Preface

In recent years, information and communication technology (ICT) has become an essential part of educational systems, and more generally, of the learning and teaching process. ICT in this role has served as a support or even as the replacement of human teachers in traditional education. In order to perform such a role, ICT supports both active and interactive learning through combining multimedia with networking and software engineering methods, hence promoting the advanced educational environments. The concept of such environments should be considered in the context of technological diversities used for blended and/or traditional instruction. Blended learning is the combination of traditional face-to-face instruction with the computer-mediated instruction. This new learning paradigm is learner-centered. The learner is positioned in the center of the learning environment with regard to the time, the place and the learning method; consequently, people, knowledge, technology, media, organization and likewise, are all comprised by the concept of learning resources. Nowadays, this learning environment is referred to as the *e-learning paradigm*, or simply *e-learning*, encompassing any learning content or experience affected by electronic technology.

The e-learning represents the meeting point between the world of information and communication technology and the world of education. Its importance is being evident, particularly when used within a well-planned and organized learning environment. Despite all of its advantages, it should be nevertheless noted that the e-learning is not a "magic crystal ball" to replace all of the existing educational methods.

The e-learning is enabled by *e-learning systems* that, according to the way the learning content is delivered, can be subdivided into synchronous and asynchronous e-learning systems. The e-learning systems are further classified according to supporting electronic technologies for learning content delivery into on-site systems (with CDROM and DVD options) and (either LAN or WAN) networked ones. Particular kind of asynchronous e-learning systems are *intelligent tutoring systems* (ITSs), which are a generation of computer systems intended to support and improve the learning and teaching process for certain domain knowledge, respecting the learner's individuality as in traditional "one-to-one" tutoring. The ITSs are knowledge based systems because they possess (i) knowledge about the domain knowledge, (ii) knowledge about the teaching principles and the methods for using them, and (iii) knowledge about methods and techniques for student modeling during the knowledge and skills acquiring process. From the standpoint of pedagogical methodology, the ITSs represent the connection between behavioral approaches as found in traditional systems for computer based instruction on the one hand, and the cognitive paradigm of learning and teaching on the other.

This book observes the intelligent tutoring systems in different research and development environments, as well as approaches of different interest groups to design, implementation and evaluation of abovementioned. It is intended for educators, professionals and researchers working with the intelligent

tutoring systems, the e-learning and the e-learning systems. Moreover, the book aims to present the ITSs design, implementation and evaluation methodology trough series of case studies.

The ITSs architectures and technologies are used by various e-learning communities exhibiting differing and special needs with respect to "intelligence". Unfolding domain specific intelligence is a prerequisite for advanced personalization of the respective e-learning environment. The core for personalization is the student, modeled either as an individual or as an aggregate. Following such a personalization, the environment evolves to a personalized advanced e-learning environment. Before "blending" such personalized advanced e-learning environment into educational process, it is very important to evaluate it. In general, an evaluation offers information to make decision about using the product or not. When it comes to e-learning environment evaluation, the most important aspect is effectiveness fortification. Only after evaluation, research in the field of intelligent tutoring systems can take a new direction. This was confirmed by our experience in research and development related to *TEx-Sys* (*T*utor–*Ex*pert *Sys*tem) model that started in 1992 and still lasts, that resulted with the new effectiveness evaluation methodology.

To be more specific, the *TEx-Sys* is a model of an intelligent hypermedial authoring shell for generating ITSs in freely chosen knowledge domains. Authoring shell is based on a number of concepts: the cybernetic model of systems, the paradigm "teaching is control of learning", the teaching principles of the "human" tutor with "one-to-one" tutoring model, and traditional ITSs architecture.

Within this context, it is worth noting that the approach applied in the design of *TEx-Sys* model, brings out some particular features concerning traditional ITSs:

- domain knowledge design is rigorously divided from courseware design; the expert owns the domain area knowledge and skills, providing grounds for teachers to design the courseware;
- authoring shells are considered as systems that have an ontological environment and enable experts to design domain knowledge, teachers to design educational content and students to learn and be tested;
- such an approach to authoring shells makes possible the realization of a number of requirements such as interoperability, reusability, durability and accessibility of knowledge and learning objects which are embedded in the educational content;
- dynamic quizzing enables adaptability by evaluating every step in students testing, where the system generates new questions depending on a student's partial testing results.

