LeActiveMath

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Abstract. LeActiveMath (Language-Enhanced, User-Adaptive, Interactive eLearning for Mathematics) is an interdisciplinary European effort that develops an internationalized Web-based intelligent e-Learning system for mathematics that can be used in high school and university as well as for self study. The many technological innovations serve a moderate constructivist and competency-based pedagogical approach. LeActiveMath integrates a number of services and tools and advances the state-of-the-art in semantic search and other usages of semantic representations, presentation of maths on the Web, course generation, coherence of material, exercise selection, modeling of motivation, modeling of competencies, annotation and structure of exercises, feedback and tutorial dialogues in exercises, First evaluations are completed and large ones ahead.

1 Introduction

LeActiveMath (*Language-Enhanced, User-Adaptive, Interactive eLearning for Mathematics*) is a European research project (STReP) funded by the 6th Framework Programme-Priority "Information Society Technologies", key action *Technology-Enhanced eLearning* in call FP6/2002/IST/1. This project is coordinated by the German Research Center for Artificial Intelligence.

The goal of LeActiveMath is to develop an innovative Web-based intelligent e-Learning system for mathematics that can be used in high school and university as well as for self study. The content and some input evaluation tools are specific for mathematics, but the main technology is not restricted to mathematics. The benefits of the new technologies are demonstrated with mathematics for which currently moderate constructivist approaches to education are even less common than for other domains. On the one hand, mathematics has the advantage of being clearly structured and to address concepts with a relatively clear semantics. Mathematics, on the other hand, poses additional challenges, e.g., in the delivery of formulas on the Web.

Since Web-technologies alone are insufficient LeActiveMath is a multidisciplinary effort which includes disciplines such as artificial intelligence, pedagogy,

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techniques and experiences from Intelligent Tutoring Systems (ITS) and representations developed for eLearning and the semantic Web. LEACTIVEMATH provides a synthesis of both worlds – ITS and eLearning – and it is one of the few mature and ready-to-use, multi-lingual, intelligent Web-based learning environments (not to be confused with Learning Management Systems). LEACTIVEMATH features generic technologies and services that are interoperable and can be reused.

LEACTIVEMATH effectively supports learning and stimulates the learner's initiative by providing interaction tools, (multi-modal) feedback and tutorial dialogues. It can suggest different levels of guidance, can follow a chosen pedagogical strategy, and reacts to the learner's motivational state. It puts the student in a more responsible position for her learning, grants students' self-guidance and supports meta-cognition where possible.

2 Pedagogical Fundament of LEACTIVEMATH

The purely instructivist approach seems to fail in many learning situations. Learning mathematics should not only aim at *solving* the problem but also at *thinking mathematically* and *arguing* about the correctness or incorrectness of the problem solving steps and involved methods, to perform simple and complex *computations*, etc. This is the idea behind **competency-based** pedagogy which provides dimensions on what to train and to evaluate, e.g., in the PISA studies.

The constructivist view of learning is based on the theory that knowledge cannot be directly taught to a student but has to be constructed by every single student with respect to her prior knowledge and experience [5]. Recent research suggests that the instructivist point of view is less efficient than a **moderate constructivist** view on learning and instruction. The term *moderate constructivism* defines a teaching and learning approach that mixes many of the fundamental features of (pure) constructivism with more instructional elements. For an eLearning environment this definition translates to a mixture of constructivist and instructivist elements in a problem-oriented learning environment. Learning is conceived as an individual, mostly active and self-regulated, situational and social process that is strongly influenced by the student's motivation and zone of proximal development.

Moreover, moderate constructivism addresses authentic problems, multiple contexts and perspectives, and learning with instructional support. It reconciles the strict constructivist with cognitive and instructional principles. This model suits the practical requirements of schools and its effectiveness has been shown in numerous empirical investigations.

3 How to Work with LEACTIVEMATH

With LEACTIVEMATH a student can choose one or several learning goals, a context and a pedagogically granted learning scenario. After such 'planning' activities she receives personalized learning material including dynamically produced