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LEARNING ENVIRONMENTS ON THE WEB: The Pedagogical Role of the Educational Material

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Abstract

As society changes rapidly education has become a life long activity, demanding for more open access to instruction. Technological developments, such as hypermedia and global access to the Internet, and especially the World Wide Web, can be used as useful tools in the implementation of alternate, open modes of instruction. In this work, distance learning through the Web is investigated. The ways in which Web functionality may serve the educational purposes of a virtual classroom are examined. The main stakeholders of a Web-based course are identified and their roles in a virtual classroom setting are described. As the impact of the educational material in the effectiveness of the learning environment is of major importance, alternative models of learning and assessing are considered. As a case study, a Web-based course on computer architecture, developed at the Department of Informatics, University of Athens, is presented. The difficulties that the learners encounter in this open environment are identified and possible solutions are proposed.

Keywords:
Distance learning, Web-based course, educational material, hypermedia, simulation

1. Introduction

In modern society, it is recognized that education is a key to a more satisfying and productive life. Rapid changes in technology, workplaces, communications and educational institutions have resulted in widespread awareness that education is not limited to childhood and adolescence but it has become a lifelong activity. Specially, in the case of adults, whose life is complex concerning their personal relationships, career, social interactions, experiences and responsibilities, the use of new approaches on the instructional practices and settings which promote learning and development, is demanding.

Even though, Distance Learning (DL) is not a new instructional practice, it seems to be adequate to meet the challenges of the new societal trends and of the rapid development of knowledge. Distance learning supports more open access to education by offering possibilities for educating and training to more people than can be easily and efficiently accommodated in traditional settings. The concept of DL is based on [1]: *(i)* Learning alone or in small groups *(ii)* Learning at the learner's pace and in their own time and place *(iii)* Less frequent help from a teacher *(iv)* Active learning rather than passive *(v)* Learners taking responsibility of their own learning *(vi)* Learning from other people besides teachers.

Furthermore, the rapid technological development and the wider accessibility of high quality telecommunication links are poised to bring about a significant change in distance learning. The Internet and especially the World Wide Web (WWW or Web) offers an innovative instructional delivery system that connects learners with educational resources. Moreover, it provides opportunities for direct interaction (including group activities) that influences a significant change

towards more direct human communication in the distance-learning process. The challenges posed by technology are countered by the abilities offered to: *(i)* Reach a wider learner audience (learners unable to attend on-campus classes because of work and personal schedules, physical problems etc.) *(iii)* Involve outside educators, scientists, resources that would otherwise be unavailable *(iv)* Link learners from different social, cultural, economic, and knowledge backgrounds *(v)* Help matriculated learners make progress towards their degree.

2. Distance learning through the Web

The growth of the Internet and the Web has led to a fundamental shift in the way information is accessed and published, while on-line learning has become a new tool in education offering new opportunities to instructional designers. Web-Based Instruction (WBI) can be defined as using the Web as the medium to deliver course material, administer a course (registrations, supervision, etc.), communicate with learners. The Web offers new tools that can be incorporated in distance learning settings in order to serve special educational objectives (see Table 1). Thus, following the principle that "learning should be active in order to be effective [2]", on-line learning is not only active; it is interactive [3].

Web features	**Opportunities offered**
Communication abilities Availability of Asynchronous (Email, Newsgroups) and Synchronous (IRC, Web-conferencing, chat rooms) communication mechanisms.	Open and ease exchange of ideas, opinions between the interested parties and feedback from the instructor. Asynchronous forms of communication support important cognitive skills as the formulating and verbalizing of ideas or questions on the subject matter as well as responding to ideas by others. Educators are able to provide significant one-to-one instruction to learners. The amount of time available to each learner is increased because it is not confined to the traditional class hours.
Hypermedia abilities The interactive, electronic medium is capable of accommodating different types of audio-visual information: combination of multimedia and hypertext.	Different styles of learning can be easily addressed. Innovative educational material: Hypermedia form of presentation makes learning a task driven process where learners are motivated to *explore* alternative navigational paths through the domain knowledge and different resources around the globe according to their educational needs. Support various instructional uses: information presentation, exploration activities, collaboration, etc.
Resource of Information	Through Web, learners can reach a variety of resources: libraries, governmental databases and academic repositories, scientists for additional information. Ease distribution of educational material around the globe while the updating process becomes trivial.

