WWW in Education: An Overview

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Abstract:

Less than ten years since its release, the World Wide Web has become a prominent new space for people to communicate, work, trade or spend leisure time. And increasingly, too, a place to learn. Aware of the potential of the WWW for education, an increasing number of educational agents (e.g., schools, community centers, special interest groups, organizations, homes), enter on a daily basis the community of producers and users of Web-based learning materials or Web-based learning environments (WBLE). In this chapter we present an overview of the development, actual state and emerging trends in the implementation of the WWW in education. First a succinct historical account is presented, then a series of main educational functions and implementation models are reviewed, following is a survey of current research on Web-based learning, and finally a series of novel trends emerging from the actual practice in the field are outlined.

INTRODUCTION

Less than ten years since its release, the World Wide Web has become a prominent new space for people to communicate, work, trade or spend leisure time. And increasingly, too, a place to learn (Berenfeld, 1996, Sherry, 2000). Its grow-rate is impressive: from a few dozens of servers/sites in the beginning of the 90's to more than ten million servers today; from a predominantly text-based environment to a sophisticated multimedia

delivery tool; from a limited and clearly defined population of users (mostly dealing with academic, research, or institutional tasks) to a large and varied world community of users (an estimate of about 300 millions) across diverse countries, age-levels, occupations, interests and purposes. Aware of the potential of the WWW for education, an increasing number of educational agents (e.g., schools, community centers, special interest groups, organizations, homes), enter on a daily basis the community of producers and users of Web-based learning materials. The educators' attempts to wrap together Web-technology features (e.g., information manipulation, communication, and creation tools) to serve their educational and pedagogical beliefs and pursued learning goals, resulted in the creation of the growing population of Educational Websites, or Web-based learning environments (WBLE).

Accompanying these developments, essential questions to have emerged regarding curricular, learning and implementation aspects. Examples of emerging issues to be addressed are the cognitive processes afforded/demanded while working within the Web (e.g., navigating the information space, collaborating with distant peers in asynchronous mode), new didactic and curricular solutions with the new technologies (e.g., the hypercurriculum, assessment in Web-based learning tasks), or staff development and organizational changes required for effective Web-based instruction implementation.

In this paper we present an overview of the development, actual state and emerging trends of the WWW implementation in education. First a succinct historical account is presented, then a series of main educational functions and implementation models are reviewed, following is a survey of current research on Web-based learning, and finally a series of novel trends emerging from the actual practice in the field are outlined.

WWW IN EDUCATION: PRECEDENTS AND LANDMARKS

It was in September 1969 when the first host-to-host message was sent from UCLA to Stanford Research Institute (SRI). Two more nodes were then added (at UC Santa

Barbara and University of Utah), and by the end of 1969 the four hosts computers conformed the initial ARPANET network. Internet seeds germinated.

In time, more networks developed; personal computers entered the scene; people with varied interests (e.g., scientific, educational, commercial, political) expanded the initially limited population of users; and by the early 90's the World Wide Web was born bringing with it the widespread and rapid adoption of browsers and sophisticated communication tools, and easy access to information linked throughout the globe. On October 1995, the following definition was presented by the US Federal Networking Council in consultation with members of the internet and intellectual property rights communities: "Internet" refers to the global information system that (i) is logically linked together by a globally unique address space based on the Internet Protocol (IP) or its subsequent extensions/follow-ons; (ii) is able to support communications using the Transmission Control Protocol/Internet Protocol (TCP/IP) suite or its subsequent extensions/follow-ons, and/or other IP-compatible protocols; and (iii) provides, uses or makes accessible, either publicly or privately, high level services layered on the communications and related infrastructure described herein (Leiner et. al, 1998).

Since its inception, the development of computer communication technology was accompanied by attempts to assimilate it into education, in pursue of teaching and learning goals. In the first stages, two particular features of the technology were implemented in educational projects: messages exchange (e.g., e-mail, bulletin boards) and information search, retrieval or delivery (Chandler & Loosley, 1997).

Particularly interesting experiences coming out during that pre-Web and text-based times were environments that allowed multi-user transactions, whether for social or learning purposes, as in MOOs and MUDs (Curtis, 1993; Kort, 1991). These virtual environments possess particular features which support learners' actions, e.g., allowance for multi-threaded activities and conversation; provision of varied virtual spaces (rooms) for learning, accomplishing tasks and meet other people; support for the formulation of collaboration and interaction procedures and codes regulating the social life within the environment (O'Day et al., 1998). Along these lines, the formation of Learning

Communities was only a natural subsequent step (Oren, Nachmias, Mioduser, & Lahav, 2000).

