Preface

A traditional division of e-learning is that of synchronous – asynchronous. Synchronous e-learning environments try to resample the traditional class-oriented training and put their emphasis on eliminating the distance parameter. The widespread of broadband networks, multimedia streaming technologies and multimedia interactive protocols allows the synchronous e-learning systems to be easily realized and cost effective. Asynchronous e-learning systems, on the other hand, needs to define alternative learning approaches in order, first, to move from training to learning and, second, to get advantage of the availability of learning content anytime, anyplace and anywhere through the Web. These challenges along with the tremendous expansion of Web and web related services and applications put the emphasis of e-learning on the asynchronous mode of operation. In addition, Web-based leaning is considered, nowadays, the basic form of e-learning. In any case, during e-learning the learner spends a significant amount of his/her time online, interacting with web-based applications. This interaction carries tremendous weight in the learning process, because it directly influences the way the learner receives, comprehends and ultimately retains information.

The strong relation of Web and e-learning motivate us to start discussing the possibility to edit a book on e-learning design. There is a lot of work and active research on the design and evaluation of Web-based applications. We consider that specialization and enhancement of this research to technology enhanced learning would be beneficiary to e-learning researchers, academics, policy makers and stakeholders. However, designing successful e-learning is not simple as that. One can find himself/herself confronted with a number of different disciplines, namely, pedagogy, human computer interaction, affective computing, cognitive psychology, multimedia design, just to list a few. Therefore, it is realistic to conclude that e-learning design and in particular designing for creating an optimal educational experience, with the maximum benefits, involves teamwork.

In the past, e-learning was mostly encountered in adult training, frequently limited to teaching primarily technical subjects to company employees. Nowadays technology-enhanced learning can be found everywhere, from K-12 education to training fighter pilots. This expansion has created more complex needs and requirements when designing an e-learning application, course, lesson or material. Being familiar with the use of a particular development tool or system is certainly not enough to lead to effective e-learning. Broad knowledge of the issues involved, in combination with creative and efficient teamwork proves to be the way to designing better educational experiences.

Affective, Interactive and Cognitive Methods for E-Learning Design: Creating an Optimal Education Experience tries to bridge the current gap that exists in e-learning literature. This book gives insight into the most important design and other issues encountered when creating e-learning, helping the reader create better designed, thoughtful e-learning materials, lessons, activities, courses or software. Perspectives from educators, designers, and developers are presented. Theory is complemented with real cases where the reader can see situations, solutions and their results. Open research questions are discussed.
As implied by the title, the book tries to investigate e-learning design along three main axes. The first deals with interaction design and the theories and developments presented in that discipline. Solid theoretical and experimentally evaluated approaches were founded and adopted in e-learning design. Especially the Web-based learning sector has a rich heritage to borrow ideas from. As an example, one may consider the key concept of interaction design: human centered organization. There is no doubt that learner centered design is not only a wish in modern e-learning systems but an absolute necessity. It is anticipated, therefore, that a lot of research in the area of interaction design to be adapted to the peculiarities of Web-based learning. The degree to which this aim can be fulfilled and what are the best practices to push forward is examined in detail in this book.

The second axis of the book examines the cognitive theories and their role in e-learning design. As the years pass more and more constructs of cognitive theory are brought into practical systems: adaptive systems are built to materialize variations on the learning style of learners, the working memory limitations are taken into account, problem based learning is promoted, etc. However, a key challenge is to examine the role of cognitive approaches from a social networking perspective. The emergence of a variety of Web 2.0 applications and the establishment of the, so-called, social Web opened new directions of research on e-learning design as well. Nowadays, the social dimension of Web-based learning is becoming the driving force on e-learning design research. Since learning involves social interactions, or at least takes place in a social environment terms such as collaborative learning and social pedagogy are becoming common. The problem based learning is revisited in a social framework while the situation based learning is becoming a reality.