Table 1. The Web providing opportunities for educational use

A Web-based classroom (or virtual classroom) is an educational environment in which learners and educators are able to perform classroom-like tasks: the *Web* provides the medium and accommodates the *learning environment*, the *educators* design the educational material, interact

with the learners and act as facilitators of learners' learning projects or activities, while the *learners* are primarily responsible for planning, carrying out and evaluating their learning. The greatest challenge in the development and implementation of a Web-based classroom is to build an environment in which the learners are motivated to assess their personal knowledge goals and objectives and to become active participants in the overall learning process. The role of educator is that of an instructor and a facilitator of learning; usually different persons undertake these two roles. Thus, the main stakeholders affecting the educational potential of a virtual classroom are: the educators, the learners, and the learning environment (for more details see Table 2).

The educator as an instructor	*The subject-matter specialist*: identifies the learning outcomes, structures & sequences the domain knowledge, chooses the appropriate activities and assessment tests
The educator as a facilitator of learning	*Learning coach* to assist learners in their study: responds to learners' questions and assignments, motivates distant learners by providing consistent and timely feedback, encourages discussion among learners and reinforces effective learner study habits.
The Learners	*Study* the educational material supplied in the course. *Undertake* the main responsibility for their learning. *Adapt* to a new way of learning, to new forms of communication, and to a technology-based environment.
The Technology: *Learning Environment*	Through the learning environment, learners/educators approach the virtual classroom and interact. Especially: Through the *user interface*, learners and educators share information and assess their personal knowledge goals and objectives. The *communication mechanisms* (synchronous or asynchronous) enable a supporting environment within learners and educators in order to form a virtual community. The *educational material* is the main source for the knowledge presented.

Table 2: The main Stakeholders of a Virtual Classroom.

In a virtual classroom, the roles of the educator and the learner resemble that of a traditional distance learning course concerning the need to adopt new forms of learning/teaching. However, in a virtual classroom they also have to *adapt* to new forms of communication, and to a technology-based environment. Thus, the new challenges imposed by the Web mainly affect the development of the learning environment through which they communicate, interact, "study" and "teach". The pedagogical role of its main components is further discussed below.

3. Pedagogical considerations on the learning environment of a Web-based course

The feature of separation between instructor and learner is considered as generating a feeling of isolation, coupled with a lack of motivation due to the physical absence of a tutor and other learners. Thus, the design and development of the learning environment, through which learners/educators form a virtual community, should be based on understanding of the learning and instructional process as well as of the learners' characteristics and their educational needs. Important factors contributing to the effectiveness of a Web-based learning environment are the *user interface*, the *communication capabilities* and the *educational material* [4]. Thus, the pedagogical profile of the course is composed by decisions affecting the design of the user interface, the communication abilities supported, and the development of the appropriate educational material (see Table 3).

Learning environment	Pedagogical Role
The user interface	*Reduce learner's anxiety*: consistent and easy-to-use. *Support learners/educators in completing their different tasks*: provide the necessary tools reflecting the profile of the users.
The communication abilities	*Enhance cognitive skills* as the formulating and verbalizing of ideas or questions on the subject matter as well as responding to ideas by others. *Support social interaction*: support cooperation between learners and educators.
The educational material	*Main source of information*: Texts must be written in a user-friendly language easily to understand. *Support alternative learning styles*: include different types of information and various levels of difficulty. *Enhance exploration activities*: adopt a hypermedia form of presentation, provide alternative resources, simulations *Enhance social interaction*: include team-projects *Assess learning procedure:* include assessment test, projects, self-assessment capabilities

Table 3: The pedagogical exploitation of the components of the learning environment