The creation of the first graphic browsers and the WWW in the early 90's was a crucial turning point regarding the widespread implementation of computer mediated communication in education. The thorough combination of multimedia delivery capabilities, intuitive visual interfaces, support for efficient search and retrieval of information, embedded allowance for synchronic and asynchronic communication, and the abrupt expansion of cyberspace into a huge hyperlinked repository of information, was perceived as new powerful resource for teaching and learning purposes (Khan, 1997). With the new technology, pre-Web models were upgraded, and new ones were born. Among the upgraded models, typical examples are: (a) retrieval of information from distant databases, now empowered with multimedia features and sophisticated search engines (Butler, 1997); (b) multiuser areas for learning, now enhanced with graphic (2D and 3D) and audio capabilities, friendly synchronic communication tools, and collaboration-support software agents (Lea, Honda, & Matsuda, 1998); (c) tutorials and lesson plans, now delivered over the Web, enhanced with multimedia features, and hyprlinked to a broad array of digital and human resources (Owston, 1997). Examples of evolving models are: (a) Web-based organizational solutions for the delivery of education, as in Virtual Schools, Virtual Universities, or On-the-Job-Training networked systems (Lee, 1999); (b) teleoperation environments for learning and training; (c) collaborative design and creation learning environments.

A more detailed account of the history of the development of Web-based educational solutions is beyond the scope of this chapter. However, it is evident that in a very short time intense work has been done, countless ideas and models have been explored, and WWW technology increasingly fulfills more and more educational functions in schools, community centers, museums, workplaces and homes.

MAIN EDUCATIONAL FUNCTIONS OF WWW

Attempts to define and classify Web-based learning environments were made from varied perspectives. One approach emphasizes different models of instructional process implemented in Websites. Harasim et al. (1993), for example, describe seven instructional modalities which are either expert based (e-lecture, 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. Collis (1999) refers to five main purposes of using "Teleware" (her term for the whole set of tools, resources and instruments that support learning-related communication-based processes): publication and dissemination of information; structured communications; collaboration; information and resources handling; course delivery.

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. Collis (1999) stresses the role of WWW-based environments for supporting group work functions (e.g., sustaining course

cohesion, supporting collaboration and communication, maintaining the group's memory, assisting group evaluation).

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.

The aggregate of these perspectives encompass the multiple dimensions of the Web as 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. As a sort of synthesis of these different approaches, we will use in the remain of this chapter a classing framework comprising four main functions of the WWW in teaching and learning processes: content delivery, instruction delivery, communication support, and creation support. Let us briefly describe each functional category.

Content delivery. The first and most obvious feature of the web is its being a huge repository of hyperlinked knowledge. Information and knowledge manipulation functions (e.g., generation, transmission, storage, processing, retrieval of information) are at the heart of educational transactions. The possibility to contribute to, or to access, on-line libraries, databases, journals, museums, and other public information repositories on the Internet may therefore qualitatively affect education.

Instruction Delivery. 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. 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.

Communication support. The Web offers is increasingly becoming virtual milieu for new forms of interaction, collaborative work and learning among partners in educational processes (e.g., students, teachers, experts, parents). Computer-Mediated Communication (CMC) provides powerful interaction means (e.g., e-mail, forums, group tele-conferencing, IRCs) which have the potential to enhance both the extent and quality of educational transactions (Berge, 1995; Harasim et al. 1995).

Creation support. The web is increasingly becoming a creation environment. A considerable number of user-friendly tools for the creation of Web-deliverable materials are currently available. These tools (e.g., Web-pages editors, teleoperation environments, image processors) support students' creativity and initiative, allowing them to generate and publish their own Web units without mediators and with minimal technical assistance. In the next section, this framework will guide the presentation of a variety of pedagogical models actually implemented in educational Websites.

MODELS OF IMPLEMENTATION OF WWW IN EDUCATION

This section surveys different models of Web-based learning environments currently implemented. In spite of the fact that a model may comprise more than one of the educational functions described in the previous section, they will be classed and presented according to the primary function they support.

Content-oriented modes (Information containers)

Given that information and its manipulation are at the heart of the educational process, it is only natural that a large number of WBLE's were developed to serve primarily as information containers. Among the typical models under this category are (please note that words in bold italics refer to URL's included in the references list):

Online digital libraries

Government and public institutions, such as the ***Library of Congress*** or the ***Bibliotheque National de France***, initiated large projects aiming to digitize bibliographical materials including classic works and national knowledge treasures. Besides the digital versions of existent institutional libraries, other projects propose the web itself as the storage space for valuable information. For example the ***Gutenberg project*** offers an impressive collection of full text searchable and retrievable books.

Digital Encyclopedias

Traditional print-technology encyclopedias are well-recognized and authoritative information sources for learners and teachers. Their counterparts, the Digital Encyclopedias in the Web (e.g., ***Encarta-on-line, Britannica-on-line***), offer the same basic information, empowered by the unique features of the technology: improved accessibility, multimedia resources (which can be downloaded for further use by the learners), intralinkage and interlinkage to additional Websites, and constant updating.

