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Adaptive Educational Hypermedia Systems in the Advanced e-Services for the Knowledge Society (ASK) Research Unit of CERTH-ITI

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DESCRIPTION OF RESEARCH GROUP

The Research Unit “*Advanced e-Services for the Knowledge Society (ASK)*” belongs to the Informatics and Telematics Institute (ITI) of the Centre for Research and Technology - Hellas (CERTH). It was founded by *Dr. Demetrios G. Sampson*, Senior Researcher at CERTH-ITI and Assistant Professor on eLearning at the Department of Technology Education and Digital Systems of the University of Piraeus, on *January 2000*. ASK is an interdisciplinary unit engaged in research and development in Technology Enhanced Learning, and Semantic and Context-based Knowledge Systems. ASK's activities involve applied research, design and development of e-services for the knowledge society, as well as technology transfer, consulting and education. Since *July 2003*, it is linked to the *Advanced Learning Technologies Laboratory* at the Department of Technology Education and Digital Systems of the University of Piraeus. Today, ASK employs 2 University Professors, 2 Associate Researcher, 5 Research Assistants and 5 Technical Assistants. More information on the ASK Research Unit activities can be found on www.ask.iti.gr.

The Research Group involved with the area of *Adaptive Educational Hypermedia Systems* includes:

1. Demetrios Sampson, Head of Unit, Assistant Prof. Univ. of Piraeus.
2. Charalambos Karagiannidis, Assistant Prof. Univ. of Aegean
3. Nikos Manouselis, MSc., Research Assistant, PhD Candidate Univ. of Piraeus
4. Pythagoras Karampiperis, MSc., Research Assistant, PhD Candidate Univ. of Piraeus

RESEARCH ACTIVITIES ON ADAPTIVE EDUCATIONAL HYPERMEDIA SYSTEMS

Adaptive Technologies for Educational Hypermedia Systems

Research Team: Dr Demetrios G. Sampson and Pythagoras Karampiperis

In Adaptive Educational Hypermedia Systems three major adaptation approaches exist, namely:

- adaptive content selection,
- adaptive navigation support and
- adaptive presentation.

Typically, adaptive content selection and adaptive presentation are based on a set of adaptation rules according to the cognitive style or learning preferences of the learners. There are several

open issues regarding adaptive content selection and adaptive presentation, including the following:

- no well-defined and commonly accepted rules on how the learning objects should be selected exist and
- a huge set of rules is required in order to design adaptive educational hypermedia systems, since dependencies between educational characteristics of learning objects and learners are rather complex.

Our goal is to address some of the above mentioned issues using *decision making techniques* that:

- aim to assist the effort needed by an instructional designer,
- produce decision models that attempt to mimic the way an instructional designer decides, based on the observation of designer's reaction on small-scale adaptation problems and
- can be implemented in automatic courseware generation and hypermedia authoring systems.

Adaptive navigation seeks to present the content associated with an on-line hypermedia course in an "optimized" order, where the optimization criteria take into consideration the learner's background and performance on related knowledge domains, whereas adaptive sequencing is defined as the process that selects learning objects from a digital repository and sequence it in a way which is appropriate for the target learning community or individuals. There are several open issues regarding adaptive sequencing, including the following:

- no well-defined and commonly accepted rules on how the learning objects should be sequenced to make "instructional sense" exist,
- no commonly accepted approach for knowledge structuring exist,
- no commonly accepted approach for structuring of the media space exist and
- no commonly accepted approach for connecting the knowledge space the media space exist.

Our goal is to address the above mentioned issues using artificial intelligence techniques that:

- attempt to mimic the instructional planning process,
- try to automatically discover optimum learning paths from the hyper-space and
- can be implemented in automatic courseware generation and hypermedia authoring systems.

Future research includes the use of Web services in adaptive educational hypermedia systems, exploration of the relation between device adaptation and content adaptation, techniques for visualizing adaptive structures and complex pedagogical activities, automatic techniques for learning object decomposition from existing hypermedia courses, allowing reuse of the disaggregated learning objects in different educational contexts and preserving the educational characteristics they where initially designed for.

