Preface

Abstract

Web-based education has influenced educational practice, fostered initiatives to widen participation, increased learner autonomy, and facilitated informal and workplace learning. In this context, learning takes place progressively by making students actively participate in instructional decisions and supporting them individually to assess their personal learning goals. This book presents recent advances in Web-based education from various countries around the world that aim to accommodate the needs of individual learners. It includes 14 chapters that cover a variety of ways to integrate personalisation technologies in Web-based education and demonstrate their use and value in designing content, navigation, and interface adaptation to create the next generation of Web-based learning environments.

Introduction

The Web has changed the way we approach learning, the teaching practices we adopt, and how the curriculum is evolving. Web-based education has grown tremendously over the past few years, creating a variety of media-enhanced approaches to formal and informal learning, including innovative uses of ambient and mobile technologies. In this vein, a number of Web features have been exploited:

- **Communication mechanisms**, such as e-mail, newsgroups, Web conferencing, and chat rooms have been used to assist one-to-one instruction, facilitate exchange of ideas between learners and teachers, provide instructional feedback, and communicate with experts. They have been used extensively for enhancing learners' cognitive skills and increasing the amount of time available to each learner compared to traditional class hours.

- **Hypermedia** allowed an increased degree of interactivity compared to standard computer-based instruction by combining hypertext with multimedia. They have been used to accommodate learners' individual differences by allowing them to explore alternative navigation paths through educational content and linked resources according to their needs. They have been used to support a variety of educational uses, for example, information seeking, content presentation, exploration activities, and collaboration.

- **Accessibility** of structured and unstructured information resources, such as library catalogues, distributed databases, academic repositories, search engine results, course materials, and learning resources has widely facilitated information exchange and dissemination of educational activities and course materials to meet various educational objectives.

Nowadays, the majority of Web-based educational systems rely on learning environments and training programmes that support or supplement teaching and learning such as Oracle's Think.com, Learn Direct (www.learndirect.co.uk), Blackboard (www.blackboard.com), Xtensis (www.xtensis.co.uk), Knowledge Pool (www.knowledgepool.com), Mindleaders (mindleaders.com), COSE (www.staffs.ac.uk/COSE/), Colloquia (www.colloquia.net), Lotus Learning Space (www-136.ibm.com/developerworks/lotus/products/elearning/), RDN's Virtual Training Suite (www.vts.rdn.ac.uk), and WebCT (www.webct.com).

These systems have influenced practical Web-based education, and when used within a constructivist framework of learning, they can actively engage the learner in the interpretation of the content and the reflection on their interpretations. Nevertheless, the complexity of the learning experience poses a number of theoretical, methodological, and practical challenges with regards to accommodating learner's individual needs and maximising the effectiveness of Web-based education.

This book presents recent approaches to Web-based education that use personalisation technologies to adapt a learning environment in ways that accommodate learners' needs. The next section provides an introduction to the fundamentals of personalized learning environments and gives an overview of the book chapters.

Personalized Learning Environments

The ultimate goal of a constructivist approach is to allow learners to construct, transform, and extend their knowledge. Thus, learners take the responsibility of their learning by interacting with educational material that covers different knowledge levels and various learning objectives. However, learners have heterogeneous backgrounds and differ in traits such as skills, aptitudes, and preferences for processing information, constructing meaning from information, and applying it to real-world situations.

Personalisation technologies are defined as approaches to adapt educational content, presentation, navigation support, and educational services so that they match the unique and specific needs, characteristics, and preferences of each learner or a community of learners. Personalisation helps build a meaningful one-to-one relationship between the learner/teacher and the learning environment by understanding the needs of each individual and helps to reach a goal that efficiently and knowledgeably addresses each individual's need in a given context (Riecken, 2000).