Topical Megasites and Portals

These Websites represent access gates to huge collections of information related to specific knowledge domains. Well-known examples are the ***NASA*** Website regarding air and space-related subjects, or the ***Discovery Channel*** Website on science and technology subjects. These megasites comprise varied types of information, including live-cams coverage of events, archival information, real-time satellite pictures, breaking news, or educational resources for teachers and students.

Topical Educational Websites

There are a large number of sites focusing on specific curricular topics that were deliberately developed for educational purposes. For example ***Chickscope*** offers the opportunity to access data generated from actual research conducted in University Laboratories using state of the art scientific instruments, such as Magnetic Resonance

Imaging (MRI) systems. This Website includes information such as a day-by-day multimedia journey through the cycle of a chicken embryonic development, or a large database of MRI images.

Virtual educational configurations (Instruction delivery)

Web technology has the potential to affect the way we configure instructional settings and deliver instructional materials. The claim for pedagogical forms that transcend the school's space and time constraints is not new. But now, with the advent of advanced communication technologies, the development of such new pedagogical solutions is an attainable task. Features like synchronous and asynchronous communication, discussion group mechanisms, multi-user capability, and others open the way for the devise and implementation of novel and varied instructional configurations (e.g., distributed team-work, hybrid face-to-face/distance-learning modes, interactive distant learning). In the following we will briefly review some of the emerging models.

Virtual courses

Many academic institutions and educational organizations and companies are engaged in developing and operating virtual courses. These courses represent a revisited version of the previous model of distance education. Their main feature is that they allow students learn from anywhere at any time any subject. In many cases the basic structure, content, and didactic resources were not substantially modified in comparison with the original course (based on the print/snail-mail-delivery technologies), being the principal innovation its availability and the addition of group communication features. But in other cases significant effort is made to redefine the very concept of virtual course, and explore novel pedagogical designs. The ***World Lecture Hall*** site offers a comprehensive list of thousands of courses of all kinds delivered in the Web.

Virtual schools

"CyberSchool", "On-line School","Virtual School" and "Net School" are all alternative terms for describing a concept that in fact is being implemented in a variety of forms. A virtual school's defining feature is that its students and teachers teach and learn in separate locations. Rather than meeting face-to-face in a classroom, teachers and students in virtual schools are linked together by a variety of communication means. Most models of virtual schools, are radically different from traditional schools. They remain open 24 hours a day, 365 days a year. Students take lessons, make tests, ask questions and get answers virtually, as they would do in a traditional physical school building but without leaving their keyboards. Instead of going to school, the virtual school comes to them through their computer screen.

An example of this model is the Virtual High School (VHS) project(Tinker, 1998), a collaborative venture of high schools from all over the USA. All participants schools have access to a wide range of high-quality online courses, offering to teachers great flexibility in the design of instructional plans and teaching assignments, and to students exposure to work with peers from other backgrounds and cultures (for a rich list of. online and correspondence K-12 virtual schools see ***Wested***.

Virtual university

Gary S.Becker, the 1992 Nobel laureate argued recently for the need to balance life-long learning with the pressures of work by stimulating the market for on-line courses of academic level (Becker, 1999). Universities and colleges offer already over 6,000 accredited courses on the Web in the U.S. only. This trend might crucially affect the structure and the role of Universities in a not so far future.

Virtual Museums

Museums were among the first to offer their collections and exhibitions on the Web. In many cases the virtual museum is an extension of the real one. But in other cases the virtual museum stands by itself as digital reality. These virtual environments are designed

according to digital rules and not according to physical rules. Rooms or walls (resembling real-life objects) included play a different role from the one they do in real buildings, functioning not as barriers but as graphical indications of objects or contents classifications. Walkways become logical entities showing logical links between knowledge entities and not constraining paths. Visits are possible from any place at any time without even leaving home; visitors can stay as long as they wish, come again as many times as they like, and communicate to other visitors and the site owners regarding their thoughts and feelings about the exhibitions; browsing and wandering around are guided by the visitors' own learning interests and goals.
Example of this model can be found in the Science Learning Network site, ***SLN***, which offers linkage to 12 major Science and Technology virtual museums worldwide.