The influence of the learning environment on the educational effectiveness of a virtual classroom is of major importance. The user interface and the communication abilities offer opportunities and useful tools to learners/educators while the educational material undertakes the double role, of the book as a source of info and of the traditional teacher as it "presents" the subject matter to the learners. Consequently, its development has to accommodate didactic operations such as, encouraging and facilitating learners (consistent presentation, positive comments on self-assessment questions), adoption of a *structured presentation* of the subject matter, detail presentation of all the possible questions, point out concepts difficult to understand and usual learners' misunderstandings, *interactivity* (self-estimation questions, rhetorical questions, projects, and simulations), learner assessment procedures [5]. In the section below we concentrate on the development of innovative educational material in order to exploit modern learning theories through Web-technology.

4. The educational material

In a virtual classroom setting, learners assume the main responsibility for their learning: identify their learning needs and goals, encounter the subject matter, reflect on stored knowledge and make inferences, and finally assess their learning objectives. Towards this direction, the learning environment, especially through the educational material, must provide opportunities that actively engage learners in learning and stimulate reflective thinking. According to [6], reflective thinking is the careful, deliberate kind of thinking that helps us make sense out of what we have experienced and what we know. The Internet, with its open access and effective linking mechanisms, can accommodate the more recent models of learning suggested in educational research [7]. However, the 'progressive' model of learning, which views learning as 'discovery,

the learner as active and the learning style as informal' [8], seems as the most appropriate in order to motivate learners to take a more 'active' attitude towards their learning and think reflectively. The role of the educational material towards this direction is further discussed below.

The pedagogical profile of the educational material is composed by decisions concerning the way all the information is supplied and the role it assumes to the learner in the knowledge acquisition process. Following the progressive model of learning, a constructivist orientation is proposed. Constructivist models of instruction strive to create environments where learners actively participate in the environment in ways that are intended to help them construct their own knowledge, learners are actively engaged in interpreting the external world and reflecting on their interpretations [9]. Thus, through the educational material *exploration activities* where learners assume the responsibility of their learning, should be supported and *social interaction* must be enhanced. Furthermore, activities that demand personal involvement and that provoke stimulation of feelings and thinking, self-initiation and self-evaluation, should enrich the educational material. However, following the issue that "learners learn through a process of first being exposed to new knowledge, and then attempting to make sense of the new knowledge in terms of their existing knowledge" [8], the educational material should also supply the theory of the subject matter but in a way that addresses different knowledge levels, learning objectives, and learning styles. The role of the educational material as it is referred in Table 3 and in the light of the progressive model, is further described below.

4.1. The educational material as the main source of information - Support of alternative learning styles

In a Web-based course the educational material, as the main source of information, must adopt a special presentation form of the theory. Theory pages present the basic knowledge of the subject matter, i.e. the objective reality that the learner has to study and understand. Texts must be written in a user-friendly language, easy to understand: using short sentences and avoiding complex ones; keeping equivalent items parallel; explaining new terms; relating new ideas to previous knowledge; relating new concepts to every day experience using examples and analogies; organizing and structuring the content; pointing out concepts difficult to understand and usual learners' misconceptions. However, the research literature suggests that, the appropriate match of the students to the learning experience has a significant impact on their achievement [10]. Instructors need to provide opportunities for students to learn in a way that suits their preferred style of learning [11]. Consequently, in a Web-based environment, the educational material has to accommodate different types of information and levels of explanation, addressing different learning styles and educational needs of the audience.

The development of this kind of material demands the cooperation, or at least the contribution, of experienced professors on the subject matter.

4.2. The educational material as the enhancing exploration activities & social interaction

Exploration activities that enable active, constructive and self-regulated learning, actively engage learners in the learning process and stimulate reflective thinking. However, in order exploration to succeed to its educational potential, the design of the "environment", i.e. simulations, activities, etc., that supports this "mode of learning" has to take account that, it should serve certain learning objectives and that learners' goals and prior knowledge should influence their learning. Exploration activities can be supported through a *hypermedia* form of presentation

of the educational material, *simulations* linked with specific activities and collaboration in *team projects*.

