

ON THE PEDAGOGY OF OPEN AND DISTANCE LEARNING SYSTEMS

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ABSTRACT

The purpose of this study was to investigate the pedagogical issues concerning Open and Distance Learning (ODL) systems through a critical review of the relevant published work. The review categorized articles into three categories, namely theoretical approaches, technological approaches and evaluation studies. The review showed that open and distance learning is mainly technology driven. Researchers exploit the technological features of Information and Communication Technologies for the design and development of ODL environments, without paying much attention to and applying theoretical models, pedagogical principles and instructional goals. They rather seem to follow the conventional, general instructional design guidelines concerning stand-alone educational software applications, mostly based on hypermedia systems. The main theoretical approach implied by the majority of the published work is constructivism together with collaborative learning, without referring to or applying social constructivism. Our proposal for effective open and distance learning environments is the exploitation of the tools Information and Communication Technologies offer in a constructivist environment involving specific didactic goals and learning outcomes.

INTRODUCTION

Open and Distance Education or Open and Distance Learning (ODL) is a quite old approach to education. Distance learning has a history of over a century involving different teaching approaches and following the technological evolution concerning the delivery of educational material and the communication between learners and instructors.

Moore and Kearsley have defined distance education as ‘planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as organizational and administrative arrangements’ (1996).

This definition incorporates all the components of distance education, modifying it from face to face education with the addition of certain techniques for each component. The term distance although a necessity, puts limitations that concern not only technological aspects, but also pedagogic such as course and instruction design.

Distance education has been extended by the term open, that is a desired characteristic. Open education means open to everyone, but the importance of the term hides in pedagogy and didactics, implying open learning environments. Something that is not evident from the above definition is the generalized idea beyond education,

that is pedagogy. Research in open and distance education seldom deals with pedagogic issues such as pedagogic interaction, acquisition of social and life attitudes and values, awareness of and sensitivity to various topics of the real life. This is probably because open and distance education aims at target groups with special characteristics and imminent learning needs (adults and life-long learning, remote students). That is the reason research on open and distance education mainly deals with course and instruction design, dissemination and evaluation of educational material (Govindasamy, 2002).

Research questions that arise on the field of ODL concern both the pedagogic and technological domains and can be compiled as following.

- Are there any pedagogic models special developed for ODL?
- Are the existent theoretical models appropriate for ODL?
- Which ones of the existent pedagogic models are the proper for the design of ODL systems?
- Are the existent cognitive, emotional and psychokinetic taxonomies appropriate for the design of ODL systems?
- Is there the need for pedagogues to develop new theories and models for ODL?
- Do the existent guidelines for the design of educational software fit to ODL systems?
- Are the tools Information and Communication Technologies offer adequate for the design of effective ODL environments?
- Is the technological enrichment of educational material adequate for ODL systems?

This article tries to give answers to some of these questions, through a critical, but not exhaustive, review of the relevant research work.

OPEN AND DISTANCE LEARNING: A CRITICAL REVIEW

Distance education may be categorized in four generations (table 1) (Passerini & Granger, 2000).

Table 1. The four generations of ODL, their features and technologies

GENERATION	TIME	FEATURES	TECHNOLOGIES
First	End of 19 th – beginning of 20 th century	Correspondence learning	Printed material, customized textbooks
Second	Early 1970s	Teleconference (radio & television)	Correspondence, radio, television, audio-tapes, telephone
Third	Early 1980s	One-way video two-way audio communication, real time interaction, two way videoconference	Communication networks (satellites), audio, video, CD-ROMs, bulletin boards
Fourth	1996 -	Interaction and collaboration, shift from instructor-led to learner - centered approach, student – student interaction	Telecommunications, Internet

One can see that all ODL generations are technology driven, with their features to emerge directly from the type of the technology used. Only in the last two generations some pedagogic characteristics appear, such as real time interaction, collaboration and learner-centered education. Again, these issues originate from technological solutions. There are no pedagogic principles that technology serves; rather technology drives the pedagogic principles that are exploited in ODL systems. This is also shown by the relevant research bibliography that follows.