Selected Publications:

- P. Karampiperis, D. Sampson (2004), "Adaptive Learning Object Selection in Intelligent Learning Systems", Journal of Interactive Learning Research, Special Issue on *Computational Intelligence in Web-Based Education*, AV Vasilakos, V. Devedzic, Kinshuk and W. Pedrycz (eds.), volume 3(3), 2004.
- P. Karampiperis, D. Sampson (2004), "Adaptive Instructional Planning using Ontologies", Proc. of the 4th IEEE International Conference on Advanced Learning Technologies ICALT 2004, Joensuu, Finland.
- P. Karampiperis, D. Sampson (2004), "Knowledge Modeling for Adaptive Content Selection in Educational Hypermedia Systems", Proc. of the IASTED Conference on Web Based Education WBE 2004, Innsbruck, Austria.
- Sampson D. and Karampiperis P. (2004), "Reusable Learning Resources: Building a Metadata Management System Supporting Interoperable Learning Object Repositories". In Rory McGreal (Editor), *Online Education Using Learning Objects*, Taylor & Francis Books Ltd.

Evaluation of Adaptive Educational Hypermedia Systems

Research Team: Dr Demetrios G. Sampson, Dr Charalambos Karagiannidis and Nikos Manouselis

Evaluation is formally described as the “identification, clarification, and application of defensible criteria to determine an evaluation object’s value, quality, utility, effectiveness, or significance in relation to those criteria”. The area of evaluating Adaptive Educational Hypermedia Systems (AEHSs) incorporates issues from the following two areas:

- Evaluation of Educational Hypermedia Systems;
- Evaluation of Adaptive Systems.

Evaluation of Educational Hypermedia Systems (EHSs) consists on the definition, application and generalization of appropriate evaluation methods and tools that will support the assessment of EHSs upon multiple parameters, and that can be applicable in different EHSs. Under the prism of quality, evaluation of EHSs is concerned with the selection and generalization of those criteria, processes and tools that can be reused in enhancing the total quality of various EHSs. Open research issues in this area include:

- Selection and generalization of empirical criteria and appropriate methods for the evaluation of EHSs.
- Examination of methodologies that can facilitate the comparative analysis of evaluation results that are collected from different user groups.
- Integration of evaluation methods, techniques and tools into a total quality plan for EHSs.

Related work includes research on criteria that affect the quality of information and hypermedia systems. Our work focuses on the selection, generalization and reuse of quality criteria for online educational content that is used in EHSs, the development, specialization and/or generalization of methodologies that can measure user-perceived quality of e-learning services, and the application of methodologies that synthesize the results from multiple groups of users.

Evaluation of Adaptive Systems is another topic driving our research in this thematic area. There are two major challenges related with the evaluation of Adaptive systems:

- Defining the reference variables against which the adaptivity of the system will be evaluated.
- Defining criteria for adaptivity success, since the effects of adaptivity in most adaptive systems are rather subtle and require precise measurement.

Related work includes modular approaches in evaluating the components of an adaptive system, and the selection and definition of appropriate methods and criteria to be engaged for every component. Our work focuses on the application of *layered approaches* in the evaluation of adaptive systems, and the exploration of their benefits and limitations through their practical application. Taken together, our general future goal is to bring these two sub-areas together, defining a general and reusable quality framework for AEHSs. Our study will engage the appropriate methodologies, techniques and tools to support the design and execution of empirical evaluations that will serve as tools for quality control and assurance of AEHSs.

Selected Publications:

- P. Brusilovsky, C. Karagiannidis, D. Sampson (2001), “Layered Evaluation of Adaptive Learning Systems”, *International Journal of Continuing Engineering Education and Lifelong Learning*, Special issue on “*Adaptivity in Web and Mobile Learning Services*”.
- D. Sampson, N. Manouselis, “A Flexible Evaluation Framework for Web Portals based on Multi-criteria Analysis”, in A. Tatnall (Ed.) *Web Portals – the New Gateways to Internet Information and Services*, Idea Group Inc., to be published in 2004.
- D. Sampson, N. Manouselis (2004), “Quality Dimensions and e-Learning: A European Descriptive Framework for the Analysis and Categorisation of e-Learning Quality Approaches”, *Educational Sciences Journal*, Special Issue on *Life-long and Distance Learning in the Information Society*, to appear.