Hypermedia systems are considered as excellent representations of constructivist approaches in theory [12], as the hypermedia form of presentation makes learning a task driven process, where learners can *explore* alternative navigational paths through the domain knowledge, and different resources around the globe. The attraction of hypermedia for education purposes lies in their ability to actively engage the learner in the acquisition and use of information, to support multiple different instructional uses (tutoring, exploration, collaboration, etc.), to support different learning styles and to promote the acquisition of different representations that underlie expert-level reasoning in complex, ill-structured domains [13]. Learners select the knowledge they perceive as being most suited to their needs. But, although the act of browsing is a pleasing experience, browsing in an unknown domain is not likely to lead to satisfactory knowledge acquisition at all [14]. Thus, navigational aids, such as a predefined hierarchical structure of the subject matter, are necessary, especially in large domains. The predefined structure of the domain knowledge provides learners (especially novices) with guidance and support during their study by offering them a sense of safety and a reliable navigation path.

Well-designed *simulations* provide experimental environments where the learners interact with the system, construct, test and compare (with the reality) their own models. The cognitive conflicts arising lead learners to discover their possible misconceptions and reconstruct their cognitive models. Thus, well-designed activities linked to specific educational objectives empower the learners to think more meaningfully and to assume ownership of their knowledge, rather than reproducing it. Simulations can also be used as comprehension tasks that lead a learner to analyze material at a deeper conceptual level than would normally follow from just studying the theory.

Furthermore, *team-projects*, enhance the communication opportunities, help learners to share their experiences, ideas, opinions and findings before creating their own understanding of the subject. *Collaboration* contributes to higher order learning through cognitive restructuring or conflict resolution.

4.3. Assessment of the Learning procedure

Learners' assessment implies an appraisal or value judgment about his/her performance relative to some criteria. Examinations and tests of equal difficulty to the learning material supplied, and team-projects provide opportunities for learner and educator to evaluate learning by receiving feedback in a variety of ways. This type of assessment aims to estimate learner's knowledge, to test educational material effectiveness, to encourage educators to reflect on the learning material, to provoke learners thought and action, and to motivate learners to ask questions and be aware of their learning [4]. However, as knowledge construction necessitates higher order thinking, new forms of assessment are required. Evaluation from a constructivistic perspective should be less a reinforcement and/or behavioral control tool and more of a self-analysis and metacognitive tool. Thus, rather than establishing a criterion to reference learning, the evaluation of learner's knowledge level results through *self-assessment tests* and *activities*, e.g. following a pre-specified scenario through a simulation, integrated into the instructional process, as learners are acquiring knowledge in some meaningful context. Appropriate activities, stimulating learner's intellectual processes of knowledge construction, provoke learners to interact with the system and reflect on their own models.

5. A Learning Environment on the Web: *A Computer Architecture Lesson*

In the Web based course we present, the audience is matriculated students. The main scope of the overall educational environment is to support them in the "Computer Architecture" course, http://www.di.uoa.gr/architecture as a supplement to the traditional teaching method. The use of multiple approaches in instructional methods increases the possibilities to meet the needs of a wide range of learners who have different learning styles, time constraints and abilities. Students that do not attend one or more lectures, because of physical or personal problems or any other reason, they have a reliable source of information on the Web to study at their pace, time, and place and an open line of communication with the professor and the fellow-students. Through the current Web-based environment we also aim to broad the learning/teaching experience of the learners and professors of the class of Computer Architecture. The educational material incorporated in this learning environment covers the scope of the certain class, while more advanced subjects are also presented. Furthermore, an experimental environment is offered where the learners can act on realistic scenarios following simulations of complex themes and test their knowledge.