The research on the field of open and distance education may be categorized in three types. Articles on theoretical approaches and on the design of distance learning environments, articles proposing various technological approaches, and papers on the evaluation of ODL systems. This work tries to study the research directions on ODL during the last seven years, covering the fourth generation of open and distance education and arguing on the domination of technological over pedagogic characteristics or vice versa. The main resources for the bibliographic research were the four world conferences on the www and the Internet (WEBNET, 1996 – 1999) and the four, world conferences on educational multimedia and hypermedia & educational telecommunications (EDMEDIA, 1996 – 1999). Two thousand nine hundred ninety four (2994) research papers

have been reviewed from these conferences (1116 articles from WEBNET and 1878 from EDMEDIA). The search for more recent articles was on relevant scientific journals. The major areas this search covered are shown in table 2.

Table 2. Major areas on research on open and distance learning

MAJOR AREAS ON RESEARCH ON OPEN AND DISTANCE LEARNING
Advances in Multimedia Application Development Tools
Browsing and Navigation Tools Collaborative Learning and Work
Web Tools and Facilities
Virtual Reality
Electronic Publishing, digital libraries and the Web Future Issues in Web Technology
Educational Multimedia on the Web Electronic Commerce
Industries and Services Integration of Web Applications and Services
Statistical Tools and User Tracking Teaching
Computer-Human Interface and Ergonomic Issues
Psychology of Web-Use Search Engines
Courseware Development Data
Cognitive Issues
Societal Issues, including Legal, Standards, and International Issues

A quick search on journals and textbooks from the domains of social and human sciences has shown that the published work on open and distance education is limited. It seems that pedagogues, although their community ought to offer in the field, do not study ODL from their point of view. Race for example in his Open Learning Handbook giving the ten reasons for open and distance education, has reported on technical and practical rather pedagogic issues. His emphasis was on educational material and the main reason he saw for ODL is the needs of the students (Race, 1993). In an overall approach to open and distance education, Keegan was emphasized on two-way communication, interaction and feedback. The author concluded that the theoretical context of distance education could be configured in the context of the general theory of education, and the more important issue was the educational processes and activities (Keegan, 1996).

The critical review presented in this article reviews works that have even a little correlation with pedagogic issues. Works having a pure technological approach concerning only architectures and systems for ODL, or assessment of environments concerning technical aspects such as number of hits or clicks are not considered in this article.

Theoretical approaches of open and distance learning environments

The first group of the published work concerns theoretical approaches, as it is referred in titles and abstracts.

Bos, Kikstra and Morgan (1996) proposed the web as a tool for social-constructivist approach. They tried to transfer the well-known Jonassen's seven concepts (1995): active, constructive, collaborative, intentional, conversational, contextualised, and reflective through various activity types and web tools. The most important of these was considered to be knowledge construction through the development of a hypermedia textbook by the students themselves. The authors' approach was the general one followed for the design of stand-alone hypermedia educational software, putting the learners to be the designers of their educational material cooperating through the Internet, and using resources from the web. Bogley and his associates presenting new pedagogies and tools for web-based courses, proposed the same design guidelines as those proposed for stand-alone hypermedia educational applications, emphasizing on interactivity as well as on the different learning styles of the students (Bogley, 1996). Concerning the design of web-based courses, Tsybenko gave emphasis on adaptive interaction and feedback (1996).

The WEBNET 97 conference panel concluded that the pedagogical issues at the web are the constructivist student-centered learning environments that are characterized by engaged cooperating and collaborating students with teachers assuming the role of facilitators (Lockard et al., 1997). It seems that social constructivism is the dominant theoretical model for the design of ODL environments in 1997, the same as with stand-alone computer based educational environments.