Communication-based models (Communication facilitators)

The primary goal of this kind of WBLE is to facilitate communication between the participants of the learning process (e.g. students, teachers, experts) in order to enhance it. Among the typical modes under this category are:

On-line tutoring and help (telementoring)

In this situation students communicate, using synchronic and/or asynchronic means, with on-line teachers and experts to get assistance in their learning. For example, students facing difficulties in doing homework assignments could communicate over the Internet with a live tutor that provides them with immediate assistance. The advantages of this educational setup are the immediacy of the assistance available just when the need rises, as well as the individually tailored diagnosis and solutions characterizing one-to-one teaching. Examples of Websites that provide on-line help in mathematics are ***Tutornet***, or ***Ask Dr. Math***, supplying question and answer services for student and teachers.

e-lectures

This model uses the Web as a mass communication medium. An expert (e.g. lecturer, writer, celebrity, astronaut) is available via communication tools (e.g., chat, video-conference, forum) to a large audience. For example, students in a literature class chat with a writer they are studying, or science students communicate to an astronaut in its way to a space mission. Communicating with people that are actually acting in the students field of study has a major learning as well as affective (motivation, attitudes) impact.

Student networks

Student networks are salient representatives of the many-to-many communication configuration, probably among the most powerful Web-supported educational situations. In this mode students from different locations use the Internet for interpersonal communication, information exchange and collaboration. The Web becomes a meeting place for students from different places and cultures, mostly (but not solely) as a school-based activity. Throughout communicating the students act as citizens of the evolving global village of the information age, developing awareness and sensitivity to the diversity of our world. For example, ***GLOBE*** is a worldwide network of students, teachers, and scientists working together to study and understand the global environment. Additional examples of the many students networks available on the Web are ***Global SchoolNet's***, ***I*earn*** and ***Web66***.

Web-supported educational transactions

Another popular model encouraging the many-to-many learning configuration is based on the use Web tools (e.g., discussion forums) for supporting communication among peers participating in a specific course. In most cases a mix instructional model is applied, using both face-to-face meetings and Web-mediated interactions during the course. The Web component expands the course's activities beyond its regular place and time, by supporting a variety of additional tasks (e.g., critical reading, collaborative projects, focal

student-moderated discussion) and transforming the usual "14 once-a-week-meeting courses" into "14 weeks courses" (Nachmias, Mioduser, Oren, & Ram, in press).

Virtual learning communities

A learning community can be defined as a novel educational system based on the combination of three components: a virtual community (social dimension), hosted by an appropriate virtual environment (technological dimension), and embodying advanced pedagogical ideas (educational dimension) (Oren, Nachmias, Mioduser, & Lahav, 2000). An example of a national science and technology virtual learning community for teachers is ***MATAR***. MATAR seeks for ways to involve Israeli elementary school science and technology teachers in a learning community by providing them on-line useful information, virtual courses, and opportunities to communicate. Another interesting example is the ***Teachers Helping Teachers*** site. This Website provides basic teaching tips to inexperienced teachers; new ideas in teaching methodologies for all teachers; and a forum for experienced teachers to share their expertise with colleagues around the world.

MUDs, MOOs and WOOs.

Educational MUDs (Multi User Domains), MOO's (MUD Object Oriented) and WOOs (Web-based MOOs) are multi-user environments allowing interaction and collaborative work among students (Haynes & Homevik, 1998). First conceived as Internet-accessible, text-mediated virtual environments, these evolved into sophisticated environments comprising 2D and 3D representations of spaces and objects. MUDs and MOOs are constructed social spaces in continuous evolution, allowing the participants to navigate among virtual rooms, to meet peers, to construct new spaces and objects and to contribute to augment the repertoire of functions within the virtual spaces. An illustrative example of these models is the ***Schmooze University*** (Tokel, 1996), created to help non-native English-speakers to practice their language, writing ability and reading comprehension skills, and allow English-as-Second-Language (ESL) teachers to interact with their students within the virtual campus facilities (e.g., library, administration building,

classroom building, dormitory, cafeteria). An interesting variation of the model are MUSEs (Multi User Simulation Environments), as in ***Oceana***, a world of islands whose inhabitants live in many different ways, sail and cruise the waters of the world, facing conflicts and decision points resembling real-world (social, political, economical, moral) situations (Ford & Eisenstat, 1994).

Knowledge Construction models (creation support)

One of the salient characteristics of the Web technology is that sophisticated, but at the same time user friendly, page and media editors and tools were developed allowing non-expert users to create quality Web-deliverable products. The fact that their products will be published and exposed to a large audience, affects the students' attitude towards the whole creative process and their commitment with the task. More than just a creation platform, the Web becomes also a stage to share the work with others, to expose it to their critical consideration, and to create together.

A relevant example is the ***OSH*** project in an Israeli High School. The project already comprises over 30 Websites created by students and teacher in various content domains. The project is perceived as a School enterprise, continuously growing year by year (for 3 years now). It also affects the learning process not only of the core group of students and teachers actively involved in the development but, by spreading out in concentric circles, of students and teachers from all age levels and content areas. In addition, the project affected the school climate both at the individual level (e.g., the students' perception of their learning capabilities, of opportunities for self-expression and contribution to the community), and the school level (e.g., its status in the local community, and attractiveness as educational environment).