Affective computing in e-learning design is the third axis. It investigates the effect emotional parameters during the learning process and attempts to combine them with cognitive theories into learning systems that present a significant degree of adaptability to learner characteristics. Affective computing is a new and very challenging area of research. Although very few solid constructs have been achieved so far, some important e-learning applications have been developed and presented in this book.

The basic aim of this book is to present the state of the art work in e-learning design and the influences from interaction design, affective computing and cognitive theories. As a result the intended audience is mainly researchers, academics and educationalists working in the above areas. This does not mean that the book cannot be used as a course book for post graduate students; we organized the material in the book to help preserving this role. The first chapters in each section present introductory material and are appropriate to set the background on research issues on e-learning design. Furthermore, all chapters were carefully selected to ensure smooth readability of the whole; that is the book is not a collection of research papers but it was designed as a single author book presenting the required coherence among all the chapters included therein. In addition to e-learning design researchers and post graduate students this book is expected to be valuable for e-learning system developers. It provides a practical framework for developing e-learning applications based on interactive behavior and pedagogical, cognitive and affective characteristics.

In addition, and based on the fact that e-learning is a strategic goal for future educational policies leads to extensive research by academics as well as by policy makers, the variety on theoretical perspectives presented in this book are anticipated to provide a comprehensive technology enhanced educational background emphasizing on Web-based learning. As a consequence the emergence of affective theories, interaction design and the materialization of a great part of cognitive research into pedagogical approaches is expected to have an important merit in governmentally supported research in e-learning. To that end, one of the targets of this book is to establish a basis of integrating various e-learning design approaches into a wide theoretical framework, as a common ground among diverse directions of research on technology enhanced learning design.
The material in this book is organized into five sections in an effort to give an integrated view of the various disciplines involved in the design of modern technology enhanced learning approaches. Section 1 presents introductory material and deals with the transition from e-learning to e-education. In Section 2 emphasis is given on collaborative learning and the effects of social interaction within the Web. Section 3 composes the main body of the book; it deals with technology-enhanced learning design which is the basic theme of this book. The role of multimedia, hypermedia and virtual reality is the subject of Section 4. There is no doubt that advances in these areas changed dramatically the way we see Web based learning. Finally, Section 5 examines some interesting ideas of affective computing and their utilization in e-learning systems. We should keep into our minds that a really intelligent computer system is the one that exposes some degree of emotion understanding and expressing capabilities.

Despite the organization of the book into these sections, in most cases the material presented in the chapters is cross discipline showing the strong binding between the affective, cognitive and interactive technologies required for creating efficient e-learning environments.

The first chapter of this book aims at setting up the goals and key problems for the transition from early e-learning systems and platforms to an integrated e-education view which examines the technology-enhanced experience from various perspectives and not only from the technological or financial point of view. It is generally accepted that most of the e-learning-related literature looks into technological issues dealing either with content creation, delivery, use and availability or with engineering or technological issues of e-learning systems and structure. The financial facet of distance learning was also examined in detail and to specific sectors (corporate; academia). E-education on the other hand requires a wider investigation which involves the role of instructors (either of traditional or technology enhanced learning), the development of new learning methodologies, the technological gaps, mainly in Information and Communication Technologies (ICT) between countries and regions, or segments of the population, the influence of these gaps on the actual potential of technology enhanced learning and the role they play in educational institutions and workplace. A look into the learning process and an attempt to relate it to what is known as “Constructivist Learning Theory” is also given in this section of the book. Finally, the implications of transition of e-learning to e-education are discussed.