In 1998 Onken and Garrison (1998) have proposed the same teaching techniques as in a traditional classroom for distance education, emphasizing on interaction and student activities.

In 1999 Jamieson (1999) stated that although teaching will improve as a result of improved use of the technology, factors other than technology are crucial in determining the way teachers conduct their teaching. The author proposed that a pedagogically oriented understanding of teaching with telecommunications is needed to improve approaches to teaching. He finally proposed student-centered, open and flexible environments. Blanchette and Kanuka (1999) proposed constructivist principles within the context of distance education, with their approaches being the same as for the design of stand-alone hypermedia educational software. The authors stated that communication technologies have removed the barrier to participant interaction and shifted the problem to the implementation of constructivist theories in educational software in general. Martinez and her associates (1999) were emphasized on the different learning styles for a successful learning in distance education environments. They proposed a series of learning issues for intentional, performing and conforming learners, giving the same guidelines as in stand-alone applications. Dunlap (1999) provided guidelines for creating constructivist-based rich environments for active learning on the web. Her proposal was based on general educational software guidelines. For Dunlap, the main potentials for active learning on the web were collaboration, access to resources, and research, acknowledging the social nature of knowledge construction. Basil and his associates presented a web-based learning environment using javascript, applying constructivist learning theory replicating the power of stand-alone multimedia applications in the web (Basil et al., 1999). The

authors emphasized on embedded learning in a social experience, and on the promotion of motivation through interactivity with feedback. Crawford (1999) has proposed general guidelines for the design, development and evaluation for distance education environments, which followed the same guidelines with those for stand-alone applications. Som and Leh (1999), and Gunawardena (1999) made the same proposals. Gunawardena argued on interactivity in web-based distance education, proposing three types of interaction. The first was learner-content interaction, where the students work with a web-based instructional program with the system adapting to their inputs. This is something that stands for stand-alone adaptive hypermedia applications too. The potential of the web is on the large number of adaptive resources, which is a technical attribute. The second type of interaction was the learner-instructor interaction that may be more versatile in web-based environments via synchronous and asynchronous communication. The last type was the learner-learner interaction, providing the opportunity for the social negotiation of knowledge and construction of meaning. Again, this could be a potential for distance education, where the learner might interact and exchange experiences with remote users with different considerations. The author concluded that the above types of interaction in web-based environments support collaborative construction of knowledge through social negotiation, that is a key feature of constructivist learning environments. Again, the theoretical approach during the years 1997 to 1999 is social constructivism duplicating the same features of stand-alone educational software.

Motiwalla and Tello (2000) proposed a Web-based model utilizing a combination of synchronous and asynchronous communication tools. The authors' goal was to maintain the positive aspects of a traditional classroom in an effort to avoid the social isolation problems learners encounter in virtual and remote environments. The key features of their web-based pedagogy and the implemented instructional approaches were substantially transferred from general educational practices, served by the technology. The authors concluded that interaction technologies could meet the learning needs of the students in distance learning environments. Passerini and Granger (2000) proposed learning and design principles for ODL, based on the constructivist paradigm within the framework of a behaviorist step-by-step development process. They emphasized on hypermedia systems, and particularly on interaction that may be more active in distance learning environments. By interaction, the authors meant interaction in instruction, where in ODL environments the real learning 'space' among students becomes closer. They reported that interaction might take place more actively in ODL environments than in traditional classrooms, arguing that interaction is limited in traditional instruction when conducted in large classrooms. They concluded that synchronous and asynchronous communication serve 'pedagogic' interaction in hypermedia based distance learning systems. Caprariis (2000) has argued on constructivism in online learning, proposing such a model. The author used asynchronous communications, stating that this type of communication allows students to think about how they want to respond to written messages from others. Granlund, Berglund and Erikson (2000) have proposed the design of web-based simulations for learning, giving two examples for teamwork and one for individual use. The pedagogical strategies they reported in the design process are overload, transfer, affect and cost, the same that stand for all the simulation-based learning environments. The social constructivist approach remains in 2000 too.

