes comprising the overall complex of computer mediated communication (CMC) technology. The proposed set includes modes such as mentoring, project-based instruction, lecturing, information retrieval, chat, peer reviewing and others together with Web-versions of traditional CAI modes (e.g., tutorials, simulations, drills).

Other researchers focus on the distant-action allowed by the Web. Berenfeld (1996) suggest five modes of “teleing” arranged according to their pedagogical sophistication and potential impact on student learning and school change. These modes are tele-access to information, virtual publishing, tele-presence, tele-mentoring and tele-sharing.

Another perspective emphasizes cultural and social aspects of Web-based educational interactions. Riel (1993) explores the role of the Web in achieving the goals of global education, namely "to promote multicultural sensitivity and understanding of interdependent systems that operate in today's world" (pp. 221). Riel proposes the engagement of the Web technology in the work of learning circles or electronic communities, for the accomplishment of varied types of interaction (at the local and international level) and project-based instructional tasks.

Yet another perspective, finally, stresses the relation between cognitive functioning and Web features. For example, Teles (1993) analyzes Web-based support of cognitive apprenticeship by features that embody a variety of methods (e.g., sequencing, scaffolding, exploration, reflection) in online-apprenticeship or teleapprenticeship activities.

These studies represent a very complex picture regarding the multiple dimensions of the Web as an educational resource. The variety of facets mentioned above, such as instructional modes, models of teleactivity, support for cognitive functions, or types of representational structures, is only a partial list of the components of the intricate fabric of the Web. All this suggests that any attempt to offer researchers and developers a comprehensive tool for understanding and/or building educational Websites, namely a classification scheme, would be a major challenge. Albeit the difficulties involved in its development, such a tool should satisfy at least three main demands:

Mapping power: The classification scheme should include and integrate a large variety of properties in the different dimensions (e.g., content, pedagogy, communications) of educational Websites. It should allow to capture the rich complexity, as well as the limitations and drawbacks, of these novel learning environments.

Generic nature: The tool should be comprehensive enough to cover many possible configurations of variables in different dimensions for the continuously growing population of educational Websites. But at the same time it should be flexible enough to undergo changes and additions, as new technological or pedagogical features and Website models appear.

Clear-cut definition: To reasonably support analytic and synthetic processes, and ensure portability of the data collected with or defined within the tool, it should offer a sound structure, precise terminology, and definite scaling and classing schemes.

Our proposal of a classification scheme

On the basis of previously published work, and with the above mentioned demands in mind, we would like to propose our model of a practical tool for describing the complexity of the educational kaleidoscope currently evolving in the Web. The tool is a classification scheme or taxonomy of educational Websites aimed to reflect developers' educational philosophies as well as their actual manifestations, namely, how different functionalities are configured, the knowledge is structured and represented, and communication features are implemented.

Our proposed taxonomy characterizes an educational Website according to four main dimensions: basic descriptive information (e.g., target population, site developers, language), pedagogical and educational considerations (e.g., instructional model, instructional means, cognitive demand), knowledge attributes (e.g., representational structure and means, navigation tools) and communication features (e.g., distant learning modes, synchronic/asynchronic activities, links configuration).

This taxonomy of educational Websites will assist the developer in implementing the technology according to educational needs and constraints; it will provide the practitioner with a tool for mindful selection and evaluation of instructional sites, and offer the researcher a conceptual framework for the formulation and study of relevant research questions. Above all, it will facilitate communication and create a common language among these professionals, contributing further support to their common aim of realizing the potential of the educational use of the Web.

Classification scheme for educational Websites

More and more educators, students, developers and researchers are becoming involved in the development of educational Websites. The focus, extension, quality and features of the resulting sites vary in correspondence with the interests, purposes (e.g., learning, instruction, knowledge dissemination, research), and technological and economical

capabilities of these different groups of users (December, 1998). As a result, the creation of a comprehensive classification framework becomes a complex and challenging task.

To reflect the complexity, as well as the unique characteristics of Web-based learning resources, we constructed a taxonomy or classification scheme which comprises over 100 variables organized in four dimensions: descriptive, pedagogical, knowledge and communication (Figure 1). Regarding an educational Website , we first look at basic identification or reference indexes (descriptive dimension). Second, we identify relevant learning aspects elicited by the implementation of the technology (pedagogical dimension). Then, we characterize the ways this technology affects the representational means and structure of the conveyed knowledge (knowledge dimension). Finally, we assess the added value of communication and networking for instructional and learning processes (communication dimension).

Insert Figure 1 about here

The dimensions of the taxonomy are presented in the following sections, and its complete version is included in Appendix A.

The Descriptive Dimension

This dimension includes basic information regarding the location, creators, target population and relevant technical data of a site. The information is organized in six categories:

Site identification. This category includes the site's name, URL, its authors and their affiliation (e.g., academic institution, public organization, government authority, private company, school, teacher, student).