The second section of the book begins with Chapter 2 which is entitled “Web Advances in Education: Interactive, Collaborative Learning via Web 2.0”. It mainly discusses the transition from “teaching” to “learning” in contemporary education in the context of ICT and the Web. Although the latter had initially a static structure and merely required passive human viewers, this notion is currently changing towards a second generation of dynamic services and communication tools that emphasize on peer-to-peer collaboration, contributing, sharing, both among humans and programs. This revolution, usually known under the collective term Web 2.0, is reviewed from an educational as well as a technological point of view. The issues and controversies arising are backed up by case studies from diverse educational contexts to illustrate the potential of the proposed solutions. The discussion is concluded with even more exciting speculations on the envisaged arrival of Web 3.0 and collaborative content sharing with semantic technologies.

Chapter 3 continues the discussion on collaborative learning by examining the cognitive processes that allow an individual to learn within learning groups. It addresses the interface between technology and the learner by using cognitive psychology to discuss learning processes in formal and informal groups. It investigates ways to create competent learning groups, and e-learning design methods that facilitate optimal learning by an individual in a group setting. An e-learning design approach which is based on a blend of cognitive and activity theories is presented along with a pilot empirical study that measures the value of e-learning from four constructs derived from the proposed theories. The result of the study suggests that pure virtual learning environments may not always be the best option as some
users require some physical contact. While e-learning may fill many gaps, it should be perceived as a tool that needs to be attended with emotional and social contact. This conclusion causes a practical issue for the discussion that follows in Sections 4 and 5.

In Chapter 4 interface design for social interaction within e-learning environments is addressed. Discussion focuses on the design of social facilities in interfaces that are intended to motivate and sustain the process of communication among students. Although there are design constraints in creating an environment capable of supporting social interaction, previous research findings indicate that social presence is a key factor for social interaction. In addition, previous research has pointed out that social presence is affected by individual, social response and media variables, suggesting that an interface design might enhance social presence. This chapter explores the interface design by investigating how placing an emphasis on interaction facilities and incorporating text, images and animation affects students’ experiences of interacting with each other. The overall conclusion is that the interface design can increase the number of interactions and enhance the perceived social presence in e-learning environment.

Section 3 deals with specific e-learning design methodologies. It begins with chapter 5 which considers technology-enhanced educational activities spanning along a significant period of time, and explores this context from a “quality of experience” perspective. Rather than addressing the design of technology, interface, or interactive contents for learning, the main focus is on the exploration of the process-oriented, affective, socio-contextual issues involved in the design of prolonged workflows of e-learning activities. A set of heuristics for designing e-learning experiences that can maintain learners’ engagement along the time, and achieve durable, profound educational benefits in the educational context in which they take place are proposed. Furthermore, it is pointed out that involving learners as experience design partners is fundamental for these purposes. The proposed approach is exemplified by widely discussing two case studies that involve different technologies (shared 3D virtual worlds and online collaborative storytelling) in different educational contexts – high and primary schools.

A pedagogic pattern model of blended e-learning design is presented in Chapter 6. Blended e-learning design based on user feedback is commonly found in grassroots educational practice. After outlining three approaches to understanding blended e-learning, Marcia Bates’s informational process approach is used to bring together the design theory of Christopher Alexander and the instructional theory of Jean Houssaye. This results in a new pedagogic pattern model enabling the transcription of blended e-learning practice in a hands-on way to both instructional designers and educational practitioners using e-learning to satisfy the emotional and cognitive needs of learners. This model takes into account the dynamics between technology-bounded determinism of e-learning and users’ need to develop their personal emotional and cognitive preferences. Case studies are also presented to demonstrate the proposed approach in simulation-based learning in Human-Computer Interface design, and in writing an online troubleshooting wiki about network computing in English. The study used a qualitative method to evaluate feedback data in the form of tutor self-reports, learners’ reports, examination results, and a collective analysis of three experienced tutors-researchers.