Lupo and Erlich (2001) presented a framework for the teaching of computer literacy that can serve as a new educational paradigm in a distance learning format. Their application was hypermedia based, integrating electronic tools with conventional distance learning tools. The authors reported a great contribution to the learning process. Their approach seems to follow the classic design guidelines for hypermedia educational software, having a more or less behaviorist character involving questions and answers. Lin and Hsieh in their short review on web-based teaching and learner control seem to follow Leidner's and Jarvenpaa's suggestion that 'no particular model is the best approach' (Lin and Hsieh, 2001). The authors referred to the program and learner control stating that 'web-based instruction systems offer non-sequential control along a continuum', something all ready known and exploited in stand-alone hypermedia educational software. The future research challenges they proposed, are the need for research on interaction between learning styles and course content, on the roles of instructors and learners in virtual classroom, as well as on the role of learning communities. These three directions are the common research axes for pedagogical research concerning pedagogical and classroom interaction, not directly emerging from ODL systems. Towards the same direction were Riva's ideas stating that 'to create successful learning environments the designers and developers have to understand how communication and interaction, two key features of the learning process, are changed by computers'. Riva extended his ideas that hold for every computer assisted learning environment to ODL systems adding that 'they have to explore the possibilities of successfully instructing via networks while proving the learning and cost effectiveness of these innovative systems' (Riva, 2001). It seems that Lin and Hsieh and Riva proposed the same constructivist framework for both stand-alone and ODL systems.

In a recent article Govindasamy noted that 'one of the most crucial prerequisites for successful implementation of e-Learning is the need for careful consideration of the underlying pedagogy' (Govindasamy, 2002). The author claimed that the most of the pedagogical principles that apply to the traditional classroom also apply to e-Learning.

The published work of the last seven years shows a tendency towards constructivism for the design of open and distance learning environments, with an emphasis on social constructivism involving collaboration between students. The main characteristics for the design of such environments seem to be interaction and feedback, with hypermedia to be the educational environments over the web. Nevertheless, a behaviorist character emerges from some learning environments, as it is with stand-alone applications. All the researchers propose the same pedagogical principles that apply to stand-alone educational software applications disseminating by the network via asynchronous or synchronous way. In general, we may hold Firiyewek's (1999) comment who identified three distinct theoretical approaches, behaviorist/empiricist, cognitive/rationalist, and situative/pragmatist-sociohistoric. Firiyewek stated that 'these three perspectives and the pedagogical assumptions that evolve out of them map well against the components of courseware systems and the pedagogical practices implied in their integration'. ODL systems reflect broadly one or the other of the above three theoretical perspectives, even this is not made explicit by the developers and in practice the tools they use may be in overlapping ways.

Technological approaches to open and distance learning environments

Regarding the technological approaches to ODL, the majority of the published work may be covered under the general title 'new technologies for old problems'. This shows that the researchers simply transfer the already known didactic approaches and instructional design to distance learning environments.

Ferguson has argued on the presentation of educational material in web-based environments and on the dialog between students and instructors (1996). This implies a transfer of guidelines of stand-alone hypermedia applications to web environments, emphasizing on interaction and feedback. Koutoumanos and his associates proposed a similar approach (1996). They presented a networked hypermedia system, which is distributed without a central server, consisting of sophisticated search mechanisms. Borkowski and her associates proposed an integrated working environment for supporting teaching and learning via the web, simply transforming hard-copy linear instructional materials into web-flexible educational and administrative tools (1996). Their main concerns were if the web is a panacea for all courses, and if the students have the basic technological background to make use of the web. Hobbs and Taylor proposed educational multimedia design for web-based education, categorizing the ways for exploitation of web-based learning environments (1996). At first, they proposed the web for research and information seeking, offering the learners a practical means of following up the educational resources discussed. Secondly, they proposed the web as a teaching tool, designing tutorials and interactive on-line lessons. They also used the web as examiner, offering tests and quizzes for both assessment and self-assessment. The authors proposed the web as an educational forum, providing a basis for virtual debate and discovery, and finally as a collaborative environment. Although the authors did not mention pedagogical models and principles, it seems that they apply both constructivist and behaviorist approaches.