5.1. User Interface

The interface adopts a consistent format, providing learners with the necessary tools to navigate through the content, to communicate with the professor/students, and to access all the information provided in the learning environment. Adequate headings and sub-headings visually guide the reader through the educational material while certain icons denote the various types of information and levels of explanation included, knowledge goals, keywords, summaries, exercises, prerequisite knowledge, etc. A glossary, Frequently Asked Questions (FAQ) and a Study Guide supplement the educational material. The *glossary* summarizes all the new, often technical terminology encountered in the course. Glossary entries are reached through hypertext links in educational material or by the main toolbar. Answers to common questions, named *FAQ*, are placed in the system to save repetition and maintain consistency. The *Study Guide* contains useful guidance information and advice, providing the appropriate guidance on what and how to study. Therefore it concerns the overall educational environment, highlights important aspects and contains brief summaries on the units of the material with necessary links to resources or terms.

5.2. Communication capabilities

Communication capabilities are provided. However, as in this setting instructor and students can meet face to face, social interaction is not a problem that the Web-based learning environment has to face. Though, asynchronous communication abilities are offered through electronic mail. Electronic mail helps students capture the moment when they need to talk to the instructor or to fellow-students but they are unavailable personally. Feedback from the instructor can be received quickly while students can read messages at their convenience and easily store them for later reference.

5.3. Content development

The educational material of the course *is developed and organised* under a predefined hierarchical structure: it is divided into manageable segments, named *chapters/units/sub-units*, similar to the list of contents in a book. A chapter is a collection of units, while a unit is a collection of HTML pages and (optionally) sub-units. HTML/Web pages (or simply pages) lay on the last level of the hierarchy chapter/units/sub-units. Every chapter is accompanied by a brief introduction of its subject matter, literature - additional resources (bibliography, URL's) and an

assessment test that the learners have to submit to the educator. The front HTML page of each unit includes: a brief introduction, the prerequisite knowledge, learning objectives, links to useful resources, and concepts-keywords that are hypertext links to the glossary. Every unit also includes self-assessment tests and an overview based on its learning objectives [15].

Different types of educational material have been developed, such as *theory pages*, *assessment tests* and *simulations* that act as cognitive tools implementing an experimental environment where the learner can test his/her knowledge and experiment under different conditions [12].

5.3.1. Theory and Assessment pages

An HTML page is a repository for course material or assessment tests. Each page of theory in the course material, named *theory page,* presents the minimum possible amount of information, providing links to expansions on other pages. This technique is known as providing a hub for basic information and a knowledge wheel for expansion [4]. The theory pages include definitions of domain concepts written in a user-friendly way incorporating various levels of explanation (keywords, summaries, learning goals, reviews, detail explanations), multimedia presentations, diagrams-images, examples embedded in text, specific references to other supplementary resources. In addition, there are theory pages that exceed the scope of the lesson, covering more advanced themes. These pages are visually denoted in order to facilitate learners in their study.

Assessment pages are HTML pages that contain revision exercises and activities. Currently, there are two types of *assessment pages*: self-assessment tests (accompanied with the correct answers) and assessment-tests that the learners have to answer and submit to the educator for further comments. Self-assessment tests are embedded in the theory pages to provoke learners to consider the material they have just seen. Assessments are embedded in each chapter aiming to evaluate learner's progress. These assessments stand as comprehensive revision exercises – testing learner's knowledge of all aspects of each chapter. The difficulty level of these assesments is related to that of the self-assessment questions, as our main concern is to encourage learner work harder and not to increase their stress level. Finally, both are enriched by exercises/activities based on the simulations supplied. Their educational objectives are mainly the difficult aspects of the subject matter and usual learners' misconceptions.

5.3.2. Simulations engaging learners in exploration activities

Simulations are embedded in the theory pages whenever a more quantitative understanding of the related subject is needed [16]. The development process of the simulations begun with the construction of a virtual model describing how we understand the environment/situation/process that would be simulated and continued with the identification of its parameters that meet the educational objectives of the course. As a paradigm, we present below the simulation named "Simulator for the DLX instruction execution".