Chapter 7 focuses on the design of e-learning applications with students through a particular methodology called We!Design. In years past, many methodological approaches, methods and techniques have been implemented based on the belief that users can and should be involved in the design process of technology products that affect them. We!Design methodology is inspired by the findings of research involving users and particularly students at diverse levels and phases of the design process. It is a student-centered participatory design methodology that assigns students a primary role in the design process. The various phases of the We!Design methodology are presented, and the results of its application are examined in four different design projects: a web-based e-assessment application for tertiary education, a course website, an e-portfolio application, and a tablet-PC-based e-assessment application for secondary education). Participant evaluations
indicated that the We!Design methodology was an adequate means for successful elicitation of students’ needs and their application in educational software design.

Chapter 8 elaborates upon utilization of ontologies for courseware design. The aim is to create teaching strategies for e-learning based on the principles of ontological engineering and cognitive psychology. The proposed framework is targeted at the development of methodologies and related technologies that can scaffold the process of knowledge structuring and orchestrating teaching ontologies for courseware design. The orchestrating procedure is the kernel of ontology development. Ontologies that describe the main concepts of exemplary domains are used both for teaching and assessment techniques. The main stress is put on using visual techniques of mind-mapping and concept mapping as a powerful mind learning tool. Cognitive bias and some results of Gestalt psychology are highlighted as a general guideline. The ideas of balance, clarity, and beauty are applied to the ontology orchestrating procedures. The examples are taken mainly from a course in C-language programming, and in the foundations of intelligent systems development.

Chapter 9 emphasizes on the design of adaptive e-learning systems. Adaptive e-learning systems can be extremely valuable tools in developing innovative learner-centered environments in any content domain. One area that can benefit greatly from adaptive e-learning systems is teacher development in the educational uses of computers. In this chapter, the design of PAUL, an adaptive computer-based learning environment for the development of ICT-related pedagogical content knowledge, a unique body of knowledge that teachers need to develop in order to be able to teach with ICT, is discussed. PAUL combines two opposing trends in adapting instruction, namely instruction that is both controlled by the learner and the system. The impact of PAUL is expected to be significant as it will provide a venue for effective teacher professional development situating learning in virtual communities of practice and supporting teacher thinking about the educational uses of ICT in teaching and learning.

Section 3 concludes with chapter 10 which presents an application of e-learning design for achieving fluency in foreign languages. It is an interesting topic because it revisits one of the oldest technology enhanced learning methods that of pattern drills. Achieving speaking proficiency in a non-native language is a highly complex process which requires the acquisition of various kinds of knowledge and skills, like the learning of words, rules and patterns and their connection to communicative goals (intentions), the usual starting point. In order to help the learner acquire these skills we propose an electronic version of an age old method: pattern drills (PDs). While being highly regarded in the past, PDs have become unpopular since then, partially because of their rigidity and lack of context (grounding). Despite these shortcomings the virtues of PDs, at least with regard to the acquisition of basic linguistic reflex or skills (automatisms), are still necessary to produce language at a ‘normal’ rate. However, improvement of PDs is necessary and this chapter deals with this subject in the context of the Web. Unlike tapes or books, computers are open media, allowing for dynamic changes, taking users’ performances and preferences into account. A small web-application is presented allowing for these extensions. It is a free, electronic version of PDs, i.e. an open exercise generator, adaptable to the users’ ever changing needs.

Section 4 deals with the use multimedia and virtual reality in e-learning. It begins with chapter 11 which discusses the key factors and new directions of multimedia learning design. It explores specific topics, issues and directions associated with multimedia and hypermedia learning environments. A key aim is to inform researchers, designers, and developers of multimedia learning systems as well as educators who wish to engage students in learning activities rooted in multimedia learning research and design of the critical factors that have had an impact on maximizing learning through multimedia. Strengths and pitfalls of multimedia learning design are discussed through the review of the important conclusions that two generations of multimedia research have contributed to multimedia design. Finally, emerging factors, which are currently formulating a third generation of multimedia design and learning research are presented.
A deeper look into the use of virtual reality in education is given in chapter 12. Virtual Reality (VR) is produced by a combination of technologies that are used to visualize and provide interaction with a virtual environment. These environments often depict three-dimensional space which may be realistic or imaginary, macroscopic or microscopic and based on realistic physical laws of dynamics or on imaginary dynamics. The multitude of scenarios that VR might be used makes it broadly applicable to many areas in education. A key feature of VR is that it allows multi-sensory interaction with the space visualized. This chapter looks at how this combination of multi-sensory visualization and interactivity makes VR ideally suited for effective learning and tries to explain this effectiveness in terms of the advantages afforded by active learning from experiences. Some of the applications of VR in education and the drawbacks associated with this technology are also discussed.