Abou Khaled and his associates have done a similar approach by the presentation of MEDIT, a distance education prototype for teaching and learning (1998). Their environment was based on a generic hypermedia authoring system, aiming at the stimulation of information exchange, interaction and collaborative work. Agents and multi agent systems have proposed for the support of teaching and learning by many authors (Morelos-Borja et al., 1998; Zaharakis et al., 1998). The main characteristics of such systems are reusability, modularity, adaptability, openness and scalability, features with great importance in educational software. Although there are many references on agent systems, their value in the learning process will be shown when they will incorporate expert characteristics and student models.

In 1999, Wong selected Internet technologies to support interactive teaching and learning at a distance (Wong, 1999). He put emphasis on interaction with the educational materials and categorized the technologies into asynchronous and synchronous tools presenting their advantages and limitations. The asynchronous tools proposed were e-mail, e-mail discussion tools and discussion bulletin boards. Synchronous tools proposed included text chat, collaboration tools, desktop video conferencing and conferencing/messaging software.

Chou, Tsai, and Tsai have proposed a networked virtual reality learning system for distance education (Chou et al., 2001). They used VRML combined with hypermedia technologies for the development of an environment for science education, stating that constructivism was the model they followed. Collaborative virtual

environments consist a technology that is under research and development for the support of the learning process. Economou, Mitchell and Boyle presented the requirements for such environments, focusing on interactivity and social issues that arise in these learning situations, implying the constructivist model (2000).

As for the theoretical published work, technological approaches exploit mainly hypermedia systems in distance learning environments, and imply the constructivist point of view. Authors refer to constructivism in a general way, proposing collaborative and interactive environments without putting educational and didactic goals emerging from their 'constructivist' environments.

Evaluation of open and distance learning environments

Besides the theoretical approaches and the technological implementations, there is much work on the evaluation of open and distance learning, a topic of major importance in the educational process.

Pohjolainen and Ruokamo presented their experiences and results from the evaluation of a three years pilot project on distance learning in multimedia networks (Pohjolainen and Ruokamo, 1999). Their main goal was the evaluation of a pedagogically appropriate and technically functional open learning environment, with the main questions being on the support of student-centered learning and on the construction of knowledge. Their project proved functional, with constructivity, intentionality and reflectivity being best realized in those environments enabling project work. Collaboration was found to pose challenges in many of the environments. The problematic point of the distance learning environments was on how to get learners motivated to the learning tasks and to make active use each other's skills and knowledge. The authors' main conclusion was that efficient and pedagogically sound use of distance learning environments required overall control of the learning process, something that holds for any computer-based open learning environment. Johnson and his associates made a comparative analysis of online versus face-to-face instruction (Johnson et al., 1999). Their results revealed that the students in the face-to-face course held slightly more positive perceptions about the instructor and overall course quality, although there was no difference between the two course formats in learning outcomes. The authors proposed improvement of the student-instructor communication, and the training of educators on the characteristics and limitations of online programs. Jiang and Ting have evaluated 78 courses on web-based environments, reporting that student-instructor interaction and online discussions played an important role in students' learning (Jiang and Ting, 1999). The results are similar to those of Johnson (Johnson et al., 1999), implying both the creation of interactive learning environments and the design of discussion activities that can trigger meaningful online discourse. An evaluation of 500 educational websites can be summarized as 'one step ahead for the technology, two steps back for the pedagogy', pointing out the necessity for the involvement of pedagogues to support open and distance learning environments (Mioduser et al., 1999).

