DEVELOPMENT OF INTELLIGENT TUTORING AND KNOWLEDGE ASSESSMENT SYSTEMS: LESSONS LEARNT

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During last decades a lot of approaches, systems, tools and environment have been proposed, developed and implemented under the umbrella of technology-based learning. Analysis of large number of publications in the field strongly manifests that the main efforts are focused on teaching and learning processes aiming to develop systems that can adapt to specific characteristics and learning styles of individual learners. At the same time these systems cannot provide qualitative enough regular knowledge assessment which allows measuring of outcomes of learning and determines whether the educational process has been successful. In fact, with the dissemination of distance learning knowledge assessment has become a constant concern. A regular knowledge assessment, as a rule, is based on various objective tests with pre-defined answers or subjective tests which are based on essays and free text responses. In case of automated assessment latter requires natural language processing and at the same time are not adaptive at all. That is why computer assisted adaptive testing appeared. Unfortunately even this approach does not support sufficiently wide and comprehensive knowledge assessment mainly because tests allow assessing learner's knowledge only at the first four levels of Bloom's taxonomy. Yet more, tests do not allow to assess learner's knowledge structure, i.e., how she/he understands relations between concepts and how new concepts are connected with previously mastered ones.

Human memory is an interrelated system and learning process is described as an alternative of this system by adding new knowledge pieces and/or modifying the structure to accommodate newly learned knowledge. As knowledge structure cannot be observed directly, various indirect methods are used among which concept maps (CM) play significant role. Since 1970's when CMs were introduced as pedagogical tool researchers have experimented with wide range of CM-based tasks to test their suitability for knowledge assessment purposes. Over the years it is cleared up that CMs provide more comprehensive knowledge assessment in comparison with tests due to the wide variety of CM-based tasks.

The latest trends in technology-based education shows that many intelligent tutoring systems (ITS) are introduced which are more adaptive because they simulate a teacher in realization of individualized tutoring using domain and pedagogical knowledge as well as knowledge about the learner. ITSs to the certain extent can adapt learning materials, generate problems and tasks, assess each learner's knowledge and provide informative feedback. The core of ITSs consists of the domain knowledge module, the tutoring module, and student diagnosis module. Typically ITSs are based on artificial intelligence methods and techniques. Recently rather many ITSs appeared which are based on a modern approach to artificial intelligence, namely, intelligent agent paradigm.

Two agent-based systems – intelligent tutoring system MIPITS for study course "Fundamentals of Artificial Intelligence" and intelligent knowledge assessment system IKAS based on CMs have been developed at the Department of Systems Theory and Design of Riga Technical University. The MIPITS was implemented

using the holistic multi-agent architecture and the novel ITS development methodology MASITS, and the corresponding tool. The design of IKAS started in 2005 with the goal of supporting student-centred systematic knowledge assessment using a variety of CM-based tasks. The IKAS has capacity for adaptation to each learner's current knowledge level – the changes of the degree of task difficulty may be initialized by the IKAS or by the learner who can also choose the initial form of feedback changing it (if needed) during the solution of the task. The IKAS has been approbated in 14 different computer science and 2 pedagogical courses. Students work with the system was analysed with main purpose to compare the known scoring systems and estimation of importance of usage of semantics of links. As a result many improvements are made and pro and cons of usage of CMs as knowledge assessment tools are clarified.

Also the conceptual framework for integration of intelligent tutoring, knowledge assessment and knowledge management systems has been worked out pushing forward by strong belief that its implementation as a multi-agent system which operates in technologically advanced environment finally will lead to the truly intelligent tutoring system.