Chapter 13 evaluates the educational and motivational value of an augmented reality learning scenario by investigating the transition from usability to user experience. Augmented Reality (AR) is merging real and virtual environments within a single interaction space. This tight integration of computer technologies into a real environment is creating new opportunities and challenges for the designers of e-learning systems as well as a new kind of user experience (UX) for the learner. Recently, AR-based educational systems were developed that are implementing learning scenarios for primary and secondary schools. An important goal of these novel teaching platforms is to enhance the students’ motivation to learn. This chapter reports on the perceived educational and motivational value of an AR-based learning scenario for chemistry based on the results of a user-centered formative usability evaluation. Quantitative and qualitative data were collected during two experiments with students from secondary schools. While the comparison between the two types of measure increases confidence in the evaluation results, the qualitative measures also provide a detailed description of the user learning experience.

The last section of the book is composed of two chapters emphasizing on the usage of affective computing in e-learning design. Chapter 14 discusses the potential of affective computing for improving the e-learning experience, both from a theoretical and a practical perspective. The initial focus is on the important role emotions play in the (e-) learning process and on the rationale to include affect in e-learning design. Three trends in the affective computing domain are briefly presented; they represent the core features of a European Union funded project on technology-enhanced learning called “Myself”. These trends are: the use of affective Embodied Conversational Agents as virtual tutors; the possibility of automatic recognition of - and adaptation to- the emotional and motivational state of the learner; and the use of 3D simulations for web-based training of emotional competence. Finally, by focusing on the feature of automatic recognition and adaptation, the authors of this chapter present a detailed account of the approach developed within the project and use it as a framework for discussing the main benefits and current limitations to the complex process of integration of affective computing features into e-learning systems.

Chapter 15 explores the incorporation of user expressivity in e-learning environment through a particular example. A learning system adaptive to learner’s behavior is considered as an innovative system. The more a learning system exchanges relevant fragments of information about the learner’s affective status the more it adapts to it. Following this direction, an integrated learning system taking into consideration learners’ emotional state in order to provide a personalized e-learning system is presented. An extended version of the IEEE Reference Model (WG) LTSA is used for this purpose. The proposed approach is based on the automatic analysis of the learners’ emotional state providing different learners’ profiles which are built and maintained by “observing” each learner behavior. As a learner is strongly positively affected to the learning procedure in the presence of an agent, the proposed system has adopted an expressive ECA which is adapted to the learner’s emotional states in the duration of the learning procedure.
We argue that all of the above chapters contribute to a better understanding of the current and future trends in e-learning design under the prism of the advances achieved in affective computing, social networking, interaction design and cognitive theories. By reading this book an integrated view of the research efforts in the above areas, as far as the e-learning design is concerned, is anticipated. Although social networking parameters seem to dominate modern e-learning systems the prospects of multimedia and virtual reality must not be neglected. These are disciplines already mature to take their role in technology enhanced learning. Affective computing, on the other hand, is definitely a bet for the future. Once establishments of emotion recognition made more efficient and widely applicable affective computing will find its way to future e-learning systems. The current trend is the utilization of emotion expressivity in combination with virtual reality and intelligent agents.

Before concluding we would like to thank the authors of the individual book chapters for their cooperation and willingness to make this book a reality. Finally, we would like to give a special thanks to all the anonymous reviewers for their contribution and help.

We wish you an enjoyable journey through the material of this book!

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