Concerning primary school teachers' education and training using telecommunications, teachers became convinced of the potential use of the Internet in the classroom (Baxter et al., 2000). The teachers were frustrated because of the lack of sufficient technical training, but appreciated pedagogical guidance delivered

electronically. Regarding their pupils, teachers reported improved motivation in accessing up to date information and improved research skills concerning information retrieval and evaluation.

A different type of evaluation was a study that attempted to identify characteristics of constructivism in open and distance learning environments (Tenenbaum et al., 2001). The authors reported absence of the component of constructivist teaching and learning not only in ODL, but also in face-to-face environments. It seems that the minimal existence of constructivist principles in both conventional and distance education practices, may stem from a lack of knowledge of these principles by the instructional designers and educators. Again, the necessity for the involvement of pedagogues to support open and distance learning environments is obvious. Volery reported on an exploratory study into success factors concerning online education (2001). The study consisted of a course content that was available online including a summary of the topic under study, slides, readings, multiple choice questions, as well as an electronic bulletin board, electronic mail and access to a virtual library. The main results of this case study were that the level of interaction between the students and the lecturer appeared predominant in online delivery and lecturers and students need to upgrade their technical skills. The author concluded identifying three critical success factors associated with teaching effectiveness in online education, that is technology, the lecturer, and the students' previous use of technology. Technology was again the predominant factor in ODL. One of the problems the author detected was that the students interacted only with technology and not with other students or the instructor. Yang reported on language learning on the web, in an empirical study with 55 students majoring in Applied English at a junior college (Yang, 2001). Learners found the experience generally positive with negative responses concerning technical problems and information overload. The conclusion of the study was that computer-learning networks have the potential to empower students in well-designed learning environments. This statement puts the weight on the design of the learning environment, but without proposing certain design guidelines emerging from the features of ODL systems.

In 2002, Yu and Yu investigated the impacts of incorporating e-mail into a 68 future teachers 'computers in education' course on student academic achievement and attitudes (2002). The authors did not find any differences between the control and experimental groups in student attitudes toward computers. Concerning academic performance, the results showed that e-mail, this most accessible, easy to use and convenient asynchronous way of communication and collaboration could be a promising instructional aid for constructing an online social learning environment. The researchers' focus was not on the exploitation of pedagogic theories, but on the facilitation of learning through supplementary support given by e-mail. We believe that the authors could get the same results on academic performance, if they used even a more traditional method for communication with the students, such as mailing diskettes or printouts. The only value aided with the e-mail was the higher speed of data communication, although problems with viruses and undelivered mails reported. Yu and Yu also referring to other researchers concluded that media do change the message, teacher and student roles and learning outcomes. This important conclusion holds for any other than the traditional media, and especially for all the computer-based learning environments.

DISCUSSION

The critical review presented in this work shows that open and distance learning is mainly technology driven. This means that the researchers in general exploit the characteristics of Information and Communication Technologies for the design and development of educational environments, without trying to develop and apply new theoretical models, pedagogical principles and instructional approaches. They rather seem to follow the conventional, general instructional design guidelines concerning educational software. This is shown not only by our review on evaluation, but also by the 1999 report from the Institute for Higher Education Policy (IHEP) of the United States of America on the effectiveness of distance learning.

IHEP main conclusions were that there is a limited theoretical or conceptual framework, there is a lack of research concerning individual learning styles, and there is an emphasis on case studies (IHEP, 1999). Maybe the prophetic and partially confirmed statement by Clark and Craig (1992) for multimedia learning environments stands for ODL systems too (Mikropoulos, 2000). These researchers have proposed not to continue multimedia research and application based on expected learning benefits, unless there is a clear theoretical reason to expect learning gains due to any characteristic exclusive to a certain mix of media. But does it stand for ODL too? May the technological features be sufficient and truly drive towards certain theoretical models such as constructivism, as proposed by many researchers?