Site evolution. The variables in this category refer to the site's creation date, last updating, and sections which are still under development.

Language or languages used in the site.

Target population of the site, according to the following scale: kindergarten, elementary school, upper elementary (7th -12th grades), college and university level, and adult education courses.

Site size, indicated by the number of html pages (using a scale ranging between a few pages and a couple of hundred pages).

Subject Matter. The variables in this category focus on the content area(s) included in the site, and the way they are presented (e.g., by discipline or in interdisciplinary manner).

The whole set of variables in the descriptive dimension offers a preliminary characterization of the site which may serve for reference purposes and/or satisfy basic classification or grouping needs, prior to in-depth analysis of pedagogical or content-related features.

The Pedagogical Dimension

The Web as a whole can be considered a huge repository of information organized in varying configurations and conveying content by different representational means. As such, it could be claimed that every single page on it has educational value, if a user decides to use it as learning resource. For the purposes of this taxonomy however, we will focus on pedagogical features of sites which were explicitly designed for education (Riel, 1993; Teles, 1993). The pedagogical dimension variables aim to unveil these features, allowing us to estimate the developers' stance regarding the nature of the instruction elicited by their site (e.g., target learning processes, instructional configuration and means, collaborative work, feedback, assessment). The variables in this dimension are organized in ten categories:

Instructional configuration. A set of variables aimed to identify the learning mode, or compound of modes, in the site (e.g., individualized, collaborative), and whether these are

confined to Web-only resources or they also link to additional external resources (e.g., local library, visits and tours).

Instructional model variables, aimed to detect the developers' conception of the learning process within the Website (e.g., directed and hierarchically organized, inquiry-oriented, open-ended).

Instructional means. The rapidly changing technology offers an impressive range of possibilities for the development of instructional resources. The variables in this category indicate the presence in the site of these resources, e.g., hypermedia data-bases, virtual 3D environments, or on-line student-modeling and adaptive mechanisms.

Interaction type. Since interactivity is one of the major attributes of educational digital materials, types of interaction and interactivity level are important characteristics of a site. In this category of the taxonomy we look for the presence of different modes of interaction, such as browsing, answering multiple-choice or open-ended questions, performing simple actions (e.g., pressing a button or activating a pre-defined script) or complex activities (e.g., controlling simultaneously several variables in a virtual environment), using on-line tools (e.g., a simple text or picture editor), interacting with a mediator, expert or peers.

Cognitive process elicited by the site's activities. Different activities may pose different cognitive demands, ranging from plain information retrieval, through complex processing of varied types of information (e.g., textual, visual, auditory, dynamic) or problem-solving and decision-making processes, to creative activity or invention.

Locus of control over the learning process, which can be guided mainly by the student's decisions or by the software's environment, or by mixed initiative of both partners.

Feedback. Contextualized response to the student's actions have become a common feature in computer-based learning tools. Many of the feedback mechanisms already implemented in pre-Web technology were adopted also by developers of Websites (e.g., automatic evaluation of the selected answer). Other features evolved from the very nature of

Web technology (e.g., human expert's response either synchronic or asynchronic). Variables in this category aim to identify main feedback features in educational Websites.

Help functions offered in the site, such as technical help in handling tools included in the site, contextualized help in the form of glossary or explanatory information, or didactic help in support of the learning process.

Learning resources. The variables in this category aim to unveil the scope and variety of resources embedded in the site's design. An additional goal is to identify if learning resources are constrained to the Website materials, or whether these are complemented with external physical resources (e.g., modeling kits for performing "real" tasks guided by "virtual" instruction) and human resources (e.g., peers, teachers).

Evaluation. The wide range of didactic configurations of Websites (e.g., from highly structured worksheets to broadly open-ended inquiry activities) poses a serious challenge to the design of evaluation resources. The variables in this category aim to elucidate whether evaluation means were included in a Website, and to identify the evaluation model behind these means (e.g., from standardized tests to alternative evaluation).

By means of the variables in the above mentioned categories, our aim is to constitute a reasonable representation of the pedagogical model guiding the development of the site, and the way different concrete components reflect and realize this model.

The Knowledge Dimension

Websites are first and foremost interactive storehouses for knowledge. While designing a Website, developers make decisions about key issues such as the overall organization and conceptual skeleton within which the knowledge is framed (structure), the means used to present it (media), or support offered for the efficient navigation of the knowledge space (navigation tools) (Churcher, 1989; Jacques et al., 1993). The consideration of this set of knowledge-related variables from the educational viewpoint, makes up the third section of the classification scheme. This section includes four categories.

Representational structure. This category aims to identify the organizational template underlying the knowledge stratum, (e.g., whether it reflects a linear, branching, or Web-like structure).