Personalisation is usually applied by three different means: content level adaptation, presentation level adaptation, and navigation level adaptation. For example, content level adaptation in an educational system may be implemented by dynamically generating a lesson or assembling it from various pieces of educational material depending on the knowledge level of the learner. Thus, advanced learners may receive more detailed and in-depth information, while novices will be provided with additional explanations. Presentation level adaptation is typically implemented through a variety of techniques, such as adaptive text and adaptive layout. Adaptive text implies that the same Web page is assembled from different texts accommodating the learner's current need, such as removing some information from a piece of text or inserting extra information. Adaptive layout aims to differentiate levels of the subject content by changing the layout of the page, instead of the text, such as font type and size and background colour. Lastly, navigation level adaptation includes various techniques, such as direct guidance, adaptive ordering, link hiding, and link annotation.

Personalisation in a Web-based learning environment builds on a reasoning process or adaptation rational that is responsible for synthesising adaptive techniques and making decisions about the kind of adaptation needed to accommodate the needs of the current user in the given context. Obviously, this process of generating a hypermedia space that is dynamically adapted to the current needs of different learners requires understanding the individual. Understanding the learner in a typical classroom setting is achieved by observing what learners would say and do, their errors, and responses to tutors' queries. In personalized learning environments, learner modeling is the fundamental mechanism to personalise the interaction between the system and the learner. Learner

model generation involves interpreting the information gathered during interaction in order to generate hypotheses about learner goals, plans, preferences, attitudes, knowledge, or beliefs. The generated learner models are stored in a database and used to identify current user needs, decide on the types of adaptation to be performed, and communicate them to a personalized interface.

First attempts in personalized, also called adaptive, learning environments appeared in the early 1990s. 1996 is considered as a turning point in the area of adaptive systems (Brusiolvsky, 2001). The timeline of Figure 1 gives a bird's eye view of the evolution of Web-based personalized learning environments. Although most of these educational systems released interim versions between major releases—one example is given here for the MetaLinks system (Murray, 2001; Murray, Condit, & Haugsjaa, 1998)—the timeline of Figure 1 includes only those releases that were considered to challenge further research in the area.

The Chapters of This Book

In order to develop an all-around understanding of the challenges in integrating personalisation technologies into Web-based education, this book is organized into four sections: (i) Modeling the Learner; (ii) Designing Instruction; (iii) Authoring and Exploring content, and (iv) Approaches to Integration.

Modeling the Learner

Recent approaches to Web-based education try to take into account various dimensions of individual differences, such as level of knowledge, gender, culture, cognitive styles, learning styles, and accessibility issues for the disabled and elderly, to create learner models. In Chapter I, Fan and Macredie examine published findings from experimental studies of interaction between gender differences and hypermedia learning and propose models to adapt the presentation of the content and the navigation on the basis of gender considerations, while in Chapter II, Souto, Verdin, and Palazzo M. de Oliveira describe a methodology to model the learner's cognitive ability level based on the observation and analysis of their behaviour in a Web-learning environment. The understanding obtained from this investigation will make possible to automate the diagnosis of learners' cognitive abilities and provide personalisation.

Razek, Frasson, and Kaltenbach in Chapter III model learners' context of interest and domain knowledge to establish the "dominant meaning" of a query and personalise the query and search results to the concepts being taught. Their