The *Simulator for the DLX instruction execution* is a Java application embedded in the theory pages of the unit "Instruction set design" in the chapter of Computer Architecture. The main objective of this software is to familiarise learners with the format, addressing modes of operands, and execution of the most important instructions of the DLX instruction set. In this exploratory environment the learner has the ability to *set and change* certain parameters that influence the operation of the selected instruction and *observe* the results verifying or not his/her own his/her own estimations. Thus the main aim of this software is to set the issues of the specific instructions that a RISC computer can execute in comparison with the CISC computers, and to support learning for the DLX instruction execution.

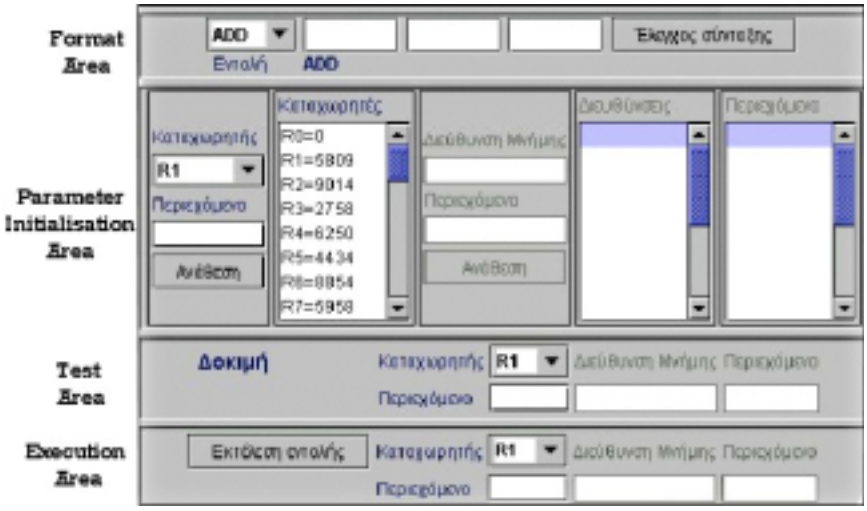

Figure 1. Graphical Interface of the Simulator for the DLX instruction execution

In more detail, in the DLX simulator, the learner has the ability to (see figure 1):

1. *Select and compose* the [ADD, SUB, LW, SW and BEQZ] instructions of the DLX computer: *Format Area*.
2. *Select and define* register or memory cells: *Initialization Area*.
3. *Predict* the results coming from the execution: *Test Area*.
4. *Check* the results coming from the execution: *Execution Area*.

6. Evaluation of the learning environment

The target group of the particular lesson of Computer Architecture (matriculated students) was characterized by a considerable heterogeneity concerning learners' background knowledge, experiences, motivations and goals. Their knowledge level was very different concerning certain themes of the subject matter, so their demands were very different. As they had the chance to reach the instructor any time through e-mail, they demand very frequent interaction. Thus this mode of instruction requires more work on the instructor's part. Also, several inconveniences were accounted.

The *hypermedia* form of presentation adopted allowed the learners to follow links and discover their own path through the information provided. The navigational aid we provided, i.e. the predefined structure of the domain knowledge resembling the book contents: chapters/units/sub-units, provided learners (especially novices) with guidance during their study, offering them a reliable navigation path. It proved as the most appropriate aid in their first steps but as the domain was becoming more complex, with various levels of explanation and kinds of material (visual, auditory, etc.), competence in the subject area was related to the learner's navigational abilities and experience in hypermedia systems. Furthermore, when browsing through the domain or other resources on the Internet, they usually fail to get an overview of how all the information fits together. Thus, information that helps learners formulate goals, e.g. learning objectives and find relevant material, is essential in order to support them (especially novices) to navigate through the corpus in an organized and instructionally efficient manner. The Study Guide

helped towards this direction, although when the corpus is large it might result in the opposite direction, aggravating the cognitive overhead problem as learners are occupied with one more task.

Consequently, the problems of disorientation and cognitive overhead, by continually making choices, seem to lessen the educational effectiveness of exploration, discovery and self-regulated learning while at the same time aggravate both the roles of the learners and the educators. Furthermore, current research in instructional design tends towards customized rather than standardized instruction [17]. Technology can undertake a significant role towards the direction of customized learning environments, through which learners with different educational needs, learning backgrounds and styles can be accommodated. Thus, we introduce the concept of dynamically making adjustments in a learning environment to accommodate diversity in student learning needs and abilities.