Representational-means. In this category variables refer to the media used for representing the knowledge (e.g., text, still image, dynamic image, interactive image, sound) and the frequencies of their respective uses in a site.

Type of knowledge. This category indicates the properties of the represented knowledge, e.g., whether it relates to facts or assertions (declarative), to processes or action-scripts (procedural), or dynamic/systemic models of phenomena or systems (qualitative models). Another relevant feature is the malleability of the knowledge-base, represented by a continuum running from pre-determined and fixed knowledge on one end, to knowledge that is dynamically and continuously updated (automatically or by users) on the other end.

Navigation tools. Even at the current preliminary stage of Web-using and Web-learning research, one of the most documented and reported problems relates to user's difficulties in navigating the knowledge-space. The developers' response was to devise supportive means, i.e. navigation tools, to help users in finding their ways while searching for knowledge. This feature seems to be particularly crucial when considering the educational value of learning-oriented sites. The variables in this category depict the set of navigation aids present in the Website, e.g., thematic indexes, image maps, time-lines, iconic directional-pointers, search facilities, or maps of the actual user's location.

The presentation and representation of knowledge by digital technology confer unique properties to the resultant representational unit, regarding its structure, conveying media, and user skills demanded. All these are highly relevant in educational transactions, and the classification variables in this section intend to help in their identification in Websites.

The Communication Dimension

Networking by definition implies communication. A Website is a communication creature. As such it is characterized by a wide set of properties related to people's interaction with knowledge and with other people - and this, obviously, also rises key educational issues (Berenfeld, 1996; Harasim, 1993; Collins, 1995). Thus, the fourth section of this taxonomy relates to communication features which are directly relevant to instruction and learning processes.

Types of telelearning. The first category focuses on the different shapes which distance learning via technology may take. These include learning situations such as distant access and manipulation of information (tele-information-handling); varied transaction modes with peers via e-mail, chat-rooms or discussion groups (tele-interaction); distant performance of actions or operation of physical systems (tele-manipulation); or participation in collaborative creative tasks (tele-creation).

Types of communication. The design of the learning in a Website may include synchronous as well as asynchronous activities. It is also relevant to identify the kind of information conveyed in synchronous mode (e.g., text, images, audio).

Links. The quintessential or constituent elements of the Web are the links. Links among units of information may fulfill different functions such as indicating free associations, structured categorization, logical chains, or causal relationships. The appropriate identification of these functions, as well as of the link addressee's qualities, seem to be important conditions for mindful travel in the Web's knowledge space. The variables in this category of the taxonomy support the characterization of a site's links structure by identifying features such as hypertext links within the site, links to other sites, to other-sites' databases, to non-Web tools and activities, to virtual reality environments or to humans (e.g., peers, teachers, experts).

Communication means. The last category in this dimension focuses on the technical means and formats by which communication is supported in a Website, (e.g., electronic mail,

discussion group with or without moderators, chat facilities, video conference capabilities, or moo/mud features).

This fourth dimension unveils both the unique and particular as well as the obvious and banal communication-related features of an educational site. On one hand, communication is what most characterizes the technology, and educational sites aim to realize this potential in rich and varied ways. On the other hand, site developers may miss this potential by adopting only the technique while replicating practices which were already successfully implemented in pre-Web technologies. In such a case, no educational added-value of communication features is obtained. Mapping the location of propossed Web-based activities between the banal and the unique, is at the core of the communication dimension of the taxonomy.

Concluding remarks

The discussion on emergent trends in Web-based learning should be considered against the background of the continuum starting from the very first CAI applications (Venezky & Osin, 1991), towards current and future networked synthetic environments for learning (Dede, 1997). One defining developmental path all along this continuum deals with the philosophies, objectives, means and modes which evolved as consequence of the implementation of interactive digital technology in education. The second developmental path deals with knowledge representation and manipulation, which has become increasingly significant since the emergence of advanced information storage and handling tools (e.g., hypertext, search engines, networked data-bases). The third path focuses on communication features, which due to recent technological developments have qualitatively affected the possibility for people to interact with peers, colleagues and experts.

The compound of these three key elements is what confers Web-based learning its educational potential. But the realization of this promising potential should not be taken for granted. A substantial research effort will be required to assess the qualities of existing

learning sites, to support the development of new sites, and to provide educators with evaluation and pedagogical decision-making information. The proposed taxonomy aims to contribute to this research effort by providing an organizing scheme and mapping tool of the defining features of educational Websites. Along these lines, the next step on our research agenda will be to conduct a systematic study on large samples of educational Websites in different subject areas, using the taxonomy as our main data collection tool. The first study, which we are currently conducting, focuses on learning sites for science and technology education.

The proposed taxonomy intends to create a common language among all participants in Web-based learning research, development and implementation. We see it as an evolving instrument rather than a fixed one. Therefore, we would welcome and appreciate any remark and suggestion which may contribute to its improvement; we should also be pleased to provide the research tool and related information to any colleague interested in its use and further improvement.