Figure 1. Evolution of Web-based personalized learning environments
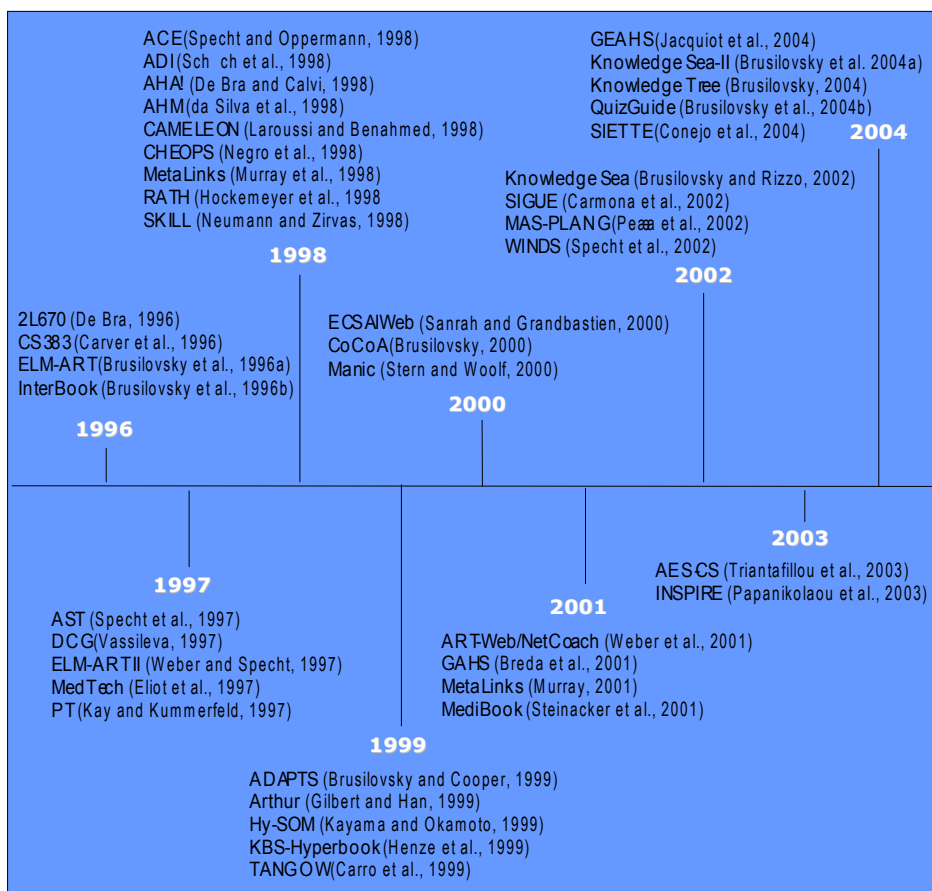
approach is incorporated into a cooperative intelligent distance learning environment for a community of learners to improve online discussions. Their experiments show that the dominant meanings approach greatly improves retrieval effectiveness in Web-based education.

In Chapter IV, Castillo, Gama, and Breda focus on the problem of tracking the changing learner needs and propose an adaptive predictive model that is used to determine what kind of learning resources are more appropriate to a particular learning style. Their approach is able to manage the uncertainty involved in detecting changes in the learner's behaviour and deviations from initial learning style preferences. The reported experiments show that the proposed probabilistic model is able to adapt quickly to changes in the learner's preferences and that it has potential to work in similar modeling tasks.

In Chapter V, the last chapter of this section, Czarkowski and Kay describe Tutor 3, the latest in a sequence of systems that they have created to provide adaptation of hypertext where the learner can maintain a real sense of control over their model and the personalized features of the environment. In their system, learners always have access to precise details of what has been adapted, how this adaptation is controlled and they are allowed to alter it. The chapter also includes a qualitative evaluation of Tutor 3, providing evidence that learners are able to understand both the adaptation and their power to control it.

Designing Instruction

The second section of the book covers instructional approaches to support adaptation in personalized learning environments. In Chapter VI, Papanikolaou and Grigoriadou present an approach to support learners in the accomplishment of their goals by enabling them to manipulate instructional approaches according to their own requirements and needs. The authors' instructional framework supports different instructional approaches, allowing learners to undertake control of the adaptation, and provides the basis for unifying several processes that formulate personalisation.

In Chapter VII, Armani and Botturi present MAID, a complete design method for adaptive courseware tailored to non-technical people. The MAID approach provides guidelines and tools that foster and enhance the communication between the technical staff in charge of managing the educational system and the tutors by adopting their instructional strategy as the pivotal point for the communication.