CURRENT TECHNOLOGICAL AND PEDAGOGICAL STATE

The transition of the Web technology from its early rudimental stages to the current "everyone-can-do-it" stage, generated high expectations among educators. These expectations relate to the Web's potential impact on educational processes in three main domains fostering (a) the raise of new pedagogical forms emerging out of unique features of the technology (a "Webagogy"?); (b) the development of improved information-organization, representation, and handling capabilities; and (c) the enhancement of communication processes among students and teachers and support for collaborative learning. In practice, a great variability characterizes the educational Websites population, in terms of the identity of the sites originators (e.g., teachers, students, development centers, research centers) the developers' goals and motivations, the subject matter, allowed functions (e.g., communication, information retrieval), pedagogical approach, and nature of the offered learning activities. The impressive pace of growth of WWW educational implementations is accompanied by high expectations regarding the potential of the technology for teaching and learning, as well as by a certain level of deception in view of actual level of accomplishments. The pace of growth, the variability in quality, and the gap between expectations and realization rise the need for mapping educational Websites in systematic ways. Such a mapping was the goal of a series of studies carried out by the authors aiming to unveil didactic features and pedagogical approaches within the current landscape of educational Websites. A complete description of the studies' rationale, instruments and results appear elsewhere (Mioduser et al., 1999; Mioduser et al., 2000; Nachmias et al., 1999). Here we will focus on salient results regarding the current state of affairs (in this section), and promising and emerging trends (in the next section).

Method

For our studies we developed a classification scheme or taxonomy of educational Websites aimed to reflect the developers' educational philosophies as well as their actual manifestations, by revealing how different functionalities are configured, the knowledge is structured and represented, and communication features are implemented. Our taxonomy characterizes an educational Website by about 100 variables regarding four main dimensions: basic descriptive information (e.g., site ID, updating, population); pedagogical and educational considerations (e.g., instructional model, interaction, cognitive processes); knowledge attributes (e.g., representational structure, navigation tools); and communication features (e.g., types of telelearning, communication means). Using this tool, about 500 Websites were analyzed by five evaluators (to ensure reliability, a sample of 25% of them was re-analyzed by an additional evaluator).

Results

Our aim in was to assess the extent to which educational Websites, these sites deliberately developed for educational purposes realize the potential of the technology and fulfill the educators' expectations . The following is a succinct summary of the studies' results regarding three main dimensions: pedagogy, knowledge representation and handling, and communication processes.,

Pedagogical Characteristics of WBLE's

Our expectation was that educational Websites would sustain current pedagogical approaches that support the students' active involvement in the construction of knowledge, their interaction with peers and experts, the adaptation of instruction to individual needs, and relevant ways to assess the students' learning. Moreover, given the innovative character of the technology, it could be expected that even new pedagogical forms based on the unique features of the technology would arise.

The findings however, show a somehow different picture (see Table 1). Only 28.2% of the sites include inquiry-based activities, and more than three-quarters were highly

Table 1: Websites analysis for the pedagogical dimension (N=436)

Websites features		No. of sites (%)
Instructional configuration	Individualized instruction	407 (93.3%)
	Classroom collaborative learning	54 (12.4%)
	Web collaborative learning	12 (2.8%)
Instructional model	Directed	330 (75.7%)
	Inquiry-based	123 (28.2%)
Instructional means	Information-base	283 (64.9%)
	Tools	56 (12.8%)
	Structured activity	211 (48.4%)
	Open-ended activity	43 (9.9%)
	Virtual environment	30 (6.9%)
	Student modeling/adaptive mechanism	0 (0%)
Interaction type	Browsing	333 (76.4%)
	Multiple choice question	137 (31.4%)
	Simple activity	185 (42.4%)
	Complex activity	13 (3.0%)
	On-line tool	28 (6.4%)
	Expert consultation	58 (13.3%)
Cognitive process	Information retrieval	229 (52.5%)
	Memorizing	183 (42.0%)
	Information analysis and inferencing	142 (32.6%)
	Problem solving and decision making	22 (5.0%)
	Creation and invention	20 (4.6%)
Locus of control	Student controlled	377 (86.5%)
	Software environment controlled	77 (17.7%)
	Mixed initiative	26 (6.0%)
Feedback	Automatic	71 (16.3%)
	Human asynchronous	17 (3.9%)
	Human synchronous	7 (1.6%)
Learning resources	Within Website resources	363 (83.3%)
	Linked WWW resources	135 (31.0%)
	Additional external resources	93 (21.3%)
	External resources only	4 (0.9%)
	Real time data collection	6 (1.4%)
	Ask an expert	38 (8.7%)
	Ask a peer	17 (3.9%)
Evaluation	Standardized tests	29 (6.7%)
	Alternative evaluation	7 (1.6%)

structured offering mainly computer-controlled learning activities. Most sites elicit cognitive processes such as retrieving information (52.5%) or rote learning (42%), fewer focus on analysis and inference processes (32.6%) and even less on problem-solving and decision-making (5%). Only 2.8% of the sites support any real form of collaborative learning. Regarding interaction, we found that most sites promote browsing (76.4%) or

simple forms of interaction (42.4%), and few sites offer complex (3%) or even on-line (6.4%) activities. Few sites include any form of feedback, either automatic (16.3%) or human (5.5%).