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Appendix A: Taxonomy Form

TAXONOMY OF EDUCATIONAL WEBSITES

I. The Descriptive Dimension

Site Identification	1.	URL	
	2.	Site Name.....	
	3.	Root site.....	
	4.	Origin	o org o k-12/edu o co/com o gov o ac other .....
	5.	Authors and their affiliation	o Academic institution, o public organization, o government authority, o private company o school o teacher o student o other
Site evolution	6. Date of creation		...../...../.....
	7. Last update		...../...../.....
	8. Completion		completed/not completed
Language(s)	9.	.....	
	10.	.....	
	11.	.....	
Target population	12.	target population	o kindergarten o elementary school o high school o college / university o further education
Site size	13.	No. of html pages	1----2----3----4----5 3---10---30---70---100+
Subject matter	14.	.....	
	15.	.....	
	16.	.....	
	17.	.....	

II. The pedagogical Dimension

Instructional configuration	1.	Individualized instruction	yes/no
	2.	Classroom collaborative learning	yes/no
	3.	Web collaborative learning	yes/no

Instructional model	4.	Directed	yes/no
	5.	Inquiry-based	yes/no
Instructional means	6.	Information-base	yes/no
	7.	Tools	yes/no
	8.	Structured activity	yes/no
	9.	Open-ended activity	yes/no
	10.	Virtual environment	yes/no
	11.	Student modeling/adaptive mechanism	yes/no
Interaction type	12.	Browsing	yes/no
	13.	Information gathering	yes/no
	14.	Simple activity	yes/no
	15.	Complex activity	yes/no
	16.	On-line tool	yes/no
	17.	Expert consultation	yes/no
Cognitive process	18.	Information retrieval	yes/no
	19.	Memorizing	yes/no
	20.	Data analysis and inference making	yes/no
	21.	Problem solving and decision making	yes/no
	22.	Creation and invention	yes/no
Locus of control	23.	Student controlled	yes/no
	24.	Software environment controlled	yes/no
	25.	Mixed initiative	yes/no
Feedback	26.	Automatic	yes/no
	27.	Human asynchronous	yes/no
	28.	Human synchronous	yes/no
Help functions	29.	Technical help	yes/no
	30.	Contextualized content-help	yes/no
	31.	Didactic help	yes/no
Learning resources	32.	Within Website resources	yes/no
	33.	Linked WWW resources	yes/no
	34.	Additional external resources	yes/no
	35.	External resources only	yes/no
	36.	Real time data collection	
	37.	Ask an expert	
	38.	Ask a peer	
Evaluation	39.	Standardized tests	yes/no
	40.	Alternative evaluation	yes/no

III. The Knowledge Dimension

Knowledge representational structure	1.	Structure	o one page only o linear structure o branching structure o hierarchical network o Web
Representational means	2.	Text	1----2----3----4----5
	3.	Image	1----2----3----4----5
	4.	Interactive image	1----2----3----4----5

	5.	Animation	1----2----3----4----5
	6.	Sound	1----2----3----4----5
	7.	Real-time updating	1----2----3----4----5
Navigation tools	8.	Index in home page	yes/no
	9.	Local-page indexing	yes/no
	10.	Content bar	yes/no
	11.	Tool bar	yes/no
	12.	Time-line	yes/no
	13.	Alphabetical bar	yes/no
	14.	Image map	yes/no
	15.	Permanent frame-index	yes/no
	16.	Internal search engine	yes/no
	17.	Knowledge map	yes/no
Type of knowledge	18.	Declarative	yes/no
	19.	Procedural	yes/no
	20.	Qualitative model	yes/no
	21.	Expanded by the users	yes/no

IV. The Communication Dimension

Types of telelearning	1.	Tele-informing	yes/no
	2.	Tele- conferencing	yes/no
	3.	Tele - manipulation	yes/no
	4.	Tele- creating	yes/no
Communication type	5.	Synchronic activities	yes/no
Type of synchronic	6.	Textual	yes/no
information	7.	Visual	yes/no
	8.	Sound	yes/no
	9.	Video	yes/no
Links	10.	Within the site	1----2----3----4----5
	11.	Links to external sites	1----2----3----4----5
	12.	Links to external databases	yes/no
	13.	Links to external tools	yes/no
	14.	Links to external activities	yes/no
	15.	Links to virtual reality devices	yes/no
	16.	Links to human communication	yes/no
Communication	17.	e-mail	yes/no

means	18.	Discussion group without mediator	yes/no
	19.	Discussion group with mediator	yes/no
	20.	Chat	yes/no
	21.	Moo/mud	yes/no
	22.	Video conference	yes/no
	23.	Tele-manipulation	yes/no

Figure 1: Four dimensions of the taxonomy of educational Websites