INTELLIGENT ASSESSMENT IN ALGEBRA

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SUMMARY

Modern pedagogical approaches focus on the learning process itself rather than dealing with the product of learning alone. Such approaches require the teacher to analyze each student's individual learning process and provide appropriate feedback. In order to realize such concepts in courses with a large number of students innovative tools and methods are needed. The research project SAiL-M ("semi-automatic analysis of individual learning processes in mathematics") targets these requirements by formulating and implementing new pedagogical design patterns of activating learning environments, and by developing semi-automatic, computer-based assessment tools for different types of mathematical problems.

SAiL-M investigates the research question of how to design learning environments that foster the development of mathematical expertise. Various pedagogical design patterns such as *Technology-on-Demand*, *Feedback-on-Demand*, and *Hint-on-Demand* (Bescherer, Spannagel 2009) have been formulated. They are implemented as **activating learning scenarios** that aim at keeping the students active during the whole semester. Exercise classes and lectures are tightly linked and structured according to the pedagogical patterns. Where applicable, the computer-based tools are integrated into the classes and support the students by providing semi-automatic, individual feedback on their learning processes. The design of the software tools also reflects the pedagogical design patterns, and thus ensures a consistent model throughout all levels of the learning environment.

Within the SaiL-M project, a specific focus is on the mathematical discipline of algebra. In the scope of introductory math courses at university level, we have identified two subject areas that students often have difficulties with: (a) understanding the concept of functions, and (b) understanding and applying complete induction proofs as a technique of mathematical reasoning. The software tools Squiggle-M and ComIn-M have been developed to support the students in these problem areas. In the following, the tool ComIn-M is described in more detail.

ComIn-M provides a web-based exercise sheet for complete induction proofs. Students may train and check induction proofs independently and at any time. When required, they can request immediate feedback by the system, tailored to their specific problems (*Feedback-On-Demand*). Different from existing approaches in the field (e.g., Goguadze et .al. 2005), not only the final result of a student's solution is analyzed, but also every single step that was entered during the solution process. As a result, students may receive detailed information on the step in their solution where an error occurred and get hints on how to resolve these mistakes (*Hint-On-Demand*).

The underlying architecture of ComIn-M strongly relies on its **Intelligent Assessment** component. Intelligent Assessment (Bescherer et. al. 2009) denotes a concept for assessing the process that led the student to the generation of a certain product. In ComIn-M, this component is responsible for performing a comprehensive analysis of the student's solution path and for generating a detailed error report on whether there are arithmetic errors in the proof, which rewriting steps are erroneous, or whether the induction hypothesis was used correctly. Thereby, the students get valuable feedback on both the correctness of their solution and the correct application of complete induction as a method of mathematical proof.

In cases where the Intelligent Assessment fails to assess the solution automatically, the solution is forwarded to a human tutor or teacher. The teacher then assesses the solution and provides human expert feedback to the student. Thus, the work load for the teacher is significantly reduced since the teacher only has to provide feedback when a non-standard solution was detected by the Intelligent Assessment. The integration of the teacher in the assessment process loop for cases that could not be evaluated automatically represents another novel key element of this approach.

POSTER PRESENTATION

The poster presentation will outline the learning scenarios based on the pedagogical design patterns developed within SAiL-M. It will also explain the web service-based architecture of the tool ComIn-M especially focusing on its Intelligent Assessment component. Furthermore, we will show first evaluation results for applying ComIn-M and Squiggle-M in mathematics lectures and exercise classes. Our ongoing tool evaluations consider both, usability aspects and mathematical self-efficacy of the users. As part of our poster presentation we will also make a life demo of the software tools and provide the opportunity to test our tools on site.

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