These results conclusively show that the pedagogical approaches favored by educators and researchers for the development of valuable learning environments are still far from being implemented in most educational Websites.

Information Representation and Handling

High-level and sophisticated integrated-media is perhaps one of the defining characteristics of state-of-the-art Websites production. Our results showed that educational Websites make little use of these advanced features. The vast majority of sites are still heavily based on text (93% of the sites include more than one text field in all its pages). About 58% of the sites include at least one image per page; most sites do not include interactive images (96.1%), animated images (81.9%), or sound.

Regarding knowledge representation, the Web is perceived as the realization of the hypertext (or hypermedia) model. Non-linear structure, complex linkage within and between information units, and appropriate navigation and search tools are defining features of this model. Our results reveal only a shallow presence of these features in the evaluated Websites. Only about half of the sites included intra-site linkage to a reasonable extent (more than one link per page), and about 11% of the sites included linkage to external sites at the same extent.

Communications

Limited communication resources were observed in most of the evaluated Websites (Table 2). The most (and almost sole) resource present in the sites is electronic mail (about 65% of the sites). Other tools such as discussion groups, chat, or any form of distant work (e.g., tele-manipulation, tele-creation) were found only in a few sites. Moreover, features aimed to support working groups or learning communities were not found in any of the evaluated sites. The gap between expectations and actual implementation in the

communications domain is even more evident than in the previously discussed domains. The main reason for that is that the technological resources do exist and are being successfully implemented in other areas of people's life (e.g., work, professional training, banking, shopping). In addition, transactions among humans and between humans and information resources are quintessential to education, and it is not hard to conceive endless forms of support that communication technology could offer for these processes. As for today's reality, this support is not yet a function in most educational Websites.

Table 2: Use of communication resources in Websites (N=436)

Communication means	**No. of sites (%)**
Synchronic activities	17 (3.9%)
e-mail	283 (64.9%)
Discussion group without mediator	15 (3.4%)
Discussion group with mediator	10 (2.3%)
Chat	8 (1.8%)
Moo/mud	0 (0%)
Video conference	0 (0%)
Tele-manipulation	1 (0.2%)
Tele-creation	7 (1.6%)

Preliminary conclusions

In a previous paper we characterized the first stages in the assimilation process of the WWW technology by educators as "one step ahead for the technology, two steps back for the pedagogy" (Mioduser et al., 1999). As experienced educators we hold substantial models regarding the varied facets of our practice (e.g., how to build a lesson plan, to assess a learner's performance or behavior, to develop a learning unit). These models are usually tied to the (technological) resources at hand, and they affect each other mutually. It seems reasonable to assume that when facing the assimilation of a new technology we rest on these models as useful resource. The result is usually a transition period at which we replicate known models by means of the new technology. Our studies reveal a similar transitional phenomenon regarding the vast majority of educational Websites. Most sites' main component is the information-base, built upon the hypermedia-CD model. As for

interactivity features based on the implementation of new technological resources (e.g., forms, Java applets, Shockwave), most online activities resemble the automatic-feedback (behaviorist-like) transactions of classic CAI (e.g., multiple-choice, select-correct-part, assemble-correct-configuration).

It should be noted here that the reported studies related to the large aggregate of Websites out there in cyberspace as target population, and not to specific exemplary sites increasingly appearing in the WWW every day. In light of these results one can adopt the skeptics' perspective and argue that Web technology has little to offer to education. But one can also adopt a more thoughtful perspective, reflecting on the potential outcomes of this transition stage and looking for unique examples of emerging (and promising) directions in the research and development of educational Websites. In the following we will briefly refer to five such relevant directions.

EMERGING TRENDS

As the educators' acculturation process into the new communication technologies proceeds, three interesting phenomena arise implying that novel directions (e.g., implementation models, pedagogical approaches, cognitive issues) worth to be explored are being recognized. The first is the attempt to define relevant questions at different levels of the educational process. The second is the devise of new pedagogical solutions in an attempt to respond in practical ways to the emerging questions. The third is the research effort being invested in the pursue of systematic answers to these questions, and the consolidation of a consistent body knowledge in their regard.