The first *TEx-Sys* model implementation was *on-site TEx-Sys*, which supported the learning and teaching process for only two main actors – student and teacher – who were offered the two basic functionalities: (i) the design of learning content for arbitrary domain knowledge, and (ii) learning and teaching, along with knowledge testing. The second implementation phase, known as *Distributed TEx-Sys* (*DTEx-Sys*), was based on dynamic Web documents, and addressed (i) accessibility for as large as possible a number of potential users, and (ii) learning and teaching in arbitrary domains. The *DTEx-Sys,* however, differs from the *on-site TEx-Sys* because it does not have the environment for domain knowledge base design, but uses the ones developed for the *on-site TEx-Sys*. The latest implementation is denoted as *eXtended TEx-Sys* (*xTEx-Sys*) and uses Web services. The *xTEx-Sys* strictly distinguishes the functionalities of experts for domain knowledge design from the ones of teachers for learning content (or courseware) design.

All the three *TEx-Sys* model versions have been, until presently, in effective use as a support for different courses, which also enabled gathering of valuable experimental data. To be more precise, prototype tests with the implemented systems have been carried out with students ranging from primary to

academic education, including 7700 knowledge tests that were solved by approximately 2300 students. According to carried out surveys, the implemented systems have satisfied both the required functionalities and the actors' demands. The student's environment has been tested to determine the system's usability and students' achievements in the learning and teaching process at a number of universities, high and primary schools in Croatia, which also resulted in a number of graduate and postgraduate theses.

The *TEx-Sys* model, as framework for research and instructional use, has been extensively studied in a number of research projects funded by the Croatian Ministry of Science, Education and Sport: *Independence of Student Using New Information Technology*, *Computational and didactical aspects of intelligent authoring tools in education*, *Web oriented intelligent authoring shell*, and *Intelligent e-learning systems design and evaluation* as part of the program *Intelligent Support to Omnipresence of e-Learning Systems*. The actual *TEx-Sys* version is publicly accessible and can be found on the following Website: http://proliant.pmfst.hr/xtexsys/

Following all the experience gained in almost twenty years of research and development of intelligent tutoring systems, we have organized the book in 16 chapters divided into six major sections entitled:

- Intelligent Tutoring Systems Architectures (four chapters)
- E-learning Communities Technologies (two chapters)
- Intelligent E-learning in Different Domains (four chapters)
- Personalized Advanced E-Learning Environments (three chapters)
- E-learning Systems Effectiveness (three chapters)
- Intelligent tutoring systems – the future and new directions

The book is meant to unfold a variety of new directions in the fields of mobile computing environments, natural language generation and understanding, applications of natural language processing in testing student's knowledge, computerized tutor for learning and teaching programming, student and group modeling in different kinds of e-learning systems, meta-analyses for determining overall effectiveness of e-learning and e-learning systems.

Both the layout and content of the first five sections substantiate the book title by taking in focus intelligent tutoring systems and their respective environments, from the design, implementation and evaluation point of view, as illustrated by different e-learning technologies. The final, sixth section presents authors views on the future of ITSs and new research directions in the respective field of study.

The first section entitled: *Intelligent tutoring system architecture* consists of four chapters addressing best practice issues in ITS development, intelligent learning environment design methodology, ITS methodology enhancement with the agent paradigm, also providing a concluding overview on the new ITS architecture with pattern approach.

E-learning communities' technology (the second section) describes advanced learning technologies that conform to the virtual and mobile paradigm exploited in ITS environments.

The third section, *Intelligent e-learning in different domains*, describes the positioning of intelligent e-learning system conditions in affective tutoring, learning trough gaming, learning programming and the overlay method in knowledge testing through natural language dialog systems.

Personalized advanced e-learning environment (the forth section) brings into focus the student as the main actor in the process of learning, teaching and testing. Student modeling and cognitive diagnostic assessment are presented as critical issues needed to be addressed for the successful development and

application of the ITSs. In modern learning and teaching conditions, it is of great importance to procure collaborative work. Relating to this goal, using effect size for group modeling in e-learning systems provides major contribution in group work evaluation. Semantic Web and adaptive selection and sequencing of learning objects based on learning profiles preferences and abilities of individual learners, along with automatic composition of assessment or examination papers based on instructors' specifications, contribute in the personalization of learning environments.

Effectiveness estimation of e-learning systems along with their respective environments is presented in the fifth section. As first, the factors for determining the overall effectiveness of e-learning systems used in higher education are elaborated. Then, a meta-analytic estimation of a common effect size methodology deriving from a series of experiments at different study levels is used for the evaluation of e-learning system effectiveness. The section concludes with understanding the phenomenon of human learning as an open system establishing relationships with its socio-historical context and the analysis of interactive processes as a path to understanding the quality of distance education.

As already mentioned, we conclude the book by providing a number of views on the future and new directions in the intelligent tutoring systems development. Personal authors' contributions to the discussion on the future of the intelligent tutoring systems are presented. It is considered that this chapter shows different opinions and research directions in the field of the intelligent tutoring systems.

Slavomir Stankov
Vlado Glavinić
Marko Rosić
Editors