The next chapter by Gouli, Gogoulou, Papanikolaou, and Grigoriadou considers the assessment of student learning as an integral and essential part of the instruction and proposes personalized feedback to accommodate learners' individual characteristics and needs. Their approach attempts to model and analyse learner behaviour to evaluate their performance and support the development of metacognitive abilities through adaptive feedback. It is incorporated in a Web-based concept mapping tool which adapts the feedback in order to stimulate learners' reflection, as well as guide and tutor them towards the achievement of specific learning outcomes.

In the last chapter of this section, Gauss and Urbas explore the didactic value of adopting SCORM, a recently proposed technological standard for sharable content objects. They focus on pedagogical issues and the potential of adapting the navigation within this standard. Chapter IX also provides an empirical evaluation of a prototype learning environment and suggestions for future research in this promising area.

Authoring and Exploring Content

Issues of authoring, reusability, and interoperability are considered of vital importance in Web-based education. The third section of the book focuses on approaches to content development and exploration, as well as design of the adaptation.

In Chapter X, Cristea presents the various aspects of authoring and introduces a new flexible framework model named LAOS. To illustrate the applicability of this approach, the chapter describes an implementation of this framework in a Web-authoring environment, My Online Teacher, and reports on tests conducted in a classroom setting. The chapter discusses interfaces with existing standards and future trends. An alternative approach is proposed by Hoic-Bozic and Mornar in Chapter XI. Their system AHyCo enables teachers from areas other than IT to produce and interconnect complex hypermedia content by utilizing intuitive form-based user interfaces. They illustrate the use of AHyCo in a number of cases and present a small scale evaluation study. Lastly, in Chapter XII, Broberg follows a different approach to exploring and reading content by utilising the tool TEXT–COL. The author adopts a phenomenological approach to learning and investigates its applicability in the context of a system that supports readers to perform deep processing of texts, letting them change the appearance of text based on different strategies for categorizing words.

Approaches to Integration

Integration of adaptation techniques in existing educational systems as well as in new learning paradigms is considered the next challenging step in the evolution of personalized learning environments. Towards this direction, the last section of the book presents two chapters that approach this issue from different perspectives.

Jacobson in Chapter XIII argues that we should focus on principled design features for implementing adaptation in learning environments and on evaluations of the learning efficacy of particular design approaches. As an example of design and research in these two areas, the chapter discusses as a case study a program of educational hypermedia research related to the Knowledge Mediator Framework (KMF). First, a discussion of non-adaptive KMF hypermedia design elements and learning tasks is provided. Next, current efforts are discussed to create a KMF that supports personalisation using a Learning Agent module that employs semantic assessment and learner modeling in order to provide adaptive content and adaptive learner scaffolding.

Finally, in Chapter XIV, Specht integrates adaptation techniques, ubiquitous computing, and current research on mobile learning systems that enable sup-

port for contextualized learning. Several examples for new learning paradigms are analysed with respect to their potential for personalisation, mobile learning, and contextualization. The chapter also presents two examples of systems that integrate mobile learning solutions in existing educational systems for formal and workplace learning. The RAFT project is an application of computer based field trip support that demonstrates the integration of mobile learning tools in an established teaching method of school field trips, while the SMILES prototype shows how mobile learning technology can be integrated into existing e-learning services.

Concluding Remarks

Personalized learning environments adapt educational content, navigation support, assessment, and feedback in various ways to accommodate learners' needs. This book attempts to provide a comprehensive view of the state of the art in personalisation technologies for Web-based educational systems, describing systems and research projects from Europe, North and South America, and Australia. It covers several issues in generating adaptation, learner modeling, design considerations, and authoring tools, and presents several approaches to integrate personalisation technologies into practical educational systems. We are very grateful to the authors of the 14 chapters for contributing their excellent works and to the reviewers for providing constructive comments and helpful suggestions.

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