For two reasons it is still impossible to present an objective and comprehensive account of this intriguing process: (a) we are still at a very early stage of it and moving as the technology itself changes rapidly, and (b) we look at this process as active (biased?) participants. However, as a manner of illustration, we will refer to questions, practices, and research directions emerging in five particular areas: Curricular issues, Collaborative Learning, Learning Communities, Visual languages, Distance learning,

Curricular issues

A great deal of theoretical and practical knowledge has been generated regarding curriculum research and development based on the print technology (e.g., see the definitive classic by Tyler, 1949, or the comprehensive review in Jackson, 1992). The shift towards representing and delivering knowledge by means of digital technology (side-by-side with the textbook? Instead of the textbook?) is today an unquestionable reality. This shift represents profound changes regarding key curricular issues, for example: (a) curricular resources (e.g., from limited-media to multimedia); (b) knowledge organization (e.g., from linear and hierarchical structure to web-like and multiple layers structure); (c) locus of responsibility for the creation of significant curricular packages (e.g., from developer/teacher generation of structured learning units, to learners' personal curriculum and ad-hoc chunking of knowledge units)

These and other changes create the need to revise current curricular theories. Considering the principles underlying the print-technology-curriculum versus the digital-technology-curriculum, how can we relate the later to the former: natural continuation, gradual evolution or break through? The preliminary answers embodied in current quality Websites are more instances of pragmatic decision-making than of theoretical formulation of new curricular principles. The challenge is thus twofold. First, we should identify, analyze, categorize and generalize these pragmatic solutions as first step in the definition of a more general body of curricular principles. But at the same time we should elaborate, focusing on the unique characteristics of the new technology, on new directions and models which appear to be promising for supporting innovative teaching and learning processes.

Collaborative Learning

Undoubtedly one of the defining features of the Web technology is that it enables peoples' interaction with (distant repositories of) knowledge as well as with each other - namely communication. These two within-group events, knowledge manipulation and interpersonal transactions, were extensively studied in the context of group learning

processes. However, in the context of the new technologies, we should pay attention to significant changes in group functioning in contrast to traditional group learning situations. For example: The group functioning is not limited by place or time boundaries; the usual face-to-face and simultaneous action characterising group work does not longer exist; members can assume varied roles and even (in less formally defined situations) varied identities according to changing situations; interpersonal transactions are mediated by the technology (e.g., massive use of writing and other symbolic resources); in many occasions, the members' participation is generated in differentiated stages also separated in time: elaboration, delivery, and feedback recollection stages. A crucial implication is that the member's contribution to the groups work can be elaborated beforehand, without the pressure or timing demands of real-time and face-to-face communication situation. Current research and development efforts have resulted in interesting models and approaches in support for WWW-based collaborative learning. Among these are multi-user task-oriented environments (Haynes & Holmevik, 1998); collaborative writing or reading systems (Van der Veen et al., 1999); collaborative online concept-mapping (Stoyanov & Kommers, 1999); shared annotation systems; or cooperative control of remote objects (Bricker et al., 1999). These and other projects represent an attempt to transcend the pre-Web-technology known models, toward approaches that are authentic to the new technology.

Learning Communities

A learning community can be defined as a novel educational system based on the combination of three components (Oren, Nachmias, Mioduser, & Lahav, 2000): a virtual community (social dimension), hosted by an appropriate virtual environment (technological dimension), and embodying advanced pedagogical ideas (educational dimension).

Many sites on the Internet define themselves as virtual learning environments. However, a detailed analysis of such sites reveals that they do not possess all the features that are essential for a virtual environment to support a virtual community aimed at learning, e.g.,

they do not present the building of a community as a goal; do not stand independently, but rather function as supplements of real institutions; their environment does not motivate social immersion; they do not offer multi-user situations; they lack pedagogical features which are essential for creating a learning community.

Virtual learning communities currently emerging in the Web are offered as a third place in addition to work or school, and to home (Oldenburg, 1991). These are being developed upon novel conceptions, offering unique tools and activity modes which differentiates them from the other spaces. These environment supply a variety of communicational tools for developing social relations, tutor-student relations, and expert-novice relations. Likewise, management and moderating functions are included to support social definitions (e.g., status, roles) and transactions. These environments promote learning processes based on members' personal interests, willingness to participate, and motivation to interact with peers, teachers and other knowledge sources within a dynamic learning community.