It seems that the tools provided by Information and Communication Technologies form a context for the design of constructivist learning environments with a social nature creating learning communities involving the cooperation and collaboration of students and giving the role of facilitators to the teachers. These tools are distributed databases for up-to-date information seeking, assessment tools, educational forums, collaborative environments, multiple representations in hypermedia contexts, interactivity and feedback. The ODL environments proposed and used are trying to be open and student centered, taking into account different learning styles. The bibliographic research shows that although there are many virtual learning environments, most of them do not possess all the features that are essential for open and distance learning. Most of them do not present the building of a community as a goal, they do not motivate social immersion, they do not offer multi-user situations, and they lack pedagogical features. As concerns the learning outcomes from constructivist distance environments, knowledge has to be constructed within the group by means of the exchanges among participants, and each participant has to change his/her understanding of create new personal knowledge as a result of interaction within the group (Gunawardena, 1999).

It seems that constructivism is the theoretical approach to open and distance learning environments. This comes from both the constructivist principles and the technological features of Information and Communication Technologies. Pedagogues and psychologists with a good knowledge of technology and its limitations have to involve its characteristics into constructivist learning environments and guide instructional designers to apply their models for truly constructivist open and distance learning environments. Moreover, technocrats have to cooperate, consult and follow the models proposed by the theorists and instructional designers, without exploiting the 'goodies' of technology to any learning situation.

We have to seriously think of Govindasamy's remark that 'there is a serious mismatch between the abundance of features in learning management systems and the lack or total absence of explanation on the pedagogy underlying the inclusion of these tools' (2002). This is in coherence with Firdiyewek's statement three years ago, that 'the current chaotic proliferation of tools and the resulting confusion about how to use them is related to the lack of overt integration of pedagogy in courseware authoring systems' (1999).

A starting point for the design and development of pedagogically sound ODL environments could be the seven principles for constructivist design, compiled by Boyle (1997):

1. Provide experience of the knowledge construction process
2. Provide experience in and appreciation of multiple perspectives
3. Embed learning in realistic and relevant contexts
4. Encourage ownership and voice in the learning process
5. Embed learning in social experience
6. Encourage the use of multiple modes of representation
7. Encourage self-awareness of the knowledge construction process.

The tools provided by Information and Communication Technologies can bring into effect the above principles. They can contribute to the design of open and distance learning environments under contexts following certain instructional design, involving proper content and integrating specific learning tasks. Multimedia environments can be parts of constructivist ODL systems providing multiple modes of representation and perspectives for up-to-date information retrieval and exchange among students supporting different learning styles. Simulations and visualizations in a collaborative context can provide experience of the knowledge construction process. Collaborative virtual environments can embed learning in realistic and relevant contexts. Synchronous and asynchronous collaborative environments can embed learning in social experience, encourage ownership and voice in the learning process and self-awareness of the knowledge construction process. An example of such an environment is EIKON, an integrated open educational environment for the support of high-school technology courses that combines state-of-the-art information technologies such as virtual reality, hypermedia and networking (Kameas et al., 2000).

It is well known that constructivist principles are hard to implement and it is not acceptable to instructional designers the idea of setting goals in a flexible manner and having students negotiate these for themselves, but only this way constructivism will be integrated into open and distance learning environments.

Information and Communication Technologies put the educational system in a new era, in front of accomplished facts. What is the way teaching and learning will be adapted in this new era? Is education ready to accept the necessary changes coming from the introduction of ICT? Does this introduction create a new relation with knowledge and its communication?

It seems that ICT tools have the potential to effect the changes needed. The goal is achievable only if both the technology and instruction designers address the underlying gaps in pedagogical coherence. The proper pedagogic use of ICT constitutes by itself an innovative pedagogic methodology that transforms the traditional

communication structures and favors the application of many other pedagogic principles that were difficult to be applied up to now in the context of the traditional educational system.

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