

The MATHESIS Algebra Tutor: Web-based Expert Tutoring via Deep Model Tracing¹

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The MATHESIS Algebra Tutor [1] is a model-tracing tutor for expanding and factoring algebraic expressions. The tutor teaches a breadth of 16 top-level math skills (operations): monomial multiplication, division and power, monomial-polynomial and polynomial-polynomial multiplication, parentheses elimination, collect like terms, identities (square of sum and difference, product of sum-difference, cube of sum and difference), factoring (common factor, term grouping, identities, trinomial). These skills are further decomposed in more simple ones giving a deep domain model of 104 math skills.

For each task, e.g. polynomial multiplication, the tutor traces all the sub-tasks, i.e. monomial multiplications, down to the simplest ones, a feature called *deep model-tracing*. Based on such a detailed domain model and the deep model tracing feature, the tutor keeps a detailed student model: all user interactions with the interface are recorded in a database so that they can be re-traced at any time. In the same time, a percentage of the correct performances of the tutored math skills is calculated and time-stamped, thus recording skill mastery over time for all skills present in an exercise, a feature called *broad knowledge tracing*. The tutor uses intelligent parsing of the expression to identify which of the above operations are present. Therefore it can tutor any expression that contains only the above operations. This feature is called *dynamic task recognition*.

The MATHESIS algebra tutor is implemented as a target tutor for the MATHESIS project which aims at the development of authoring tools for reusable model-tracing math tutors using Semantic Web Technologies such as OWL ontologies and Semantic Web Services. It has been implemented using dynamic HTML for the interface and JavaScript for the domain and tutoring models. The primary interface element is Design Science's WebEq Input Control applet, a scriptable editor for displaying and editing mathematical expressions.

References

- [1] D. Sklavakis, I. Refanidis, An Individualized Web-Based Algebra Tutor Based on Dynamic Deep Model Tracing, Proceedings of the 5th Hellenic Conference on Artificial Intelligence (SETN '08), LNAI vol. 5138, 389-394, Springer, Berlin/Heidelberg, 2008.

¹ See demo at <http://users.uom.gr/~dsklavakis/en/mathesis/aied2009/IE/index.htm>

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