Visual languages

The use of visual materials to represent aspects of the world, ideas, and emotions has been an essential component of human's experience since the beginning of humankind. From the very first visual creations on the cave walls and people's own bodies, to the current digital virtual worlds, visual materials fulfil a variety of roles in our lives, e.g., communication, education, expression. For several centuries however, the written and printed word have been the main conveyors of information, and the main representational means serving educational purposes as well (Baron, 1997). During this period, images were incorporated in texts mainly for illustration or for ornamental purposes. In this century, image-based technologies (e.g., cinema, television), and more recently digital multimedia, brought visual representations back into the center of the scene with unprecedented strength. Educational Websites play an active role in this process adopting as well as contributing to the development of a variety of interesting trends, as the following examples could show.

- Visual materials recovered their function as self-sufficient educational and communication agents. In pre-literate cultures, visual materials played a unique role in the transmission of information and values (e.g., as in he immersive environments of frescoes-saturated churchs). Due to the dominant position of the text in the print technology, images were relegated to a complementary or support role. With the digital technology, visual materials' status as self-contained units has been renewed, but now in more complex and sophisticated ways than in previous cycles.
- Comprehensive symbol systems for learning and working within digital environments have been developed on the basis of visual materials. These developments include the informal consolidation of conventions as part of the Internet evolving culture (e.g., the adoption of shared conventions in e-mail and chat environments such as the symbol ":)", or in the design of icons for common functions in Web pages), as well as the formal definition of complete visual languages for accomplishing programming or design tasks.
- The representational resources repertoire is expanding. Visual materials are no longer restricted to still images. Alternative representational forms (e.g., static, dynamic, 2D, 3D, pre-made or rendered in real-time) allow learners to deal with additional ways of accessing information other than decoding it from still images (e.g., use of scientific visualization tools with real-time data, acting virtually within immersive environments). These alternative forms also contribute dynamic and interactive dimensions to the digital learning environments.
- Cognitive processes based on the use of visual raw materials are encouraged, promoting new forms of visual reasoning (e.g., mental modeling of processes, reasoning with visual metaphors).
- The communication resources universe for Learning disabled persons expands. Visual materials, metaphors and languages enable people to use alternative channels (besides the text-only and formal-analytical-only characteristic of the print technology) for learning and working.

Distance learning

Web technology has contributed to the creation of new forms of distance learning, either by empowering existing resources of traditional distance education or by the creation of new resources. For example, in contrast to the traditional one-way and one-to-many traditional TV broadcasting of lectures, video conferencing represent a significant switch towards multiple-ways participation and many-to-many interactivity. A dominant form in the development of Web-based distance learning are virtual courses. Their number is continuously growing, and appear in a wide range of configurations. At one end a large number of isolated courses can be found on a large diversity of topics. At the other end are organized virtual schools of different types (e.g., secondary, vocational, university) proposing many courses, and even offering formal accreditation and degrees.

Among the interesting features characterizing Websites being developed to support distant learning are:

- The idea of the "global school", namely, that the courses can be reached from everywhere, at any time, in unlimited number of subjects (at least potentially, depending on pace of development and demand). School space, time, organization and formal curriculum are no longer constraints for people's decision making about the configuration of their own learning.
- Ample range of instructional bundles can be found, from open ended repositories of information complemented with sets of worksheets and/or focused task briefs, to highly structured online courses.
- Extensive range of topics are dealt with, including highly specific or rare topics, and the interaction with experts and lecturers which could not be expected to be available otherwise in traditional learning settings.
- Asynchronic interactions confer unique characteristics to learning transactions. For example, traditional group discussions usually confined in time and space, gain new dimensions: the discussion evolve in time and proceed through cycles; the participants have the opportunity to reflect on their own and others' contributions; participants have the opportunity to contribute at their own pace and decision, and every

contribution is registered and reach all others; the number and diversity of potential partners for the discussion increase dramatically.

These and other developments indicates the consolidation of real opportunities to harness the new technological tools in pursue of long life learning objectives, offering different populations a variety of learning opportunities according to their desires and needs.

FINAL REMARKS

This final section could be subtitled something on the lines of "on the risk of overviewing and summarizing transitional processes". Or following an associative hyperlink, we could paraphrase the closing of the initial scene of every chapter of the unforgettable "Mission Impossible" series: "This chapter will destroy itself in a couple of years"… We should be aware that this is transition time, that the technology in use is far from being definite and stable, and that we are only in the preliminary stages of redefining and devising pedagogical solutions for the appropriate educational implementation of the new technologies.

In one hand, writing an overview chapter on WWW in education seven or eight years ago (we should say only seven years ago!) could sound as awkward as writing the unabridged biography of a newborn baby. In the other hand, seven years later, we should be aware of the signs indicating that we are still facing the very first stages of a long way to go. As in Antonio Machado's words, "caminante no hay camino, se hace camino al andar" (walker there is no trail, by walking we make the trail). We feel we are part of the large community of walkers who got the exceptional opportunity to, instead of travelling secure and ready-made roads, open new paths by inventing, exploring and implementing novel technology-based pedagogical forms.

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