7. Future Trends

Adaptive Learning Environments approach the main problem of individualization of the course material tailored to the (changing) needs of particular learners. Adaptive educational hypermedia systems have instantiated a relatively recent area of research integrating two distinct technologies in computer assisted instruction, Intelligent Tutoring Systems (ITS) and Hypermedia Systems. This is in effect a combination of two opposed approaches to computer assisted learning: the more directive tutor-centered style of traditional AI based systems and the flexible learner-centered browsing approach of a hypermedia system [18].

Adaptation is a notion referring to the ability of the system to change dynamically according to the changing learner's needs in order continually to maintain the appropriate context for interaction [19]. In an adaptive system, the curriculum is not an overall order imposed on a course material, but is an emergent phenomenon that arises through the interaction of current pedagogical goals, student goals, and the system's knowledge of the domain and the student [20]. Some important factors influencing the system's adaptivity, are the *domain model*, the *modeling of the learner* and the *instructional approach*. The domain model acts as the source for the knowledge to be presented, thus it should be structured in manageable units that easily selected and re-used under different conditions. The model of the learner represents the learner profile concerning his/her knowledge background, learning style, preferences, skills and abilities. The instructional approach defines and regulates tutoring interactions with the learner by means of teaching strategies that provide opportunities for learners to learn in a way that suits their preferred style of learning.

Two methods are generally proposed in the literature for implementing adaptation in these systems: adaptive presentation (or content sequencing) [21] and adaptive navigation (or link-level adaptation) [22]. In the first case the content of a hypermedia page is generated or assembled from pieces of educational material according to the learner's knowledge state [23], while in the second case altering visible links to support hyperspace navigation is suggested [24][25]. The last research interests of our team are on the implementation of content sequencing. The goal is to adapt the educational material supplied to the particular learner's knowledge level, goals and preferences. In this way the navigation space is restricted in order to protect (especially novices) learners from information overflow. Several key points that affect the effectiveness of an adaptive learning environment and that constitute different research areas, are investigated: the development of the educational material [15], the structure of the domain knowledge [23], the instructional design [26] and the evaluation of the learner knowledge under uncertainty [27][28].

8. Conclusions

Without ignoring the very real benefit of the interactive atmosphere of the classroom that is hard or impossible to replicate on-line, we state that distance education provides a flexible, affordable way of continuing the learning process without having to leave home or work. Distance learning programs and activities in general can help us create a global schoolroom or lab; the Web can provide the appropriate interface through which learners, educators and scientists share information and gain a broader perspective on a specific subject.

The design of a Web based course includes informed decisions about what comprises the content of the course and how it is to be sequenced and synthesized, taught and learned. This process is essential in distance education, where the instructor and learners may share limited common background but typically have minimal face-to-face contact. We argue that different instructional strategies, guiding the development of the educational material, are best for accomplishing different purposes. Thus, didactic instruction (just supply the basic information covering the scope of the course) is most appropriate for that aspect of instruction in which learners need to acquire factual knowledge. Exploration and discovery learning, on the other hand, are most appropriate for those situations in which the goal is to motivate them to self-direct their learning process, to learn how to apply knowledge and generally to develop higher-order thinking. In a virtual classroom, where the role of the learner is crucial since s/he has to study and learn and at the same time s/he is responsible for the whole learning process, a hybrid instructional strategy is proposed as the most adequate one.

A Web based course in its traditional form is designed to address certain educational objectives. Thus, the different educational needs of the learners have to be addressed (if possible) through the educational material or otherwise appropriate feedback by the educator is demanded. In both cases the responsibilities of the learners/educators augment. Adaptive educational hypermedia systems have instantiated a relatively recent area in Artificial Intelligence. This research area introduces the concept of dynamically making adjustments in a learning environment to accommodate diversity in student learning needs & abilities.

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